
TECNOLOGIA

SEMINARIO INTERNACIONAL SOBRE MANEJO Y

TRATAMIENTO DE DESECHOS SOLIDOS INDUSTRIALES

EN AMERICA CENTRAL

PROYECTO ICAITI - GTZ

PROTECCION AMBIENTAL DE LOS CENTROS
URBANOS DE CENTROAMERICA

ANTIGUA, GUATEMALA
27 a 31 Mayo de 1985

INSTITUTO CENTROAMERICANO
INVESTIGACION Y TECNOLOGIA INDUSTRIAL

(ICAITI)

PROLOGO

El Insituto Centroamericano de Investigación y Tecnología Industrial - ICAITI - como parte de las actividades que en el campo de la protección y mejoramiento del medio ambiente realiza, inició en enero de 1984 el proyecto "Protección Ambiental de los Centros Urbanos de Centroamérica", proyecto este último que fue patrocinado por el gobierno de la República Federal de Alemania, a través de la Agencia para la Cooperación Técnica - GTZ - (Deutsche Gesellschaft für Technische Zusammenarbeit).

Dentro de las actividades a desarrollar, como parte integrante del proyecto, se concibió la idea de realizar dos Seminarios a nivel centroamericano, con la participación de expertos alemanes, centroamericanos y del ICAITI. Dichos Seminarios fueron realizados en la ciudad de Antigua Guatemala en el mes de noviembre de 1984 y mayo de 1985. Sobre los tópicos de: Desechos Líquidos y Sólidos respectivamente.

Toda la información pertinente a dichos Seminarios se presenta en dos publicaciones bajo los títulos de: Seminario Internacional sobre el Manejo y Tratamiento de Desechos Líquidos Industriales en Centroamérica" y "Seminario Internacional sobre el Manejo y Tratamiento de Desechos Sólidos Industriales en Centroamérica".

La presente publicación se refiere al Seminario sobre Desechos Sólidos.

CONTENIDO

INSTITUTO CENTROAMERICANO DE
INVESTIGACION Y TECNOLOGIA INDUSTRIAL
(ICAITI)

CENTRAL AMERICAN RESEARCH INSTITUTE FOR INDUSTRY
Avenida La Reforma 4-47, Zona 10
GUATEMALA, C. A.

COSTA RICA
EL SALVADOR
GUATEMALA
HONDURAS
NICARAGUA

APARTADO POSTAL 1552
Cables: ICAITI
Telex: 5312-ICAITI-GU
TELEFONOS: 310631 y 317466

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SEMINARIO INTERNACIONAL SOBRE EL MANEJO Y TRATAMIENTO DE DESECHOS SOLIDOS INDUSTRIALES EN CENTROAMERICA

(International Seminar on Industrial Solid Waste Management)

Hotel Ramada - Antigua
Antigua, Guatemala

27 - 31 mayo, 1985

Auspiciado por:

REPUBLICA FEDERAL DE ALEMANIA A TRAVES
DE LA
DEUTSCHE GESELLSCHAFT FUR TECHNISCHE ZUSAMMENARBEIT
(GTZ)

COMO PARTE DEL PROYECTO

"PROTECCION AMBIENTAL DE LOS CENTROS URBANOS DE CENTROAMERICA

Organizado por

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INVESTIGACION Y TECNOLOGIA INDUSTRIAL
(ICAITI)

CENTRAL AMERICAN RESEARCH INSTITUTE FOR INDUSTRY
Avenida La Reforma 4-47, Zona 10
GUATEMALA, C. A.

COSTA RICA
EL SALVADOR
GUATEMALA
HONDURAS
NICARAGUA

Apartado Postal 155
Telex: 5312 ICAITI-GU
Teléfonos: 310631/5
Cables: ICAITI

PROGRAMA

LUNES 27 (mañana)	Moderador - Lic. J. Fernando Mazariegos, ICAITI
8:30 - 10:00	Registro Participantes
10:00 - 10:50	Acto de Inauguración (Programa Separado)
10:50 - 11:30	Café
11:30 - 12:00	"Manejo de desechos sólidos en el campo de la cooperación técnica internacional". Lic. Aura Noemí Ruiz de Archila ICAITI
12:00 - 13:00	Discusión sobre el tema: "Qué puede esperar Centroamérica de la transferencia de tecnología de expertos alemanes en el manejo y disposición de desechos sólidos". Dr. Peter Kolbusch Alemania
13:00 - 15:00	Receso
LUNES 27 (tarde)	Moderador: Lic. Tomás Prieto, ICAITI Lic. Julia Alicia de Zeissig, ICAITI
15:00 - 15:30	"Manejo de los desechos sólidos en la ciudad de Managua". Ing. Víctor Vega Junta de Reconstrucción, Managua
15:30 - 16:00	"Manejo de los desechos sólidos en la ciudad de Guatemala, Aspectos legales y administrativos". Lic. Francisco Way Municipalidad de Guatemala

16:00 - 16:30	"Manejo de los desechos sólidos en las ciudades de Tegucigalpa y San Pedro Sula". Ing. Jorge Rodríguez Municipalidad de Tegucigalpa
16:30 - 16:50	Discusión
16:50 - 17:00	Café
17:00 - 17:30	"Manejo de los desechos sólidos en la ciudad de San Salvador". Ing. Rafael Salvador Miranda Municipalidad de El Salvador
17:30 - 18:00	"Manejo de los desechos sólidos en la ciudad de San José". Ing. Mario Gomar Municipalidad de San José
18:00 - 18:15	Discusión

<u>MARTES 28 (mañana)</u>

Moderador: Dr. César Barrientos
Lic. Francisco Way
Municipalidad de Guatemala

8:30 - 9:00	"Aspectos generales sobre el manejo de desechos industriales (con énfasis en leyes y reglamentos)". Dr. J. Orlich Alemania
9:00 - 9:30	"Reciclaje de desechos sólidos". Dr. Peter Kolbusch Alemania

9:30 - 10:00	"Manejo de los lodos primarios procedentes del tratamiento de aguas de desecho industrial". Dr. K. Pöppinghaus Alemania
10:00 - 10:20	Discusión
10:20 - 10:30	Café
10:30 - 11:00	"Situación actual de las técnicas fundamentales para el manejo de desechos sólidos municipales" Dr. O. Sillah Alemania
11:00 - 11:30	"Manejo de desechos industriales peligrosos". Dr. H. Sutter Alemania
11:30 - 12:00	Discusión
12:00 - 14:00	Receso

MARTES 28 (tarde)

Moderadores: Lic. Aura Noemí Ruiz de Archila
Lic. Enrique Hernández
ICAITI

Exposición de los objetivos de los diferentes grupos de trabajo.

14:00 - 14:10	"Aspectos legislativos en el manejo de desechos sólidos". Dr. J. Orlich Alemania

14:10 - 14:20	"Reciclaje de desechos sólidos". Dr. P. Kolbusch Alemania
14:20 - 14:30	"Tratamiento de los lodos primarios procedentes de la industria". Dr. K. Pöppinghaus Alemania
14:30 - 14:40	"Técnicas básicas para el manejo de desechos sólidos". Dr. O. Sillah Alemania
14:40 - 14:50	"Manejo de los desechos industriales peligrosos". Dr. H. Sutter Alemania
14:50 - 15:10	Organización de los grupos de trabajo y discusión.
15:10 - 15:30	Café
15:30 - 17:00	Taller (Discusión en paralelo de los temas en cada grupo de trabajo).

Los temas a tratarse serán, bajo la forma de casos, los siguientes:

- Legislación
  Dr. Orlich
- Reciclaje
  Dr. Kolbusch
- Tratamiento de lodos primarios
  Dr. Pöppinghaus
- Métodos básicos para el manejo de desechos sólidos
  Dr. O. Sillah
- Desechos Peligrosos
  Dr. H. Sutter

Los casos presentados se discutirán con el propósito de formular soluciones adecuadas para Centro América.

MIERCOLES 29 (mañana) — Moderadores: Dr. Orlich, Dr. Kolbusch, Alemania

8:30 - 9:00 "Situación actual del manejo de desechos sólido industriales en Centroamérica".

Lic. Julia Alicia de Zeissig
ICAITI

9:00 - 9:30 "Revisión de la legislación sobre manejo de los desechos sólidos en Costa Rica".

Ing. Andrés Inser
Ministerio de Salud, Costa Rica

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INVESTIGACION Y TECNOLOGIA INDUSTRIAL
(ICAITI)

CENTRAL AMERICAN RESEARCH INSTITUTE FOR INDUSTRY
Avenida La Reforma 4-47, Zona 10
GUATEMALA, C. A.

COSTA RICA
EL SALVADOR
GUATEMALA
HONDURAS
NICARAGUA

APARTADO POSTAL 1552
Cables: ICAITI
Telex: 5312-ICAITI-GU
TELEFONOS: 310631 y 317466

9:30 - 10:00	"Revisión de la legislación sobre manejo de los desechos sólidos en El Salvador". Ing. Oscar A. Escobar Ministerio de Salud Pública, El Salvador
10:00 - 10:20	Discusión
10:20 - 10:30	Café
10:30 - 11:00	"Revisión de la legislación sobre manejo de los desechos sólidos en Honduras". Ing. Amelia Santos Ministerio de Salud Pública, Honduras
11:00 - 11:30	"Problemas actuales y soluciones previstas en el manejo y disposición de los desechos sólidos en Guatemala". Dr. César Barrientos Municipalidad de Guatemala
11:30 - 12:00	"Revisión de la legislación sobre manejo de desechos sólidos en Nicaragua". Ing. Eduardo Caldera IRENA - Nicaragua
12:00 - 12:30	Discusión
12:30 - 14:30	Receso

MIERCOLES 29 (tarde)

14:30 - 17:00	Reunión de grupos de trabajo (Discusión en cada grupo)

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GUATEMALA, C. A.

COSTA RICA
EL SALVADOR
GUATEMALA
HONDURAS
NICARAGUA

APARTADO POSTAL 1552
Cables: ICAITI
Telex: 5312-ICAITI-GU
TELEFONOS: 310631 y
317466

JUEVES 30 (mañana)	Moderadores:	Ing. Andrés Inser, Costa Rica Ing. Eduardo Caldera, Nicaragua

8:30 - 9:00	"Disposición de desechos sólidos procedentes de la industria de Centro América". Lic. Enrique Hernández ICAITI
9:00 - 9:30	"Pretratamiento de los desechos sólidos industriales". (Sistemas no térmicos). Dr. O. Sillah Alemania
9:30 - 10:00	"Tratamientos térmicos de desechos sólidos". (Ventajas y limitaciones). Dr. P. Kolbusch Alemania
10:00 - 10:20	Discusión
10:20 - 10:30	Café
10:30 - 11:00	"Investigación sobre el empleo de procesos biotecnológicos para el aprovechamiento de subproductos agrícolas". Ing. Carlos Rolz ICAITI
11:00 - 11:30	"Remoción del agua en los lodos primarios industriales". Dr. K. Pöppinghaus Alemania
11:30 - 12:00	"Tratamiento de los residuos industriales que más afectan los sistemas ecológicos". Dr. H. Sutter Alemania

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INVESTIGACION Y TECNOLOGIA INDUSTRIAL
(ICAITI)

CENTRAL AMERICAN RESEARCH INSTITUTE FOR INDUSTRY
Avenida La Reforma 4-47, Zona 10
GUATEMALA, C. A.

COSTA RICA
EL SALVADOR
GUATEMALA
HONDURAS
NICARAGUA

APARTADO POSTAL 1552
Cables: ICAITI
Telex: 5312-ICAITI-GU
TELEFONOS: 310631 y 317466

12:00 - 12:30	Discusión
12:30 - 14:30	Receso

JUEVES 30 (tarde)

14:30 - 16:00	Reunión de Grupos de Trabajo (preparación de resultados y conclusiones)
16:00 - 17:00	Reunión plenaria. (presentación de resultados y conclusiones de cada grupo de trabajo).
17:00 - 17:30	Discusión final

VIERNES 31 (mañana) — Moderadores: Ing. Jorge Rodríguez, Honduras; Ing. Rafael Salvador Miranda, El Salv

8:30 - 9:00	"Perspectivas y limitaciones técnicas, ecnómicas y legislativas en el manejo de desechos sólidos con especial hincapie en la reducción y reciclaje de los desechos". Dr. J. Orlich Alemania
9:00 - 9:30	"La protección ambiental y el manejo de desechos sólidos". Lic. Tomás Prieto ICAITI
9:30 - 10:00	"Requisitos para una legislación adecuada de manejo de desechos en Centro América". Dr. P. Kolbusch Alemania

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(ICAITI)

CENTRAL AMERICAN RESEARCH INSTITUTE FOR INDUSTRY
Avenida La Reforma 4-47, Zona 10
GUATEMALA, C. A.

COSTA RICA
EL SALVADOR
GUATEMALA
HONDURAS
NICARAGUA

APARTADO POSTAL 1552
Cables: ICAITI
Telex: 5312-ICAITI-GU
TELEFONOS: 310631 y 317466

10:00 - 10:20	Discusión
10:20 - 11:00	"Resoluciones propuestas del Seminario para los Gobiernos de Centro América en el manejo de desechos sólidos (Conclusiones de los Grupos de Trabajo). Lic. Enrique Hernández Lic. Julia Alicia de Zeissig ICAITI
11:00 - 11:15	Café
11:15 - 11:45	Clausura Lic. Francisco Aguirre B. Director ICAITI

LISTA DE PARTICIPANTES

ALEMANIA

- Dr. Klaus Kemp
  Manager
  GTZ
  Eschborn
  FEDERAL REPUBLIC OF GERMANY

- Dr. Peter Kolbusch
  GTZ
  FEDERAL REPUBLIC OF GERMANY

- Dr. J. Orlich
  Head of Division
  Federal Enrionment Agency
  Bismarch Platz 1
  D-1000 Berlin 33
  FEDERAL REPUBLIC OF GERMANY

- Dr. Klaus Pöppinghaus
  GTZ
  FEDERAL REPUBLIC OF GERMANY

- Dr. Ousman Sillah
  Assitent
  INTERATOM
  Bergisca Gladbach
  FEDERAL REPUBLIC OF GERMANY

- Dr. Hans Sutter
  W. Division
  Federal Protection Agency
  1 Berlin 33
  FEDERAL REPUBLIC OF GERMANY

COSTA RICA

- Edgar Ortíz Castro
  Asesor Sanitario
  Acueductos y Alcantarillado
  SAN JOSE, COSTA RICA

- Mario Rodolfo Gomar Antolinez
  Director Salbridad de San José
  Municipalidad de San José
  Apartado Postal 277
  SAN JOSE, COSTA RICA

- Luis J. Montejo Madriz
  Superintendente de Mantenimiento
  Industria Nacional de Cemento, S.A.
  4009-1000 SAN JOSE, COSTA RICA

- Alexis Rodríguez Ulloa
  Profesor Investigador
  Universidad de Costa Rica
  Centro de Investigaciones en Contaminación Ambiental
  Escuela de Química
  SAN JOSE, COSTA RICA

EL SALVADOR

- Oscar Alejandro Escobar
  Colaborador Técnico
  División de Saneamiento
  Ministerio de Salud Pública y Asistencia Social
  Calle Arce
  SAN SALVADOR, EL SALVADOR

- Luis Miguel Alirio Herrera
  Jefe Departamento Técnico
  Cartotecnica Centroamericana
  27½ Km Carretera a Santa Ana
  EL SALVADOR

- Ana María Jerez
  Colaborador Técnico Gerencia de Saneamiento
  Alcaldía Municipal de San Salvador
  Final Calle 5 de Noviembre #1334
  SAN SALVADOR, EL SALVADOR

- Salvador Rafael Miranda
  Jefe Departamento
  Alcaldía Municipal de San Salvador
  Final Calle Concepción #188
  SAN SALVADOR, EL SALVADOR

GUATEMALA

- Lic. Francisco Aguirre B.
  Director
  ICAITI
  Avenida Reforma 4-47, zona 10
  Guatemala

- Lic. Aura Noemí R. de Archila
  ICAITI
  Avenida Reforma 4-47, zona 10
  GUATEMALA

- Ing. Luis Arriagada
  Sub Gerente Control Técnico
  CELGUSA
  El Rancho, Progreso
  GUATEMALA

- Ing. Jeannette Barrios
  Supervisor Control Ambiental Pérdidas
  CELGUSA
  El Rancho, Progreso
  GUATEMALA

- Dr. César Barrientos
  Jefe
  Programa del Medio Ambiente
  Municipalidad de Guatemala
  Centro Cívico, zona 1
  GUATEMALA

- Rafael Castro M.
  Asesor Admon.
  Municipalidad de Guatemala
  Centro Cívico, zona 1
  GUATEMALA

- Oscar Manuel Cóbar Pinto
  Vocal I
  Colegio de Químicos y Farmacéuticos de Guatemala
  4a. calle 2-73, zona 1

- Dr. Juan de Dios Calle
  Supervisor Gral.
  Servicio Cont. Técnico
  CELGUSA
  El Rancho, Progreso
  GUATEMALA

- Carmen Rosa de León
  Encargada Apoyo Social
  Programa del Medio Ambiente
  Municipalidad de Guatemala
  Centro Cívico, 6° nivel, zona 1
  GUATEMALA

- Miguel Cecilio García Rojas
  Supervisor Saneamiento
  División de Saneamiento del Medio
  2a. avenida 0-61, zona 10
  GUATEMALA

- Wolfgang Gómez
  Asesor
  Municipalidad de Guatemala
  Centro Cívico, zona 1
  GUATEMALA

- Hugo Leonel García Montenegro
  Jefe del Departamento de Estudios y Proyectos de Obras Públicas
  Dirección General de Obras Públicas
  10a. calle 9-37, zona 1
  GUATEMALA

- Ricardo Gramajo
  Asistente de la Dirección de Servicios Públicos
  Municipalidad de Guatemala
  Centro Cívico, zona 1
  GUATEMALA

- Luis Felipe Herrera A.
  Jefe Departamento
  Saneamiento del Medio / Salud Pública
  2a. avenida 0-61, zona 10
  GUATEMALA

- Carlos Hernández
  Coordinador Residuos Sólidos
  Programa Medio Ambiente
  Municipalidad de Guatemala
  Centro Cívico, zona 1
  GUATEMALA

- Lic. Enrique Hernández
  ICAITI
  Avenida Reforma 4-47, zona 10
  GUATEMALA

- Lic. Fernando Mazariegos
  Jefe, División Análisis, Pruebas y Ensayos
  ICAITI
  Avenida Reforma 4-47, zona 10
  GUATEMALA

- Hugo Leonel Marroquín
  Insp. Saneamiento Ambiental
  Jefatura de Salud Area Guatemala Sur
  Ministerio de Salud Pública
  40 calle "A" 3-49, zona 8
  GUATEMALA

- Ileana de Ordóñez
  Asesora Legal
  Municipalidad de Guatemala
  Centro Cívico, zona 1
  GUATEMALA

- Lic. Tomás Prieto P.
  ICAITI
  Avenida Reforma 4-47, zona 10
  GUATEMALA

- Ing. Carlos Porres
  División Investigación Aplicada
  ICAITI
  Avenida Reforma 4-47, zona 10
  GUATEMALA

- Ing. Carlos Rolz
  Jefe, División Investigación Aplicada
  ICAITI
  Avenida Reforma 4-47, zona 10
  GUATEMALA

- Carlos Raúl Reyes
  Jefe Departamento de Limpieza
  Municipalidad de Guatemala
  Centro Cívico, zona 1
  GUATEMALA

- Giovanni Reyes
  Director Depto. Ingeniería Agrícola
  Universidad Rafael Landívar
  Vista Hermosa III, zona 16
  GUATEMALA

- Lic. Noe Adalberto Ventura L.
  Asesor
  Comisión Asesora del Presidente de la Comisión Ministerial Encargada de la Conservación y Mejoramiento Humano
  Ministerio de Gobernación
  14 calle 14-64, zona 1
  GUATEMALA

- Francisco Way M.
  Director de Servicios Públicos
  Municipalidad de Guatemala
  Centro Cívico, zona 1
  GUATEMALA

- Lic. Julia Alicia de Zeissig
  División de Análisis, Pruebas y Ensayos
  ICAITI
  Avenida Reforma 4-47, zona 10
  GUATEMALA

HONDURAS

- Leovigildo Aguilar
  SANAA
  Jefe Alcantarillado Sanitario
  TEGUCIGALPA, D.C., HONDURAS

- José Fernández G.
  Asociación Nacional de Industriales
  TEGUCIGALPA, D.C., HONDURAS

- Jorge Rodríguez
  Concejo Metropolitano D.C.
  TEGUCIGALPA, D.C., HONDURAS

- Amelia Santos
  Ingeniero Civil
  Ministerio de Salud Pública
  TEGUCIGALPA, D.C., HONDURAS

NICARAGUA

- Eduardo J. Caldera
  Dirección de Recursos Naturales y del Ambiente (DIRENA)
  MANAGUA, NICARAGUA

- Francisco Delgado Calderón
  Ministerio de Salud
  Pista La Sabana
  MANAGUA, NICARAGUA

- Mario Garache Castellón
  Cámara de Industrias de Nicaragua
  - CADIN -
  Casa Nazareth 1 Cuadra al Sur y ½ arriba
  MANAGUA, NICARAGUA

- Víctor Vega Meléndez
  Alcaldía de Managua
  Centro Cívico Camilo Ortega Saavedra
  Edificio H. Módulo 113
  MANAGUA, NICARAGUA

- Juan Marvin Moncada S.
  Alcaldía de Managua
  Colonia 10 de junio A-167
  MANAGUA, NICARAGUA

MANEJO DE LOS DESECHOS SOLIDOS EN EL CAMPO DE LA COOPERACION TECNICA INTERNACIONAL

Aura Noemí R. de Archila

SUMMARY

This paper deals with and historical account of efforts made by the Central American countries in cooperation with international organizations to cope with the environ mental contamination problem.

The treatment is general and does not purports to be an in-depth and exhaustive study of the situation.

A more detailed description is given of the ongoing efforts by ICAITI and the GTZ of the Federal Republic of Germany to assess the state of contamination on the urban areas of Central America, mainly the capital cities. These cooperation efforts should result in some positive measures to be taken by the responsible authorities to prevent furtherr deterioration of the environmental in the countries of Central America.

La legislación ambiental guatemalteca, no está organizada sistemáticamente en un código o por una ley, que haga las veces de ley orgánica o de ley cuadro: en sí, pues, es una legislación "Difusa", sus normas se encuentran habitualmente dispersas en una gran variedad de ordenamientos legales; las fuentes de esa legislación, son textos de diversa jerarquía:

Lic. Aura Noemí R. de Archila, División de Análisis, Pruebas y Ensayos, ICAITI.

Países en desarrollo, como los nuestros, que corresponden al área centroamericana, diariamente están sufriendo cambios en todas sus estructuras. Algunos de éstos, son producto de la acción natural, en tanto que otros, vienen motivados por la transferencia cultural a niveles de publicidad y tecnología.

Sobre esa base, es significativo destacar que casi la única forma de medir el desarrollo de estas regiones, es a través de los distintos grados que en cada una de las ciudades y países del área va alcanzando la urbanización de los mismos.

Esto presupone que se continúa centrando la atención del hombre sobre el hombre mismo de manera que, al igual que cuando comenzó a dejar de ser nómada, continúa en la acción de poner en juego toda su capacidad, su creatividad y su pensamiento, en la manera de transformar el medio ambiente en que vive. Y que todavía no se percata de que es él mismo quien a final de cuentas recibirá las acciones de la transformación que realiza.

Cada vez son más complicadas las relaciones políticas, sociales y económicas con las condiciones ambientales en nuestros países del área. Hay regiones en nuestra área, en que la tasa de crecimiento se dice que es del 4,5%, en tanto que en otras, se señala con un 2.2%. Sin embargo en ambos casos, es consecuente el crecimiento demográfico, y con éste el aumento de necesidades de la población.

Sin contar con los elementos científicos-tecnológicos, esta demografía en contínua expansión, puede llegar a agotar los recursos ambientales, en otras palabras a la total destrucción de los sistemas ecológicos.

Resulta imposible mejorar el medio ambiente sin una buena economía, pero tampoco es posible mejorar la economía sin recursos naturales protegidos o no y sin un medio ambiente sano.

Los desechos sólidos, que no son otra cosa más que las distintas formas de basura doméstica y de todos los desperdicios sólidos que provienen de actividades comerciales e industriales que se desarrollan dentro del contexto urbano, también son consecuencia del mismo crecimiento demográfico y de la misma demanda de la población, constituyendo una muestra de lo complejo que son las interacciones entre los recursos naturales, el medio ambiente, la población y el progreso económico.

Antiguamente la protección del medio ambiente y el progreso industrial, se consideraron dos actividades humanas independientes, pero estudios de la contaminación ambiental en los países desarrollados, han obligado a cambiar este enfoque de tal manera que hoy día se consideran interdependientes, a tal grado que las inversiones de capitales que propenden el progreso económico e industrial, hoy por hoy, se planifican de una manera global, ésto es tomando en cuenta un prudente uso de los recursos y una estabilidad ecológica que además de mantener vivo el habitat, resulte rentable y económicamente viable.

Es entonces en los países desarrollados industrialmente donde aparecen los primeros síntomas de alarmante contaminación, y son ellos, quienes dentro del mismo contexto de desarrollo tecnológico, encuentran las primeras armas para el cambate de la contaminación. Sin embargo, durante la investigación se dan cuenta que la acción contaminadora iniciada involuntariamente en sus propios países, se dispersa a ritmo acelerado y cada vez va adquiriendo dimensiones mayores temiéndose una pandemia del globo terrestre. Conscientes de este avance, vuelven sus ojos a las instituciones internacionales y es así como Suecia en Julio de 1968 toma la iniciativa y formula una petición concreta a las Naciones Unidas para que se desarrolle una conferencia sobre el Medio Humano.

Sobre las bases de lo expuesto por Suecia en su solicitud, la Asamble General de las Naciones Unidas en diciembre de 1968, acepta el contenido del mismo y convoca a una reunión de las Naciones Unidas para el año de 1972.

Las diferentes publicaciones acerca del deterioro ecológico en distintas regiones del mundo, concientizan a distintos hombres de ciencia del Area Centroamericana, esta concientización se hace evidente cuando en Guatemala, durante los días 8, 9, y 10 de febrero de 1971, bajo el patrocinio de la Facultad de Ingeniería de la Universidad de San Carlos, con participación directa de la Escuela Regional de Ingeniería Sanitaria (ERIS), El Consejo Superior Universitario Centroamericano (CSUCA), La Oficina Regional para Centroamérica y Panamá (ROCAP) y la Oficina Sanitaria Panamericana (OPS/OMS), se realiza un Simposio sobre Problemas de Contaminación del Ambiente Urbano.

Luego, bajo los auspicios del Ministerio de Salud Pública y Asistencia Social y con la colaboración de distintas organizaciones nacionales y representantes de organismos internacionales se realizan dos seminarios sobre saneamiento del ambiente, el primero en diciembre de 1974 y el segundo en julio de 1975.

En el plano internacional, indudablemente organizaciones como OMS/OPS, FAO, ROCAP y otras similares han brindado su colaboración y su asistencia técnica para la conservación, preservación, y mejor uso del medio ambiente en distintas regiones del mundo. Sin embargo, parece ser que toda acción humana es incidente con el medio ambiente, y desde este punto de vista, las evaluaciones únicamente permiten recomendar cómo se hacen menores daños a los ecosistemas, pero no señalan formas que dejen intactos los mismos, de tal manera que el cambio de los habitat será acelerado o desacelerado en relación con la tecnología que se utilice.

Una de las instituciones internacionales que contribuye significativamente a la protección ambiental, es la Organización de las Naciones Unidas para el Desarrollo Industrial (ONUDI), ya que según se lee en su informe decenal, editado por las Naciones Unidas en 1983, esta institución ha realizado estudios sobre el medio ambiente en los cinco continentes, ha prestado asistencia técnica para la antidesetilficación, la producción de biogas, la producción de compost, la forma de utilizar los desechos orgánicos como combustibles y fertilizantes. Esto, además de una serie de estudios sectoriales y la presentación de las espectativas en actividades que para el futuro tiene programadas sobre el uso de los desechos sólidos.

En la Síntesis Histórica que hace parte del Estudio del Plan de Recolección y Tratamiento Final de Desechos sólidos, publicado por la Municipalidad de Guatemala, en el año de 1976, se señale que al rededor del año 1879, "las autoridades del Municipio de Guatemala, dispusieron la incineración de basuras en el Crematorio que para el efecto se construyó en la 7a. Calle final de la zona 1". También se dice que "la actual División de limpieza de la Municipalidad de Guatemala se inició en la misma época y que el crematorio en mención funcionó como tal hasta el año de 1969". Esta misma reseña hace ver que "por los años de 1950 se dispuso depositar las basuras en el barranco situado al final de la 30 calle de la zona 3 con lo cual se trató de construir el primer relleno sanitario de la ciudad, el cual sin todas las características de caso, continúa haciéndose".

Por su parte, el Instituto Centroamericano de Investigación y Tecnología Industrial (ICAITI) cuya misión es la del adelanto científico y tecnológico del área, ha puesto mucho interés en los problemas de contaminación ambiental de la misma, interés que se ha canalizado desde hace tiempo, en diferentes seminarios y elaboración de proyectos, en colaboración con entidades como: La Academia Nacional de Ciencias de los Estados Unidos de Norte América, del Instituto de Investigaciones de Denver (DRI), la Dirección General de Recursos Naturales Renovables de la República de El Salvador, El Programa de las Naciones Unidas para el Medio Ambiente, la Oficina Regional para Centroamérica y Panamá (ROCAP) y otros.

En la actualidad, el ICAITI, auspiciado por la GTZ de la República Federal de Alemania, está desarrollando el proyecto "Protección Ambiental de las capitales de Centroamérica".

Dicho proyecto se inició con la elaboración de las ideas básicas del mismo, las cuales, fueron presentadas a funcionarios de la GTZ. Luego, a través el Ministerio de Relaciones Exteriores se envió el primer papel conceptual del proyecto a la Embajada de Alemania en Guatemala, quien transmitió el documento al Gobierno de su país.

Luego, después de la preparación de la propuesta, se realizó una evaluación a nivel centroamericano, la cual fué llevada a cabo por expertos de Alemania Federal que fueron destacados a Centro América para investigar la posibilidad de cooperar en el proyecto con ICAITI.

Esta misión, fue formada por el Dr. Kolbusch y el Dr. Orlich, quienes presentaron un informe preliminar sobre agua y desechos sólidos, en el cual, señalan entre otros datos que, tanto en Guatemala, como en San José C. R., San Salvador y Tegucigalpa, la recolección y transporte de desechos sólidos, así como también la limpieza de las calles y los mercados, eran efectuados por las municipalidades respectivas. Indican también la ubicación de los depósitos centrales de desechos sólidos en cada ciudad, con la observación de que ninguno tiene sellado básico ni control de drenajes de agua. Mencionan también la existencia de muchos depósitos pequeños de basura en el área urbana.

Señalan además que: en el basurero central de Guatemala existen quemazones sin control y pequeños incendios. Que cientos de personas, perros, buitres etc., se mantienen cerca de ese basurero y que emana un olor penetrante, así como algunas características propias de cada uno de los basureros centrales de los otros países.

Fue en el año 1983, después de una visita a los organismos coordinadores en Alemania, que se estableció en definitiva el plan de acción del proyecto.

A partir de Enero de 1984, los expertos de ICAITI realizaron un entrenamiento en técnicas de protección ambiental en la Republica Federal de Alemania.

Hemos recibido además la asistencia técnica por parte de los expertos alemanes, de GTZ quienes han brindado asesoría al proyecto, por períodos cortos de tiempo, de acuerdo a las necesidades del mismo, y especializaciones que ellos tienen.

Se firmaron acuerdos de cooperación y coordinación con entidades centroamericanas que colaboran con el ICAITI en el desarrollo de este proyecto.

Se han realizado encuestas sobre desechos industriales en Guatemala, San Pedro Sula, Tegucigalpa, y San José de Costa Rica.

Siempre dentro de las actividades internacionales de cooperación técnica sobre el manejo de desechos sólidos, dentro del Proyecto "Protección Ambiental de los Centros Urbanos de Centroamérica", anteriormente mencionado, se encuentra la Organización de Seminarios como el que se está realizando actualmente y que al reunir personalidades del area centroamericana y de Alemania Federal, no dudamos que serán de un beneficio real y positivo para en el futuro resolver de una manera eficaz nuestros problemas de contaminación.

ADMINISTRACION, DISPOSICION Y MANEJO DE LOS DESECHOS SOLIDOS EN LA CIUDAD DE MANAGUA

Víctor Vega Meléndez

SUMMARY

An overall view of the handling of solid wastes in the city of Managua is given. A detailed description of the main sources of wastes is presented and the problems to be dealt with are identified. All types and sources of solid wastes are included and, where pertinent, the problems and deficiencies in the disposal systems are analyzed.

The role of Municipality of Managua in waste disposal is described as well as the equipment available and the systems in operation. The inadequacy some sanitary landfills is pintpointed and recommendations are offered to solve problems on a short and long term basis.

The paper is illustrated with many tables to document the presente situation.

INTRODUCCION

La ciudad capital de Managua está ubicada en una cuenca hidrológica cerrada, a orillas del lago Xolotlán, fué destruida totalmente por los terremotos de 1931 y 1972 y parcialmente en 1979, por la dictadura militar somocista. Su configuración actual, vestigio del sismo de 1972, se sitúa alrededor de lo que fue el centro urbano de la ciudad, con prolongación al este y oeste formando dos polos densamente poblados. La superficie del -

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Ing. Víctor Vega Meléndez, Junta de Reconstrucción, Managua, Nicaragua.

área urbana es de 17.826 hectareas, ocupada en la actualidad por una población de 800,000 habitantes, sus vías de acceso de mayor importancia - que la comunica con el resto del país, son las carreteras norte, sur y - este e internamente por pistas de circunvalación que agiliza su movimiento vial.

El sistema de limpieza de la ciudad de Manuagua, antes del triunfo de la revolución popular sandinista, estaba a cargo del Ministerio del Distrito Nacional, cuyo servicio en general, era ineficiente, debido a que se priorizaban las zonas residenciales. Los recursos humanos eran pocos, - no existía un sistema estadístico que cuatificara el servicio, además, la dictadura no se interesaba por el ornato de la ciudad, ni por la contaminación del ambiente, con los consecuentes perjuicios que ello produce en la salud de la población. Hoy, nuestro gobierno revolucionario considera este problema con alta prioridad dentro del desenvolvimiento de la esfera socio-económica del país.

Siendo la alcaldía de Managua la que dentro de su composición orgánica y bajo la Dirección de Servicios Municipales y del Departamento de Ingeniería Sanitaria esta a cargo del sistema de limpieza y de los subsistemas de recolección, transporte, barrido de calles, disposición y tratamiento final de los desechos sólidos, para garantizar la higiene y la sanidad ambiental de la comunidad. Pese a esto, el crecimiento poblacional y la generación de basura per capita de 0.5 KG/día, se ha manifestado como un factor determinante para buscar elementos de juicio que determinen métodos organizativos bajo una planificación científica, como es el uso de la programación de los recursos que nuestra austeridad económica permita, a fin de dar un servicio eficiente y - cuantificable a toda la ciudad capital. A fin de reducir infecto-contagiosas elevando el nivel de salud de la población, a fin de proporcionar un manejo adecuado de los desechos sólidos para disminuir la - contaminación ambiental, a fin de mejorar el servicio de limpieza ampliando su cobertura, a fin de cambiar la actual disposición final de la basura para contribuir al programa de salvación del lago Xolotlan, a fin de implementar el relleno sanitario en el tratamiento de los desechos sólidos.

SUB-SISTEMA DE ALMACENAMIENTO

El almacenamiento consiste en depositar los desechos sólidos en diferentes tipos de recipientes. Estos desechos son originados en lugares que tienen sus propias características en función de las actividades - que se realizan. Se clasifican en:

1) Alm. Domiciliar

2) Alm. Industrial

CUADRO I-1

PROYECTO SISTEMA DE LIMPIEZA DE LA CIUDAD DE MANAGUA
RECIPIENTES USADOS EN EL ALMACENAMIENTO DE DESECHOS
SOLIDOS EN LA CIUDAD DE MANAGUA Y SU PORCENTAJE

TIPOS DE RECIPIENTES		% DE RECIPIENTES
BARRIL		10.56
1/2 BARRIL		6.46
LATAS		22.14
BALDE METALICO		3.25
BALDE PLASTICO		6.61
BOLSA PLASTICA	(5 LBS.)	5.90
BOLSA PLASTICA	(25 LBS.)	7.01
BOLSA PLASTICA	(50 LBS.)	4.25
BOLSA DE PAPEL	(5 LBS.)	0.85
BOLSAS DE PAPEL	(25 LBS.)	0.82
BOLSAS DE PAPEL	(50 LBS.)	1.464
CAJA DE CARTON	(10 LBS.)	3.34
CAJA DE CARTON	(20 LBS.)	1.28
CAJA DE CARTON	(50 LBS.)	0.042
SACOS MACEN		19.47
TINA METALICA		1.52
PORRAS		1.17
CANASTOS		0.82
CESTOS		0.44
TARROS		0.10
CAJA DE MADERA		0.52
CAJA DE PLASTICO		1.90
CAJAS METALICAS		0.084

FUENTE: UNIDAD DE DESECHOS SOLIDOS (JRM) 1983

CUADRO V-1

PROYECTO: SISTEMA DE LIMPIEZA DE LA CIUDAD DE MANAGUA
TIPOS DE RECEPTACULOS UTILIZADOS EN EL ALMACENAMIENTO DOMICILIAR

TIPO DE RECIPIENTES	CANTIDADES	PARTICIPACION %	OBSERVACIONES:
SACOS MACEN	436	35.4	OBSERVAMOS QUE EL TIPO DE RECEPTACULOS MAS UTILIZADOS ES EL SACO MACEN QUE TIENE DIFERENTE TAMAÑO, SEGUIDOS POR LATAS, NO OBSTANTE, ACLARAMOS QUE ALREDEDOR DE UN 15% DE RECIPIENTES NO FUERON CONTABILIZADOS POR SER SACADOS POR LOS USUARIOS.
LATAS	280	23.	
BALDES PLASTICOS	140	11.3	
BARRILES DE 55 GALONES	95	8.	
1/2 BARRILES	80	6.4	
BOLSAS PLASTICAS	65	5.2	
CANASTOS	55	4.4	
CAJAS DE CARTON	50	4.	
CAJAS DE MADERA	30	2.4	
TOTAL	1,231	100	

FUENTE: ELABORACION PROPIA DEL GRUPO DE TRABAJO

3) Alm. en Mercados
4) Alm. de Hospitales
5) Alm, Comercial e Institucional

Alm. Domiciliar:

La recepción de la basura varía de acuerdo a las posibilidades económicas de cada familia, esto quiere decir que existe una gran cantidad de recipientes con desechos provenientes de los domicilios. Tal como se presenta a continuación en el cuadro I-1 donde se observa lo siguiente:

En el año 1983 los recipientes más usados fueron los de latas representado el 22.14%, seguido de los sacos con el 19.47% y las bolsas plásticas de diferente capacidad con un porcentaje del 17.16% y el barril con el 10.56%, representado casi el 70%, estos 4 recipientes; los restantes son medios barriles, baldes plásticos y metálicos, bolsas de papel, cajas de cartón, madera, metálicas y plásticos, tarros, cestas y porras.

Actualmente predominan los sacos macen 34.47%, latas 23%, baldes plásticos 11.3% y barriles 8% observándose gradualmente el desplazamiento de la bolsa plástica y el incremento de los sacos macen. Ver cuadro V-1

Predominando los desperdicios de alimentos con el 52.61%, desperdicios de jardínes 20.58%, papeles y cartón el 10.49%, plásticos el 6.11%, los restantes son tierra, textiles, metales, vidrios, hules y cueros y maderas.

Los recipientes especiales llamados containers de $1.5 m^3$ de capacidad se encuentran en su gran mayoría de servicio por falta de repuestos en las unidades recolectoras diseñadas para este fin.

Alm. Industrial:

Los desechos generados son de tipo tóxico por lo que su disposición la efectúa la empresa en recipientes especiales como barriles de 55 galones y containers que a la vez sirven para el almacenamiento de los desechos provenientes de las oficinas.

Alm. en Mercados:

Los desechos que aquí se generan en su mayoría son productos perecederos, desperdicios de alimentos, papeles y bolsas plásticas, hojas y son almacenados en barriles de $0.20 m^3$, 1/2 barriles de $0.10 m^3$, containers de 1.50 m y bolsas plásticas de 0.10 m (ver cuadro I-3).

CUADRO I-2

PROYECTOS: SISTEMA DE LIMPIEZA DE LA CIUDAD DE MANAGUA

COMPOSICION FISICA DE LA BASURA

DESCRIPCION	PORCENTAJES (%)	
DESPERDICIOS DE ALIMENTOS	52.61	*
DESPERDICIOS DE JARDIN	20.58	*
PAPELES Y CARTON	10.49	*
PLASTICOS	6.11	
TIERRA	3.90	
TEXTILES	2.59	
METALES	1.18	
VIDRIOS	1.00	
HULES	0.63	
CUEROS	0.46	
MADERAS	0.43	

FUENTE: UNIDAD DE DESECHOS SOLIDOS (JRM)

* : BASURA CUYA COMPOSICION FISICA TIENEN UN ALTO PORCENTAJE

Alm. de Hospitales

Los desechos hospitalarios contienen elementos infectantes por lo que se tienen que manejar con el amyor cuidado. Dentro de éstos se pueden considerar los desechos quirúrgicos como gases, hilos, agujas, jeringas y restos de extirpaciones quirúrgicas altamente contaminantes, los cuales son incinerados. Además, se encuentran desperdicios provenientes de cocinas, oficinas y bodegas de almacenamiento. Estos desechos son almacenados en barriles y containers y no se mezclan con los desechos de tipo quirúrgico.

Alm. Comercial e Institucional:

Se realiza en bolsas plásticas, baldes plásticos y metálicos, cajas de cartón que son depositadas en barriles y containers. Previo a ésto se recolectan en las papeleras o receptáculos internos.

No existe ninguna norma de almacenamiento que denote el tipo y capacidad de los recipientes a usarse en los domicilios, industrias, comercios, mercados, etc.

La capacidad de los receptáculos es muy variada, lo que influye en el peso de los mismos y su dificultad en la recolección. (Ver cuadro: I-3 y V-2).

SUB-SISTEMA RECOLECCION DOMICILIAR Y TRANSPORTE

El sub-sistema de recolección y transporte forma parte esencial del servicio de limpieza de la ciudad y se presenta a través de la dirección de Servicios Municipales por medio del Departamento de Ingeniería Sanitaria que tiene tres secciones operativas y una administrativa (cuadro I-5).

La sección de limpieza domiciliar se desarrolla en 3 áreas de trabajo.

1) Recolección Domiciliar
2) Recolección de Sectores Varios
3) Recolección Particular

CUADRO I-3

PROYECTO: SISTEMA DE LIMPIEZA DE LA CIUDAD DE MANAGUA

CAPACIDAD DE ALMACENAMIENTO DE LOS DIFERENTES RECIPIENTES

TIPO	CAPACIDAD M^3	NUMERO RECIPIENTES	PORCENTAJE (%)
CONTENEDORES	1.50	240	3.3
BARRILES	0.20	1,070	14.69
MEDIOS BARRILES	0.10	138	2.58
LATAS	0.02	1,663	22.85
BOLSAS PLASTICAS	0.10	2,092	28.73
SACOS	0.15	1,556	21.37
CAJAS	0.10	472	6.48

FUENTE: MEJORAMIENTO DEL SISTEMA JRM 1981

CUADRO V-2

CAPACIDAD DE RECIPIENTES DOMICILIARES UTILIZADOS EN EL AÑO 1984

CAPACIDAD DE RECIPIENTES (LITROS)	CANTIDAD	MODAS 1/	%	O B S E R V A C I O N E S :
5	10		1	SE OBSERVO QUE LA CANTIDAD DE RECI-
10	13		1	PIENTES EN EL PRIMER VIAJE FUE MA-
15	28		3	YOR: PERO LA CANTIDAD DE BASURA EN
20	377	377	41	LOS RECIPIENTES ERA DE UN 80% MIEN-
25	7		1	TRAS QUE EL SEGUNDO VIAJE HABIENDO
30	79		9	MENOR CANTIDAD DE RECIPIENTES, ES-
40	67		7	TOS LLEGAN EN TERMINOS GENERALES A
50	33		4	UN 100% EL TAMAÑO DE LAS DOS PARTES
60	42		5	RECOLECTADAS EN NUMERO DE CASAS ES
80	184	184	20	BASTANTE SIMILAR.
110	22		2	
220	55		6	
150	-		-	

FUENTE: ELABORACION PROPIA DEL GRUPO DE TRABAJO

1 / MODA: CAPACIDAD MAS UTILIZADA

La recolección domiciliar presta servicios aproximadamente a 180 barrios en el área urbana de Managua. Su objetivo es el de evacuar el mayor volumen de M^3 de basura que acumula la población y transportarla al botadero municipal. La recolección domiciliar se realiza por medio de camiones recolectores compactadores marca Mercedez Benz tipo Kuka-Piratininga con capacidad de 11 M^3.

Estos camiones hacen su recorrido por la ciudad que se encuentra dividida en 62 zonas y 6 zona especiales, cumpliendo su actividad diaria en dos turnos, cada camión cuenta con 4 operarios y 1 chofer: La frecuencia con que se realiza la recolección es alterna, 3 veces por semana (lunes - miércoles - viernes y martes - jueves - sábado). El departamento de Ingeniería Sanitaria cuenta con el siguiente equipo:

28 Camiones recolector tipo Kuka

2 Camiones compactadores de carga frontal (internacional)

11 Camiones simples tipo volquete

1 Pala mecánica de carga frontal

De los camiones recolectores, 15 son nuevos que son los que actualmente están en buen estado, los restantes en regular y mal estado. Los 2 camiones internacional de carga frontal se encuentran en mal estado por falta de repuestos, su capacidad es de: 16 M^3.

Los 11 camiones volquetes marca Mercedes Benz, tienen una capacidad de 4 M^3 y su estado es regular. Dos palas mecánicas de carga frontal, las que trabajan con los camiones de volquetes en recolección de basura en predios varios donde permite su acceso.

En la recolección se da una cobertura aproximadamente del 75% de la población urbana. El volumen de basura recolectado en toda la ciudad, representa 780 M^3/día equivalente a 430 TON/DIA. La densidad de la basura en los camiones compactadores es de 0.5 TON/M^3 cada equipo recolecta aproximadamente 18 M^3 de basura por turno o sea: 9 TON/TURNO/DIA.

El tiempo promedio productivo es de 4 hrs. El rendimiento promedio es de 1 TON de basura por KM recorrido a una velocidad de 4.64 KM/HR.

Los desperdicios en los domicilios de la población urbana representan aproximadamente el 83% del total de desechos sólidos, recolectados en toda la ciudad de Managua el año 1984 (cuadro III-10)

En 1984 se recolectan 167.028 metros cúbicos, con 27 recolectores acti

DEPARTAMENTO ING. SANITARIA

- Responsable
- Secretaria
- Auxil. de Contabilidad
- Auxil. de Estadística
- Oficial de Personal
- 2 Superv. de Campo
- Bodeguero
- Aseadora

LIMP. DE CALLES

Resp. de Secc.	1
Secretaria	1
Capataces	25
Choferes Barredoras	6
Inspector Fiscal	1
Chofer Plataforma	1
Operarios	155

LIMP. A DOMICILIO

Resp. de Sección	1
Secretaria	1
Superv. de Equipo	5
Choferes Recolectores	46
Choferes Volquetes	9
Supervisor de Cuadro	1
Cargadores Basura	188
Paleros	2
Llanteros	4

RELLENO SANITARIO

Resp. Secc.	1
Secretaria	1
Inspectores	2
Tractoristas	3
Ayudantes	2
Chequeadores	2
Piperos	2

vos como promedio diario durante el año o sea el 68% del equipo activo.

El costo unitario es de 109.72/M^3.

La recolección de sectores varios se caracteriza por la recolección de desechos sólidos en instituciones, comercios, hospitales, botaderos clandestinos y cauces.

En 11% del total de desechos sólidos recolectados en toda la ciudad representa la recolección del sector varios incluyendo la limpieza de calles de tipo manual. El horario de trabajo es de las 6:00 am a las 12:00 pm a las 6:00 pm.

En los sitios de recolección se han colocado containers para que se deposite ahí los desechos, estos son retirados por camiones especiales - que tiene brazos mecánico y/o hidraúlicos para cargar. La recolección en mercados, supermercados restaurantes y hospitales se efectúa a diario en los botaderos clandestinos se utilizan camiones volquetes o camiones plataforma que son mas funcionables y su frecuencia de recolección es - alterna. Existen 240 botaderos clandestinos de los cuales a 35 se les dá un servicio permanente por ser los que producen mayor volumen de basura y los restantes se les da un servicio no permanente.

En los botaderos clandestinos se practica la disposición con desechos - provenientes del barrido manual de calles y avenidas, ya que no existe ningún tipo de almacenamiento transitorio entre la recolección de basura de calles y el botadero.

SUB-SISTEMA BARRIDO DE CALLES

El organismo responsable de este servicio es el Departamento de Ingeniería Sanitaria que depende de la Dirección de Servicios Municipales. La sección de limpieza de calles implica dos maneras de recolectar la basura: Manual y Mecánico

Barrido Manual:

El objetivo de la limpieza de calles manual es mantener limpias todas las calles del área urbana de Managua que están adoquinadas o pavimentadas.

El servicio se realiza por medio de 269 operarios, 22 capataces distri-

CUADRO III-10

PROYECTO: SISTEMA DE LIMPIEZA DE LA CIUDAD DE MANAGUA
OFERTA: SERVICIO DE LA LIMPIEZA DE DESECHOS SOLIDOS DEL SISTEMA
DE LIMPIEZA
LA CIUDAD DE MANAGUA POR SECTORES EN METROS CUBICOS

AÑOS	SECTORES					
	RECOL. DOM.	RECOL. PART.	SECT. V.	BARR. MEC.	OTROS	TOTAL
1978	n.d	n.d	n.d	n.d	n.d	n.d
1979	n.d	n.d	n.d	n.d	n.d	n.d
1980	284,852	22,938	20,360	2/	4,991	333,141
1981	286,801	17,211	20,161	2/	10,244	316,417
1982	188,945	10,546	35,106	2/	n.d	234,597
1983	175,161	8,309	32,727	1,475	6,834	224,506
1984	167,028	6,530	26,874	876	n.d	201,308
TOTALES:	1,084,787	65,536	135,228	2,351	22,069	1,309,069
DISTRIBUCION PORCENTUAL:	82.81	5.00	10.32	0.18	1.69	100.0

n.d : INFORMACION NO DISPONIBLE
1 / : EN SEC RES VARIOS SE INCLUYE LA LIMPIEZA DE CALLES DE TIPO MANUAL
2 / : EN LOS AÑOS: 80, 81 y 82 NO EXISTE SERVICIO DE BARRIDO MECANICO
FUENTE : INFORME DEL DEPARTAMENTO DE INGENIERIA SANITARIA JRM

PERSONAL OPERATIVO LIMPIEZA DOMICILIAR

OCUPACION	PERSONAL ACTIVO
OPERADOR RECOLECTOR	36
OPERARIO LIMPIEZA A DOMICILIO	195
INSPECTOR LIMPIEZA A DOMICILIO	4
OPERADOR DE VOLQUETE	12
INSPECTOR DE VOLQUETE	3
OPERADOR DE GRUA	5
OPERADOR DE PALA	2
OPERADOR DE TRACTOR	3
OPERARIO DE BOTADERO	6
INSPECTOR DE BOTADERO	3
LLANTEROS	4
TOTAL	273

CUADRO III-5

PROYECTO: SISTEMA DE LIMPIEZA DE LA CIUDAD DE MANAGUA
PROYECCION DE LA DEMANDA Y SU DISTRIBUCION POR SECCIONES

AÑOS	DEMANDA TOTAL	S E C T O R E S :				
		DOMICILIAR	PARTICULAR	SECTORES VARIOS	BARRIDO MECANICO	OTROS
1985	304,777	252,386	15,239	31,453	549	5,151
1986	318,388	263,657	15,919	32,858	573	5,381
1987	332,607	275,432	16,630	34,325	599	5,621
1988	347,461	287,732	17,373	35,857	625	5,872
1989	362,979	300,583	18,148	37,459	653	6,134
1990	379,190	314,007	18,960	39,132	683	6,408
1991	396,125	328,031	19,806	40,880	713	6,695
1992	413,815	342,680	20,691	42,706	745	6,993
1993	432,296	357,984	21,615	44,603	778	7,306
1994	451,602	373,972	22,580	46,605	813	7,632
1995	471,771	390,674	23,586	48,687	849	7,963
1996	492,841	408,122	24,642	50,861	887	8,329
1997	514,851	426,348	25,743	53,133	927	8,329
1998	537,844	445,389	26,892	55,505	968	9,090
1999	561,864	465,280	28,093	57,984	1,011	9,495
2000	586,975	486,076	29,349	60,576	1,057	9,920
2001	613,170	507,766	30,659	63,279	1,105	10,362
2002	640,555	530,444	32,028	66,105	1,153	10,825
2003	669,162	554,133	33,458	69,057	1,204	11,309
2004	698,605	578,515	34,930	72,096	1,257	11,806
2005	729,343	603,969	36,467	75,268	1,313	12,326

FUENTE: DEPARTAMENTO DE INGENIERIA SANITARIA JRM

SECTORES VARIOS:
INSTITUCIONES
COMERCIOS
INDUSTRIAS
HOSPITALES
BOTADEROS CLANDESTINOS
CAUCES

OTROS: MERCADOS

buidos en 22 zonas que representan 22 cuadrillas. El número de operarios varía de 5 a 10 en cada cuadrilla. Dependiendo de la zona, laboran en un turno de seis horas de 6:00 am a 12:00 pm. Cada equipo cuenta con 1 carretón de madera cuya capacidad es de 0.22 M^3 (MIN) y máximo de 0.26 M^3.

1 Pala metálica

1 Escoba renovable cada semana

1 Machete

1 Par de botas cada 6 meses

1 Gorra cada 6 meses

2 Pantalones cada 6 meses

2 Camisas cada 6 meses

1 Par de guantes de cuero cada 3 meses

1 Capote (invierno)

La basura que se recolecta es depositada en lugares pre-establecidos denominados "Botaderos Clandestinos".

El personal del barrido manual representa el 49% del total del sistema de limpieza. Es importante señalar que dentro del personal que se dedica a este sistema más de un centenar son mayores de 50 años. En este año se jubilarán entre 30 y 40 operarios del barrido manual.

Las herramientas de trabajo una vez terminada la actividad son guardadas en casetas distribuidas en diferentes zonas.

El promedio de cuadras barridas por día es de 7 (cuadra: 100 Mts.).

En el siguiente cuadro se muestra el número de operarios y cuadras barridas mensuales desde el año 1979-85.

La ciudad de Managua cuenta actualmente con 1346 cuadras adoquinadas y 3770 pavimentadas. En 1984 se lograron recolectar 26.56 con un cumplimiento del 75%. El costo unitario es de C$ 0.34/M^2

Barrido Mecánico

En la limpieza de calles de manera mecánica se trata de mantener limpia

NUMERO DE OPERARIOS Y CUADRAS BARRIDAS

MENSUALES DESDE EL AÑO 1979-85

AÑO	OPERARIO	CUADRAS BARRIDAS
1979	500	57.641
1980	440	57.641
1981	400	44.471
1982	348	40.040
1983	290	28.569
1984	260	22.983
1985	150/120	20.724

PERSONAL OPERATIVO DE LIMPIEZA DE CALLES (MANUAL)

OPERACION	PERSONAL ACTIVO
CAPATACES	22
OPERARIOS	269
CHOFER	10
TOTAL	292

todas las calles pavimentadas en el área urbana de Managua. (3770 calles) por medio de barredoras mecánicas marca IFA

De los 110 x 10^6 M^2 que se tenía programado se logró 41.83 x 10^6 M^2 o sea el 38%, debido a que las 10 barredoras asignadas trabajaron solamente 3 - con promedio diario durante el año 1984. El costo unitario es de ₡ 0.05 /M^2. Actualmente trabaja una de las 10 barredoras con que cuenta la alcaldía de Managua. El resto estan paralizadas por falta de repuestos.

Su recorridó es por las principales pistas y avenidas de la ciudad. Las barredoras tienen una capacidad de 3 M^3 compactadas y realizan dos turnos por día.

El personal esta compuesto por 10 inspectores 8 choferes y 11 operarios - representando el 5% del personal de la limpieza. El barrido mecánico se efectúa en horas de menor flujo vehicular generalmente en la madrugada. La disposición de los desechos de las barredoras mecánicas, es realizada directamente en el botadero municipal. En 1983 se recolectaron 1,475 M^3 mientras que en 1984, 876 M^3 debido a la paralización de las barredoras. (cuadro III-B). En los años 80, 81, y 82 no existio servicio de barrido mecánico. El rendimiento varía entre 3 y 5 KM/horas barriendo entre 18 y 30 KM/turno. La vida útil de cada barredora es de 7 años.

SUB-SISTEMA DISPOSICION FINAL

La totalidad de los desechos sólidos que genera la ciudad de Managua se deposita en el botadero municipal, situado al noroeste de la ciudad capital, entre las márgenes del lago Xolotlán y la Laguna de Acahualinca. Se conoce con el nombre de Botadero de Acahualinca.

El actual botadero no presenta características adecuada porque la disposición de basura se efectúa sin tratamiento previo.

Su ubicación ejerce un negativo de contaminación de las aguas del Lago Xolotlán, además de incidir sobre la salud pública y el medio ambiente debido a que se encuentra ubicada en el casco urbano. A pesar de que existe buena accesibilidad al sitio, la distancia no es la adecuada para optimizar el aporte de los desechos porque el botadero se encuentra alejado de la zona sur y oriental de la ciudad.

El cuadro III-8 muestra el comportamiento histórico de los volúmenes de basura recolectado por sectores y depositados en Acahualinca desde 1980 a 1984. En 1984 se depositaron 201.308 M^3.

PERSONAL BARREDORAS (BARRIDO MECANICO)

OPERACION	PERSONAL ACTIVO
OPERADORES	8
OPERARIOS	10
INSPECTORES	10

CUADRO III-8

PROYECTO: SISTEMA DE LIMPIEZA DE LA CIUDAD DE MANAGUA
COMPORTAMIENTO HISTORICO DE LOS VOLUMENES DE BASURA
RECOLECTADOS POR SECTORES Y DEPOSITOS EN ACAHUALINCA

(1980-1984)

EN METROS CUBICOS

AÑOS	SECTORES										TOTAL
	DOMICILIAR	%	PARTICULAR	%	SECTORES VARIOS	%	BARRIDO MECANICO	%	OTROS	%	
1980	284,852	85	22,938	7	20,360	6	n.d	n.d	4,991	1.5	333,141
1981	268,801	85	17,211	5	20,161	6	n.d	n.d	10,244	3	316,417
1982	188,945	81	10,546	4.5	35,106	15	n.d	n.d	n.d	n.d	234,597
1983	175,161	78	8,309	3.7	32,727	14.6	1,475	0.1	6,834	3	224,506
1984	167,028	83	6,530	3.2	26,874	13.3	876	0.4	n.d	n.d	201,308

FUENTE: INFORMES ANUALES DEL DEPARTAMENTO DE INGENIERIA SANITARIA DE LA JUNTA DE RECONSTRUCCION DE MANAGUA (JRM)

n.d: DATOS NO DISPONIBLES

CAMPAÑA DE EDUCACION SANITARIA

Sistemáticamente la Alcaldía de Managua dentro del marco de las nuevas políticas económicas y con el fin de dar mayor proyección publicitaria a la problemática de los desechos sólidos ha programado una campaña de Educación Sanitaria cada año.

El objetivo central de esta publicidad va dirijido a motivar a la población para que disponga adecuadamente su basura, conserve limpios y en buen estado los lugares públicos tales como: Parques, Boulevares, Plazas, Edificios, casas de habitación. La línea de publicidad se enmarca dentro de la Educación Sanitaria, motivando a la población en el deseo de mantener una ciudad limpia y hogares sin basura.

Paralelo a estas campañas, se han implementado Jornadas de Trabajo Rojinegro a través de los organismos de masas integrando masivamente a toda la población en la limpieza general de sus barrios.

En síntesis se trata de desarrollar una campaña educativa alrededor de los problemas que causa la mala disposición de la basura. Todas las acciones que se realizan masivamente en la limpieza de nuestra ciudad se hacen en base a esta campaña, tratando de lograr la responsabilidad colectiva con relación a la imagen y estética de nuestros barrios.

También es oportuno señalar que el Ministerio de Salud realiza sus propias campañas, cuyo objetivo central es de educar a la población.

La alcaldía de Managua a lo largo del año 85 pretende iniciar su campaña a partir del 15 de Junio abarcando los diferentes medios de comunicación (Televisión, radio y prensa).

Existen otros aspectos que ayudan a reforzar la campaña y ello, son precisamente los organismos de masa, los cuales a través de acciones directas ayudan masivamente en Jornadas de Limpieza.

MANEJO DE LOS DESECHOS SOLIDOS EN HONDURAS

Jorge Rodríguez

SUMMARY

This paper gives a thorough account of the handling of solid wastes in Honduras. The main governmental organizations entrusted with this disposal problems are described and their spectrum of responsibilities is analized.

Current laws and regulations for waste disposal are described and their shortcomings are also mentioned.

Recommendations for improvement of such laws are given and also for means of effectively implementing them. As in the rest of the Central American countries, the regulations for environmental protection depend upon too many state organizations and therefore, in most cases, lack of coordiantion and duplication of efforts are deterrents to an effective environmental protection program.

INTRODUCCION

A través de los años, el medio ambiente, (agua, aire, suelo) ha sido el recipiente de todos los productos de desechos resultantes de las activi dades humanas. Mientras estos desechos vanían siendo depositados en el medio ambiente en pequeñas cantidades y en forma dispersa, el medio recipiente ha sido capaz de asimilarlos sin sufrir daños o cambios irre-

Ing. Jorge Rodríguez, Municipalidad de Tegucigalpa.

versibles, mientras ha tenido la capacidad y el tiempo suficiente para inactivarlos, absorberlos, dispersarlos o estabilizarlos. Como Consecuencia el daño causado ha sido relativamente limitado, y en general - los recursos afectados han sido capaces de recobrar la mayoría de sus características originales.

Durante los últimos años, la población rural ha venido emigrando en números crecientes hacia los centros urbanos. Sumada a esta migración - el incremento acelerado de la población urbana en sí, ha resultado en la reconcentración demográfica en áreas relativamente reducidas y consecuentemente una producción concentrada en grandes cantidades de desechos.

Tanto la cantidad como la manera en que los desechos han venido siendo depositados en el medio ambiente de estas áreas urbanas, han sido tales que dicho medio ambiente, no ha podido absorber el impacto de la - sobrecarga, resultado en su deterioro paulatino y en algunos casos - irreversible.

Los daños sociales y económicos a consecuencia de esta producción y - eliminación indiscriminada de desechos, ya han llegado a tal magnitud que actualmente son considerados como problemas de primer orden que - requiere atención y medidas inmediatas para su control primero, y consecuentemente su solución a corto plazo.

En nuestro país, los problemas que han surgido en las principales ciudades como consecuencia del crecimiento acelerado de la población e - industrialización; se han visto agudizados particularmente por la afluencia de la población rural hacia las ciudades, y el rezago ya - existente de facilidades, fondos y tecnología necesarios para atender las exigencias urbano-ambientales.

En términos generales, las ciudades han considerado el manejo (remoción y disposición) de los desechos producidos por sus habitantes, - como una tarea necesaria, pero de carácter secundario asignado únicamente un mínimo de esfuerzos, personal y fondos

El manejo de los desechos sólidos, es un ejemplo sobresaliente de negligencia en la administración, planeamiento y protección del medio ambiente urbano. No obstante que esta actividad absorbe la mayor - fuerza laboral de las Municipalidades consumiendo una cantidad relativamente elevada del presupuesto de las mismas, en la mayoría de - los casos esta labor no es lo que podría llamarse eficiente y productiva. Esto se comprueba fácilmente en los alrededores de nuestras - ciudades, donde la presencia de basuras y desechos de todo tipo, son parte del panorama cotidiano.

Los desechos sólidos han dejado ya un sendero de destrucción, suciedad e inmundicia. En cualquier parte de nuestras ciudades se puede ver basura en las calles y a lo largo de las carreteras, playas sucias, solares baldíos llenos de escombros y desperdicios y depósitos de basura humeando hediondos e infestados de ratas, moscas etc.; otros aspectos menos visibles pero derivados de este problema y sumamente críticos son: la basura en ríos, océanos y lagos, y consecuentemente la contaminación de aguas superficiales y subterraneas; contaminación atmosférica y el desperdicio de recursas naturales. Además de lo anterior, la glotoneria por artículos de conveniencia desechables está llegando a un punto que la producción y disposición de éstos ha resultado en el incremento acelerado de los problemas ya existentes.

Tal como sucede en diversos rubros del saneamiento, no es posible establecer una relación casual clara y definida entre las basuras y la salud humana, sin embargo hay concenso que constituyen uno de los elementos significativos de la estructura epidemiológica de una determinada comunidad.

En Tegucigalpa y en las principales ciudades del país es altamente probable que la falta de cobertura de los sistemas de desechos sólidos y el mal manejo que se efectúa en áreas marginales y mal atendidas junto con otros focos de insalubridad existentes tales como: disposición no sanitaria de escretas, botaderos de materia orgánica putrecible incluidas las basuras domésticas, alimentos no protegidos, acumulación y almacenamiento inapropiado de basuras y otros desechos, aguas estancadas o con poca velocidad de escurrimiento, lotes baldíos con vegetación y basura, contribuyen de un modo importante a la proliferación de insectos y roedores transmisores de enfermedades, a la presencia de animales, a la existencia de factores ambientales y a prácticas comunitarias que van en desmedro de la salud, seguridad de las personas y de la calidad. El efecto negativo en el ornato de las ciudades y la degradación de zonas con la consecuente pérdida de valor catastral es también evidente.

Bajo las circunstancias antes mencionadas las Municipalidades deberán de tener mucho cuidado en la manera como eliminan los residuos; la práctica de transportar los desechos de las ciudades fuera de sus confines y eliminarlos en forma expedita y con un mínimo gasto en lugares poco frecuentados, debe ser abandonada primeramente porque lo único que se está haciendo es trasladar un problema en una magnitud mayor.

El interés en la administración del servicio de limpieza pública para el residente urbano, se limita a que sus desechos sean recogidos regularmente a un costo mínimo y en horas y lugares que sean convenientes. Esta falta de interés del público, es quizás el factor negativo más importante al que se enfrentan el personal y las entidades responsables deseosas de proveer servicios, cuando menos adecuados; presentando un obstáculo para cualquier intento del planeamiento comprensivo; adquisición de equipo, nivelación de salarios y empleo de personal competente.

En conclusión, el problema de la contaminación de la tierra y deterioro del medio ambiente causado por las basuras, es el resultado de: descuido y sobre-estimación de la capacidad de la naturaleza para disipar o asimilar los desechos producidos y depositados en forma indiscriminada; un público mal informado y/o desinteresado e invertir esfuerzos, tecnología y fondos insuficientes para el manejo apropiado de sus desechos; insensibilidad contra los insultos a las bellezas naturales y destrucción y deterioro de recursos naturales y fuentes de esparcimiento. Claramente, este problema no podrá ser resuelto sin un plan comprensivo para educar al público en general, al personal encargado de la remoción y disposición de las basuras y a las autoridades interesadas y responsables en particular; para así poder desarrollar la conciencia y apoyo que serán necesarios para desenvolver y poner en acción las medidas necesarias que aseguren el bienestar y la salud de la población, y los trabajadores de los servicios de limpieza; además de proteger los recursos, bienestar y fuentes de vida de generaciones futuras.

ANTECEDENTES DEL SECTOR SALUD

La Asamblea Mundial de la Salud decidió en 1977 que la principal meta social de los Gobiernos de la Organización Mundial de la Salud en los próximos decenios debe consistir en "Alcanzar para todos los ciudadanos del mundo en el año 2.000 un grado de salud que les permita llevar una vida social y económicamente productiva", quedando el lema abreviado a "Salud para todos en el año 2.000". Subsecuentemente, la Asamblea Mundial de la Salud en 19799 instó a los Estados Miembros a definir y poner en práctica estrategias nacionales, regionales y globales tendientes a alcanzar la meta señalada.

A raíz de esas estrategias regionales de salud para todos, adoptadas por los Gobiernos Miembros en la Reunión celebrada por el Consejo Directivo de la OPS en 1980, surge lo que conocemos como "Plan de Acción".

El Plan de Acción marca un hito importante e histórico en el largo camino hacia la justicia social en las Américas para aplicar las estrategias regionales de salud para todos en el año 2.000. Constituye una pauta detallada, obtenida mediante un concenso regional respecto a las metas, objetivos y estrategias, encaminadas a cumplir con el propósito fundamental o sea, la correspondiente traducción a programas concretos; las que cualquier otro documento singular, el Plan de Acción representa un compromiso político, solemne y conjunto de los gobiernos de esta Organización con los pueblos de las Américas.

Dentro de las estrategias contempladas se encuentran los objetivos específicos considerados como esenciales en relación con la meta mundial de salud para todos en el año 2.000.

Para alcanzar los objetivos y metas regionales se necesitará el desarrollo de estrategias de atención primaria acordes con las diferentes características y posibilidades de cada país de la Región, quedando adoptada por los países miembros la siguiente definición de atención primaria: "La atención primaria de salud es la asistencia sanitaria esencial basada en métodos y tecnología prácticas, científicamente fundados y socialmente aceptables, puesta al alcance de todos los individuos y familiar de la comunidad mediante su plena participación y a un costo que la comunidad y el país puedan soportar en todas y cada una de las etapas de su desarrollo, con un espíritu de autoresponsabilidad y autodeterminación.

La atención primaria forma parte integrante tanto del sistema nacional de salud, del que constituye la función central y el núcleo principal, como del desarrollo social y económico global de la comunidad. Representa el primer nivel de contacto entre los individuos, la familia y la comunidad con el sistema nacional de salud, llevando lo más cerca posible la atención de salud al lugar donde residen y trabajan las personas y constituye el primer elemento de un proceso permanente de asistencia sanitaria.

Dentro del Plan de Acción se ha elaborado un programa en donde se identifican áreas prioritarias para lograr y hacer efectivas las estrategias de Atención Primaria. Entre las áreas a considerar se encuentra:

a) La Protección y Promoción de la Salud de grupos especiales.
b) La Protección y Promoción General de la Salud.

Y también, la Protección y Promoción de la salud ambiental que es, el campo en donde se enfoca lo referente a Administración de Desechos Sólidos. En cuanto a esto dicho Plan se orienta a mejorar y ampliar los servicios de eliminación de Desechos Sólidos, con atención especial a las poblaciones marginadas de las grandes ciudades y zonas metropolitanas haciendo hincapié en lo siguiente:

- Establecimiento de políticos, planes, programas y proyectos nacionales.

- Fortalecimiento de los servicios de los Desechos Sólidos en el sector urbano.

- Mejoramiento de la Disposición higiénica de Desechos en las comunidades rurales.

- Y la eliminación de Desechos tóxicos.

Por todo lo anterior se han definido las siguientes áreas de acción:

1) Formulación de políticas y lineamientos para la administración de desechos sólidos incluyendo el aprovechamiento y la reducción de los residuos.

2) Promoción de la identificación de Proyectos para zonas metropolitanas y ciudades, y preparación de propuestas para financiar su - ejecución.

3) Participación de la comunidad en programas de control de desechos sólidos.

4) Desarrollo de Recursos Humanos.

Las principales fuentes de información sobre desechos sólidos son las encuestas efectuadas por el Banco Municipal Autónomo en 1973, por la División de Saneamiento Ambiental en 1979 y 1983, por la - Dirección General de Asesoría y Asistencia Técnica Municipal en - 1984 y estudios e investigaciones llevados a cabo en el Concejo - Metropolitano del Distrito Central en el período 1978-1984.

Los datos obtenidos son bastante recientes, sin embargo, hay razones suficientes para concluir que los índices de cobertura y población servida se han mantenido en proporción mayor al 60% y que la tendencia en los últimos 10 años ha sido de deterioro, con el aumento desmedido de las áreas urbanas que prácticamente han sobre pasado la capacidad de prestación de servicio que tienen las Municipalidades.

En el aspecto legal, las leyes datan desde principio de siglo y - algunas han sido revisadas y modificadas en los últimos años, sin embargo como sucede casi siempre en nuestro país, estas no se cumplen.

A continuación se hace una referencia sobre los principales recursos legales con que cuenta el sub-sector:

a) La Constitución de la República Decreto No. 311 en el Capítulo VII, De La Salud Artículos 145 y 149, reconoce el derecho a la protección de la salud y asi mismo compromete a todos los ciudadanos a participar en la promoción y preservación de la salud, personal y de la comunidad. El Estado conservará el medio ambiente adecuado para proteger la salud de las personas y designa al Poder Ejecutivo por medio del Ministerio de Salud Pública y Asistencia Social para que coordine todas las actividades del sector mediante un plan nacional de salud.

b) El Código Sanitario Decreto No. 75 ....
........................, en los artículos del 68 al 71 se refiere al sub sector desechos sólidos estableciendo que las basuras deberán ser eliminadas sanitariamente bajo la responsabilidad de los Concejos del Distrito y de las Municipalidades ciñéndose a las normas reglamentarias que fija la Dirección General de Salud.

c) El Reglamento Sanitario de Saneamiento Ambiental en el Capítulo IV De las Disposiciones de Basura y la Ley de Policia en el Capítulo XX número segundo- Aseo, regulan el funcionamiento de los sistemas de desechos sólidos del país, en los aspectos operacionales, control sanitario, relaciones interistitucionales y con la comunidad, arbitrios y multas, etc.

d) La Ley de Municipalidades y del Régimen Político en el Título VI- Atribuciones Generales, Artículo No. 53 establece la responsabilidad de las municipalidades en el sub sector desechos sólidos y en el Título VII Atribuciones Especiales establece lo referente a educación, salud y protección de los recursos, aspectos que están intimamente ligados con la administración de los desechos sólidos.

Participación Histórica del Ingeniero

De acuerdo con lo establecido en el Código Sanitario, es responsabilidad de las municipalidades la eliminación sanitaria de las basuras, y esta tarea se ha venido realizando tradicionalmente desde principios de siglo disponiendo las basuras en botaderos a cielo abierto y su posterior quema.

A medida que nuestras ciudades han crecido, y la densidad de población aumentando, las basuras han ido ocupando la atención tanto de las autoridades que aun no lo consideran como un problema a resolver en el campo de la ingeniería, como de los habitantes de las ciudades que únicamente están interesados en que les retiren la basura de su vista y no en el impacto ambiental y de salud que representan.

Por otra parte la mayoría de las ciudades del país se han mantenido con una población muy baja y únicamente San Pedro Sula y Tegucigalpa han contado con población que demande servicios y han asignado recursos para utilizar ingenieros en las diferentes actividades prioritarias como lo son las obras públicas orientadas a construcción y mantenimiento de calles, edificios, etc. pero no se conocen programas relacionados con los aspectos sanitarios de las ciudades ni mucho menos que requieran la participación del ingeniero.

SITUACION ACTUAL DE LOS SERVICIOS DE ASEO EN HONDURAS, SUB SECTOR DESECHOS SOLIDOS PLANIFICACION Y PROGRAMACION

La dirección, coordinación y evaluación de los planes, programas y proyectos para la promoción del desarrollo económico y social corresponde a la Secretaría Técnica del Consejo Superior de Planificación Económica (CONSUPLANE).

En la Dirección de Planificación Social de CONSUPLANE está ubicado el Departamento de Salud, el cual tiene a su cargo las tareas de conducción durante la elaboración del Plan Nacional de Salud, conjuntamente con las distintas instituciones del Sector Salud. Los objetivos centrales de este Sector son:

- El mejoramiento de la salud de la población especialmente en zonas rurales y marginales urbanas.
- Reducir los riesgos de enfermar y morir del binomio Madre-Niño.
- Mejorar la coordinación entre las instituciones del Sector Salud, incluyendo aquellas relacionadas con los programas, proyectos y actividades específicas del Sector

Lo relativo al Saneamiento del Medio y los Desechos Sólidos se pueden apreciar en el Cuadro No. 1. Desde luego hay otras políticas y medidas intimamente relacionadas con el sub sector Desechos Sólidos entre los cuales pueden mencionarse el control de la contaminación del ambiente y el mejoramiento de la vivienda y asentamientos humanos.

ADMINISTRACION DE DESECHOS SOLIDOS

Están a cargo de las municipalidades del país en virtud de la Ley de Policia y de lo señalado en el Código Sanitario. El Reglamento Sanitario de Saneamiento Ambiental define lo que se entiende por basuras, establece ciertas prohibiciones y norma los sistemas de Desechos Sólidos.

A pesar de la legislación existente solamente unas 36 de las 282 municipalidades del país tienen organizados Sistemas de Desechos Sólidos; comunmente denominados "Trenes, de Aseo".

Asistencia Técnica y Control

Existen dos Instituciones nacionales cuyas funciones son otorgar asistencia técnica y controlar los municipios:

a) La Dirección de Asesoría y Asistencia Técnica Municipal.

b) El Ministerio de Salud Pública.

Dirección de Asesoría y Asistencia Técnica Municipal

Especialmente desde 1974 esta Dirección del Ministerio de Gobernación y Justicia, ha transformado su organización interna, con el fin de mejorar los servicios que demandan las Municipalidades, y aquellas Instituciones relacionadas con el fomento Municipal.

Dirección de Promoción y Saneamiento Ambiental

Las acciones de Saneamiento Básico en lo referente a Desechos Sólidos, den-ro de la Organización del Ministerio de Salud Pública se ejecutan por la Dirección de Promoción y Saneamiento Ambiental del nivel central cuyas funciones básicas son:

1. Administrar programas y Proyectos.
2. Participar en el proceso de planificación de salud.
3. Elaborar programas y consolidar las Metas y Presupuestos Regionales.
4. Formular proyectos y gestionar su financiamiento.
5. Coordinar con otras instituciones.
6. Elaborar las normas y controlar factores ambientales.
7. Colaborar en el adiestramiento y selección de personal.

Las Regiones de Salud: que efectúan actividades específicas:

1. Dirigen y coordinan el trabajo de campo.

2. Participan en las actividades de planificación y programación.

3. Cuentan con una estructura orgánica de saneamiento pero sus funciones no están bien definidas todavía, lo que dificulta la realización de Actividades Operativas.

Si bien en los últimos años ha habido un progreso considerable aún se requiere mejorar la estructura y la asignación de funciones del Saneamiento Básico en el Ministerio de Salud Pública.

A continuación se consignan los principales problemas que afronta el sub sector en nuestro país, y que se reflejan claramente en la información que sobre el tema se ha recopilado en las principales municipalidades de Honduras.

1. Desconocimiento y/o indiferencia casi total del problema por parte de las autoridades correspondientes y público en general.

2. Falta de una definición de políticas sobre desechos sólidos a nivel nacional.

3. Inexistencia de planes y programas establecidos en cuanto a los servicios de aseo.

4. Falta de coordinación intra e interinstitucional e intermunicipal.

5. El sistema político provoca inestabilidad laboral especialmente en personal calificado de alto nivel.

6. Obsoleta legislación existente en el área de la salud y el ambiente y falta de ejecución de las mismas.

7. Alto índice de migración del campo a la zonas urbanizadas.

8. Falta de control en los planes reguladores de crecimiento de las ciudades.

9. Estructuras administrativas débiles e ineficaces.

10. Insuficiencia de recursos técnicos, humanos, materiales y económicos.

11. Alto grado de importación de tecnología incongruente con la realidad nacional.

12. Deficientes sistemas de información.

13. Presencia de segregadores de basura con el consecuente daño para la salud de los mismos y la comunidad en general.

14. Falta de autonomía para el manejo de los fondos específicos prove-

nientes de la prestación del servicio.

15. Sistema de tarifas y cobros inadecuado.
16. Falta de normalización y reglamentación para la adquisición de equipo.
17. Mala utilización de los recursos existentes.
18. Infraestructura insuficiente y/o inadecuada.

La información obtenida incluye el personal disponible, el equipo, utilizado, la población beneficiada, tarifas promedios, ingresos y egresos. Disposición Final y Cobertura. Aunque los datos existentes que son escasos y ciertas cifras proporcionadas por algunos Departamentos de limpieza municipales no son muy consistentes con la realidad se obtuvieron ciertas conclusiones sobre el sub-sector:

a) Hay sistemas de trenes de aseo en una baja proporción de las localidades urbanas; ya que de las 282 municipalidades del país solamente 36 cuentan con un Sistema de Desechos Sólidos.

b) La cobertura de los servicios es insuficiente generalmente del 60% de la población.

c) La recolección presenta fallas por falta de equipo y mal mantenimiento del mismo, la Disposición Final no es sanitaria, excepto en las dos principales ciudades Tegucigalpa y San Pedro Sula que cuentan con rellenos sanitarios.

d) Además de los botaderos municipales existen muchas acumulaciones de basuras en las ciudades, las cuales atraen animales y son focos de proliferación de insectos y roedores.

e) La organización y el funcionamiento de los Departamentos de Limpieza Municipal no es adecuada y, por lo regular, el personal no tiene adiestramiento específico.

f) Es muy escaso el personal de ingenieros y de otros profesionales y técnicos.

g) Aparentemente los fondos y el financiamiento actual de los Departamentos de Limpieza es suficiente, ya que hay excedentes que se utilizan en otras actividades.

h) La legislación y reglamentación, aunque anticuada es razonablemente completa; se aplica en forma muy restringida.

i) La planificación de los desechos sólidos y la generación de proyectos no ha tenido prioridad.

j) Hay pocos recursos profesionales y técnicos en las instituciones -

responsables de asesoría y control en desechos sólidos; por consiguiente la cooperación técnica prestada a los municipios es poca.

k) La coordinación del subsector desechos sólidos es insuficiente.

Conclusiones Generales, Aspectos Socio Económicos, Ambientales y de Salud.

El manejo inadecuado de los desechos sólidos representa un peligro para la salud pública y para el medio ambiente. Así la descarga a cielo abierto y otras prácticas inapropiadas ocasionan la contaminación del aire, del agua y del suelo, y facilitan la proliferación de vectores de enfermedades que pueden directa o indirectamente causar impactos desfavorables sobre la salud de la población, los trabajadores del servicio de aseo y de personas que se dedican a la recuperación de algunos de esos desechos.

En 1971 el Comité de Expertos de la OMS sobre el Tratamiento y Disposición de Desechos Sólidos reconoció, desde el punto de vista de la protección de la salud, la necesidad de tener en cuenta las fases sólida, líquida y gaseosa en la disposición de los desechos, de manera que se puedan reducir al mínimo los efectos nocivos que afectan al medio ambiente. Esta consideración debe tenerse en cuenta siempre que se estudien las soluciones al problema de disposición de desechos.

Además, hoy en día es preciso considerar los factores ecológicos y de conservación de recursos naturales y, por lo tanto, las decisiones sobre disposición desechos se deben basar en el estudio de todos los posibles métodos y sus correspondientes repercusiones considerando los aspectos de salud pública, los criterios técnicos y económicos, y la protección del medio ambiente. Todo esto exige un análisis más completo de los conceptos en que se apoya el tratamiento y la disposición de los desechos sólidos para encontrar una solución equilibrada que sea compatible con la conservación de recursos, la ecológia, la salud, y la política económica.

El tratamiento y la disposición de los desechos sólidos plantea problemas específicos en cada país, región y, aún, en cada localidad. La densidad demográfica, la modalidad cultural propia, el grado de desarrollo y la estructura de la economía, así como las condiciones ambientales como clima, topografía y disponibilidad de recursos naturales, entre otros, son factores que caracterizan la problemática en cada caso y que si se aprovechan racionalmente pueden facilitar soluciones en materia de disposición de desechos sólidos. Es imprescindible también dictar normas nacionales que compatibilicen los intereses regionales y locales con los varios intereses y políticas nacionales. En resumen, la solución de los problemas tiene que ajustarse a las condicio nes y características específicas de cada situación.

El manejo y la administración de los desechos sólidos no es una labor puramente técnica, su interdependencia con la ecología, los recursos naturales, la energía, la economía política, la legislación y la administración, le dan un carácter multidisciplinario y complejo, que precisa la colaboración intersectorial de técnicos y especialistas en esos campos.

Por último es necesario tener presente que las medidas adoptadas para la solución de los problemas en materia de disposición de desechos sólidos solo podrán llegar a ser eficaces si toda la población es capaz de entenderlas y participarlas, lo que demanda educación y motivación.

El Ingeniero tendrá dos tipos principales de funciones en el campo de los desechos sólidos:

01) Participar y Promover como ciudadanos y como profesional que se aprueben leyes normas y reglamentos, tendientes a proteger los recursos naturales y a prohibir la producción de muchos bienes superfluos con empaquetadura ostentosa.

02) Diseñar las técnicas adecuadas de manejo y disposición de las basuras para minimizar los daños que estas pueden causar al hombre y al medio ambiente. Estas técnicas podrían dividirse como sigue:

a) Determinar la calidad y cantidad de desechos sólidos que se producen en cada una de las actividades del hombre, mediante el diseño de métodos de muestreo y análisis apropiados. Aqui es importante según el objetivo fijado, determinar el contenido, la toxicidad, la putricibilidad, el peso volumétrico y otros parámetros importantes como el poder calorífico en el caso de la incineración y el porcentaje de recurperables y de materia orgánica en el caso del reuso y la conversión en abonos.

b) Diseñar los sistemas adecuados de almacenamiento de los desechos desde el momento en que se producen hasta que son recogidos tomando en cuenta sus características físicas químicas y biológicas, la frecuencia y el tipo de recolección para lograr un manejo higiénico y que no cause contaminación del medio ambiente.

c) Encontrar en cada caso los métodos adecuados de recolección que, además de cumplir con los objetivos mencionados en el inciso anterior, optimicen la eficiencia del sistema minimizando costos, tanto en la recolección en si como el transporte de los desechos a su destino final.

d) Usar las técnicas de la Ingeniería en general y de la Ingeniería ambiental en particular para proporcionarles un tratamiento adecuado que permita reincorporarlos a la naturaleza, apro vechando al máximo su capacidad de autopurificación, de tal manera que no produzcan problemas a la salud del hombre ni alteraciones ecológicas irreversibles. La reincorporación puede hacerse usando como vehículos el agua, al suelo o al aire, como es el caso de la molienda de basuras en molinos húmedos caseros, el relleno sanitario o la incineración respectivamente.

e) Finalmente con el objeto de proteger los recursos naturales es necesario investigar, diseñar y promover los métodos de reciclaje adecuados en cada actividad del hombre cuidando los aspectos sanitarios y haciendo serios estudios de la relación costo-beneficio.

Conclusiones a Nivel Institucional

1. Existen en el país leyes y reglamentos que determinan la responsabilidad del Ministerio de Salud Pública en el área de los residuos sólidos.

2. Es evidente que el Ministerio de Salud Pública en sus planes nacionales y en los compromisos internacionales lo ha considerado prioritario, pero no ha creado una unidad específica dentro de su organización que le permita de acuerdo con lo que la ley estipula, ser el organismo que establece las políticas y coordine los proyectos de aseo urbano en el país.

3. Existe en el Ministerio de Gobernación una oficina de Asesoría Técnica Municipal que carece de personal técnico calificado y de programas para el sector aseo urbano, razón por la cual las municipalidades del país realizan programas aislados no definidos.

4. El banco Municipal Autonomo, organismo de financiamiento de proyectos municipalidades, no considera a muchas de ellas sujetas de crédito, y estas al no contar con asesoría y financiamiento no pueden realizar proyectos.

5. El Consejo Superior de Planificación Económica, bajo el sector Salud coordinó un grupo de trabajo con la asistencia del Ministerio de Salud Pública, Concejo Metropolitano del Distrito Central, OPS/OMS quienes en 1980 prepararon un documento titulado "Bases para un Proyecto de Desechos Sólidos en las principales Ciudades de Honduras" que es el primer intento de una acción a nivel nacional sobre residuos sólidos no hubo seguimiento por parte del organismo responsable (M.S.P.).

RECOMENDACIONES

1. El Ministerio de Salud Pública como rector del área de salud en el país, deberá proceder a tomar la iniciativa en el sub-sector de residuos sólidos para normar y asesorar a las municipalidades sobre las cuales recae actualmente esta responsabilidad y así mismo formular los planes particulares y nacionales de aseo urbano.

2. Deberán colaborar en este aspecto en una forma colegiada todos los organismos del gobiernos que se han mencionado anteriormente, las principales municipalidades del país y organismos cumunales para aprovechar el limitado recurso humano capacitado que existe en nuestro país y tener la colaboración en la promoción para la obtención de la participación comunitaria.

3. La Universidad Nacional Autónoma deberá ampliar los planes de estudios y crear la carrera o especialización de Ingeniería Sanitaria y asimismo promover la capacitación e investigación en el sub sector.

4. La participación del Colegio de Ingenieros Civiles en la busqueda de solución que inciden directamente en la actividad diaria de las comunidades es de suma importancia la cual puede ser estimulando a la organización dentro del Colegio de asociaciones afines a la ingeniería sanitaria y coordinar programas de mejoramiento y promoción con la UNAH, asociaciones públicas y privadas y municipalidades.

INDICES ACTUALES PARA LA CIUDAD DE TEGUCIGALPA

a) Producción por habitante por día.

		Kb/hab. x día.	
AÑO	1980	Clase alta	0.69
		Clase media	0.42
		Clase baja	0.38

(En Kg. / Hab. x día)

ESTRATO	1980	1981	1982	1983	1984	1985
Clase alta	0.69	0.70	0.71	0.72	0.73	0.74
Clase media	0.42	0.43	0.44	0.45	0.46	0.47
Clase baja	0.38	0.39	0.40	0.41	0.42	0.43

Aplicando estos índices a las poblaciones proyectadas para el período, se tiene la siguiente producción total de basura para 1980 - 1985.

ESTRATO	1980 (Ton/día)	1981 (Ton/día)	1982 (Ton/día)	1983 (Ton/día)	1984 (Ton/día)	1985 (Ton/día)
Clase alta	22.01	29.09	31.36	33.79	36.40	39.20
Clase media	95.64	103.97	113.09	122.87	133.44	144.85
Clase baja	67.60	73.67	80.32	87.46	95.19	103.73
TOTAL	190.25	206.73	224.77	244.12	265.03	287.58

Estas cantidades deben sufrir un incremento correspondiente a la basura no domiciliaria, que también es recolectora por el servicio de Limpieza (basura de barrido de calles y de industrias y comercio).

Cobertura del Servicio

La tendencia natural es aumentar la cobertura del servicio en el período de estudio. Este aumento depende principalmente de la mejoría de la infraestructura vial de la ciudad. Estímase que un aumento de 3% / año en la cobertura del servicio sería razonable para la ciudad.

Características de los Residuos Sólidos

Los residuos sólidos experimentan significativos cambios en su composición con la evolución socio-económica de las poblaciones que los producen. El ritmo del desarrollo puede reflejarse en las características cualitativas de las basuras, aumentando el porcentaje de las fracciones más nobles. Como papel, envases metálicos y de plástico.

COMPOSICION FISICA DE LA BASURA
(TEGUCIGALPA)

Componente	% Composición
Materia orgánica	58
Materia inerte	13
Papel	18
Metal	4
Vidrios y otros	7

BASURA DOMICILIARIA

Basura Producida Ton.	Cobertura %	Basura Recolectable Ton.	Peso Específico medio comprimida Ton. día	Vol. necesario de camión capacid Ton /M^3	Vol. disponible a M^3 2V Comp.	Volumen disponible actual M^3 2V/día Volquetas	
206.73	75.9	156.91	0.412	380.8	448.3	60	50
244.77	78.2	175.77	0.412	426.6	448.3	60	50
244.12	80.5	196.52	0.412	477.0	448.3	60	50
265.03	82.9	219.71	0.412	533.3	448.	60	50
287.58	85.4	245.59	0.412	596.1	448.	60	50

Basura no Domiciliaria

Estimando que la basura recolectada no domiciliaria, proveniente del barrido de calles de comercios, industrias, hospitales y de otros establecimientos crece a un ritmo de 2% / año, y tomando como base las 60T/día colectadas en 1980. Se tiene para el período 1981-1985, las siguientes cantidades de basura recolectada diariamente por el servicio de aseo.

1981	61.2	Ton/día
1982	62.4	"
1983	63.6	"
1984	64.9	"
1985	66.2	"

Si se considera que estos desechos son recolectados en un camión con compactación los volumenes correspondientes a estos pesos son los siguientes:

AÑO	PESO ESPECIFICO TON./DIA.	VOLUMEN M^3
1981	0.412	148.5
1982	0.412	151.5
1983	0.412	154.4
1984	0.412	157.5
1985	0.412	160.7

PROBLEMAS DE SALUD ASOCIADAS A LAS BASURAS ANTECEDENTES SOBRE LA SITUACION DE TEGUCIGALPA

Tal como sucede en diversos rubros del saneamiento, no es posible establecer una realción causal clara y definida entre las basuras y la salud humana, sin embargo hay consenso que constituyen uno de los elementos significativos de la estructura epidemológica de una determinada comunidad.

En Tegucigalpa es altamente probable que la falta de cobertura del sistema de desechos sólidos y el mal manejo que se efectúa en las áreas marginales y mal atendidas, junto con otros focos de insolubridad existentes: disposición no sanitaria de excretas, botaderos de materia orgánica putrescible incluidas las basuras domésticas, alimentos no protegidos, acumulación inapropiada de basuras y otros desechos, aguas estancadas o con poca velocidad de escurrimiento, lotes baldíos con vegetación y basuras, contribuyen de un modo importante a la proliferación de insectos y roedores transmisores de enfermedades, a la presencia de animales a la existencia de factores ambientales y a prácticas comunitarios que van en desmedro de la salud, seguridad de las personas y de la calidad de vida.

Los problemas específicos serían los siguientes:

Enfermedades o lesiones	Agentes causales
Fiebre tifoidea y otras Salmonelosis, gastroenteritis y parásitos intestinales	Mosca doméstica
Gastroenteritis, destrucción de alimentos y daños a las estructuras	Rata
Dengue e irritación de piel	Mosquitos del tipo aedes.
Rabia animal (y peligro de rabia humana).	
Cortadura y otras lesiones	Vidrios, latas, metales y objetos desechables como basuras.

Irritación de mucosas nasales y de ojos y enfermedades respiratorias de incendios y quemaduras.	Humo y fuego derivados de quema basuras.

Además de lo señalado, contribuyen a la degradación ambiental los siguientes prácticas comunitarias.

Efectos ambientales adversos	Prácticas
- Obstrucción de la circulación de personas, disminución de lugares de recreación.	Botaderos en áreas sin recolección.
- Presencia de perros, caballos y vacas en botaderos en sitios baldíos.	"
- Contaminación visual, por la presencia de papeles, latas y otros componentes de las basuras.	
- Malos olores por putrefacción de los desechos.	

INFESTACION POR AEDES Y DENGUE

Es interesante destacar que con motivo de un brote de dengue ocurrido en la costa norte en 1978 y que se propagó a varias zonas del país, llegando a estimarse unos 150,000 casos (la mayor parte en San Pedro Sula) se realizó una investigación sobre infestación en Tegucigalpa.

Las principales conclusiones de esa investigación fueron que el 38% de las viviendas estaban infestadas, concentrándose los problemas en las áreas marginales (San Francisco, El Reparto, Suyapa, etc.) y en los sitios baldíos con acumulaciones de basuras. Los casos de dengue inventigados en la capital resultaron ser importados y se presume que la energica campaña de aplicación de insecticidas y limpieza impidió la generación de un brote con una elevada tasa de ataque. En la actualidad hay un programa de control que ha mantenido suficientemente bajo el índice de infestación, pero está previsto realizar en breve un nuevo tratamiento en base a insecticidas y medidas de limpieza general.

CARACTERISTICAS DE LA MORBILIDAD EN LA REGION SANITARIA METROPOLITANA

La fuente de información disponible es el conjunto de estadísticas que recopila el Ministerio de Salud Pública y Asistencia Social para una extensión territorial un poco más extensa que la correspondiente al área urbana de Tegucigalpa por lo tanto, las cifras reflejan bastante bien lo que ocurre en dicho entorno.

En preciso dejar constancia que el sistema de información existente adolece de deficiencias, de modo que los datos deben tomarse como ilustrativos y no como un reflejo fiel de la realidad, puesto que el porcentaje de omisión es bastante alto.

Las enfermedades transmisibles registradas en 1979, de acuerdo al telegrama apidemológico semanal están indicados en el Anexo XX.

La tasa resultante para las afecciones atribuidas a deficiencias en el saneamiento es:

$$\frac{40,126}{422,349} \text{ casas} \times 100.000 = 9500 \times 100 \text{ mil habitantes}$$

El último informe estadístico de la Región Metropolitana, correspondiente a 1979, se proporciona la morbilidad registrada en la consulta externa (Anexo YY), destacándose la importancia de las gastroenteritis, parasitosis intestinales y otras enfermedades derivadas del mal saneamiento, que para 1979 alcanzaron en 31.8% del total.

TOTAL DE ENFERMEDADES TRANSMISIBLES, REGION METROPOLITANA DE SALUD, 1979

ENFERMEDADES	CASOS
Amibiasis	5,530
Angina Estreptococica	30,782
Brucelosis	-
Dengue	-
Difteria	-
Disentería Bacilar	410
Encefalitis Virica	1
Enfermedad Diarreica	33,500
Fiebre Paratifoidea	10
Fiebre Tifoidea	208

Hepatitis Infecciosa	468
Infección Gonocócica	2,393
Infección Moningocócica	-
Influenza	19,267
Leshmaniasis	-
Malaria	147
Parotiditis Epidémica	310
Poliomilitis	7
Rabia Humana	-
Viruela	78
Sarampión	1,084
Sífilis (todas formas)	1,222
Tétanos	-
Tosferina	83
Tuberculósis (Aparato Respiratorio)	643
Tuberculosis (otras formas)	8
Varicela	344

FUENTE: Telegrama Epidemiológico Semanal de Enfermedades Transmisibles. Boletin de Estadísticas e Información de Salud, año 1979.

Departamento de Estadística de Salud, Ministerio de Salud Pública y Asistencia Social.

Tegucigalpa, D.C., (junio de 1980)

PRINCIPALES CAUSAS DE MORBILIDAD REGISTRADAS EN CONSULTA EXTERNA POR GRUPOS DE MAYOR INCIDENCIA AÑOS 1978-1979

CODIGO	GRUPO DE CAUSAS DE MORBILIDAD	1 9 7 8		1 9 7 9	
		N.	%	N.	%
009	Enfermedad Diarreica	11.581	5	54.812	22
500.508	Infecciones Agudas Vías Respirat.	39.093	17	31.177	13
127.129	Helmintiasis Intestinal Mixta	24.702	11	13.019	5
485.490	Bronquitis, Bronconeumonía y Neumo.	15.694	7	9.019	4
006	Amebiasis	3.022	1	6.954	3
280-285	Anemias	9.211	4	5.444	2
580-629	Enfermedad Aparato Genito-urinario	5.973	3	3.504	1
098	Infecciones Gonococidas	1.728	7	2.942	1
004	Disentería Bacilar	244	1	2.332	1
011	Tuberculosis Aparato Respiratorio	1.159	5	1.703	7
070	Hepatitis Infecciosa	-	-	1.690	7
401	Hipertensión Arterial	3.830	2	1.641	6
290-309	Psicosis Trastornos Nervios y Emoc.	4.215	2	1.531	6
090-097	Sífilis	1.083	4	1.302	5
140-199	Tumores Malignos	665	3	1.240	5
520-577	Enfermedad Aparato Digestivo	1.377	6	1.210	5
055	Sarampión	687	3	1.048	4
410-429	Cardiopatías	2.703	1	939	4
N945-N907	Heridas y Traumatismo	4.901	2	843	3
N800-N929	Fracturas y contusiones	2.456	1	728	3
052	Varicela	210	08	696	3
210-288	Tumores Benignos	500	2	629	3
692	Alérgias	2.885	1	555	2
072	Parotiditis Epidémica	135	05	519	2
303	Alcoholismo	541	2	432	2
110-117	Micosis Cutánea	1.237	5	319	1
001	Fiebre Tifoidea	86	03	266	1
240	Bocio	539	2	258	1
250	Diabetes	339	1	138	05
	Otros	92.911	39	102.254	41
	TOTAL	233.707	100.00	249.144	100.00

FUENTE: Informe Estadístico 1979
Departamento de Estadística Regional
Región Sanitaria Metropolitana
Ministerio de Salud Pública y Asistencia Social
Tegucigalpa, D. C., (Febrero de 1980)

POBLACION DE HONDURAS 1/
(En miles de personas)

A ñ o s	T o t a l	Urbana	Rural
1960	1,944.9	439.5	1,505.4
1961	2,002.3	465.1	1,537.2
1962	2,061.0	491.8	1,569.2
1963	2,120.9	519.2	1,601.7
1964	2,182.2	548.0	1,634.2
1965	2,244.6	577.5	1,667.1
1966	2,308.4	608.5	1,699.9
1967	2,373.5	640.4	1,733.1
1968	2,440.0	673.7	1,766.3
1969	2,507.8	708.0	1,799.8
1970	2,534.9	731.6	1,803.3
1971	2,604.3	767.7	1,836.6
1972	2,674.9	805.4	1,869.5
1973	2,746.9	844.1	1,902.8
1974	2,820.3	884.4	1,935.9
1975	2,896.2	926.5	1,969.7
1976	2,974.9	970.1	2,004.8
1977	3,056.5	1,016.0	2,040.5
1978	3,140.8	1,063.5	2,077.3
1979	3,228.4	1,113.5	2,114.9
1980	3,319.2	1,165.4	2,153.8
1981	3,413.4	1,219.9	2,193.5
1982	3,511.0	1,276.6	2,234.4
1983	3,612.2	1,336.2	2,276.0
1984	3,717.3	1,398.1	2,319.2
1985	3,826.2	1,463.1	2,363.1

1/ Cifras estimadas por la Sección de Cuentas Nacionales del Departamento de Estudios Económicos del Banco Central de Honduras, en base a los Censos de Población y Vivienda de los años 1950, 1961 y 1974, ajustados a junio de cada año y considerando Omisión Censal.

Tegucigalpa, D. C., marzo 10, 1980

Cuadro No. 1

OBJETIVOS, POLITICAS Y MEDIDAS DE SANEAMIENTO Y DESECHOS SOLIDOS

Objetivos	Políticas	Medidas
	Saneamiento del Medio Ambiente	
Mejorar las condiciones del medio ambiente que contribuyen a elevar el nivel de vida de la población preservar aquellas que contribuyen a su mantenimiento adecuado.	Aumentar la cobertura y mejorar la calidad de los servicios de saneamiento ambiental.	
	Desechos Sólidos	
	Mejorar e incrementar los sistemas de desechos sólidos urbanos y su manejo y disposición final en los sectores rurales.	Aumentar la cobertura o instalar en las principales localidades urbanas trenes de aseo, por medio de actividades coordinadas de promoción y cooperación técnica y financiera a las instituciones con obligación de atender este rubro. Estimular el uso del sistema de relleno sanitario en las principales ciudades del país.

[redacted] IN[redacted]ACI[redacted]SOB D. SIC.
EN LA REGIONES DE SALUD

FUENTE: MINISTERIO DE SALUD PUBLICA

REGION O MUNICIPIO INFORME	JUTICALPA	CATACAMAS	COMAYAGUA	SIGUATEPEQUE	REGION No.5	DANLI	CHOLUTECA	SN.PEDRO S.	CHOLOMA	LA LIMA	PUERTO CORTES
1.-POBLACION ACTUAL	20.800 h.	11.898 h.				30.000 hab.		321.000 h.			
2.-PERSONAL DISPONIB.											
2.1INGENIEROS	0	0	0	0	0	0	1	0			
2.2COORDINADOR(ALC.POL)	0	0	1	1	0	1	0				
2.3MOTORISTA	2	1	2	1	4	1	1	12	1	2	3
2.4AYUD.MOTORISTA	2	2	0	0	0	0	0				
2.5ENCARGADOS DEL TREN DE ASEO 1/	2	2	13	16	10	5	33	80	6	4	9
3.-EQUIPO 3.1VOLQUETAS	2	1(event)	2	1	1	1	1	2		2	3
3.2CHAPULIN CON TROCO	0	1	0	0	0	0	0				
4.-POBLACION BENEFI-	8589 hab	9518 hab.	10500 h.	5950 h.	6000 h.	S.D.	S.D.	256.800 h.	6000 h.	1955 h.	-o-
5.-TARIFA PROMEDIO 2/	L.2.-/mes	L.2.-/mes	L.2.-L.5.-/mes	L.2.-L.5.-/mes	L.1.-L.4.-/mes	L.1.50/mes	L.2.-L.3.-/mes			L.3.00	-o-
6.-INGRESOS/MES	L.2453.	L.1710	L.3300	L.1570	L.1042.=	L.1813.=	L.9478.50		L.744.18	L.5865.00	L.18471.14
7.-EGRESOS/MES	L.1654	S.D.	L.2960.=	L.3366	L.1500	L.834.=	L.6521.80		L.1035.00	L.1388.00	L.3454.43
8.-DISPOSICION FINAL	Al aire Lib.	Al aire Libre	Al aire Lib. (con quema posterior)	Al aire libre	Al aire libre (con quema posterior)	Crematorio (con quema posterior)					
9.-PRODUCCION	4.48 Ton./d.	15 Ton/d.	5.73 Ton.	1.5 Ton/d.	5 Ton/d.	14 Ton/d.	8.77 Ton/d.	240 Ton/d.	1/2 Ton/d.	24 Ton/d	---
10-COBERTURA DE SERVICIO	S.D.	S.D.	60%	60%	80%	S.D.	S.D.	80%	---	---	---

S.D. Sin dato.
1/ Barrenderos,Recolectores de Basura y Encargado de Limpieza de calles y cunetas,Peones
2/ Para vivienda según zona o tamaño
3/ Existe tarifa Industrial y Comercial,la que oscila entre L. 15.00 - L. 5.00 / mes.

BANCO CENTRAL DE HONDURAS
Depto.Estudios Económicos

POBLACION URBANA POR PRINCIPALES CIUDADES
1960 - 1985
(Miles de Personas)

S E C T O R	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Distrito Central	135.4	143.3	151.7	160.5	169.9	179.7	190.1	201.1	212.7	224.9	237.7	251.3
San Pedro Sula	58.8	63.2	68.0	73.2	78.6	84.6	90.9	97.6	104.9	112.7	120.9	130.0
La Ceiba	25.5	26.5	27.5	28.5	29.6	30.7	31.8	33.0	34.2	35.4	36.7	38.0
El Progreso	14.1	14.7	15.5	16.4	17.3	18.3	19.4	20.5	21.6	22.8	24.1	25.5
Puerto Cortés	17.6	18.1	18.7	19.3	19.9	20.5	21.2	21.9	22.6	23.3	24.1	24.8
Choluteca	11.7	12.2	13.0	13.9	14.8	15.8	16.9	18.0	19.1	20.4	21.8	23.2
Tela	14.3	14.4	14.8	15.2	15.6	16.0	16.4	16.8	17.3	17.7	18.2	18.7
Danlí	6.5	6.7	7.0	7.3	7.6	7.9	8.2	8.5	8.9	9.3	9.6	10.0
Juticalpa	7.2	7.7	7.9	8.1	8.3	8.5	8.7	9.0	9.2	9.4	9.7	9.9
Olanchito	4.5	4.6	4.8	4.9	5.1	5.2	5.4	5.6	5.8	6.0	6.2	6.5
Comayagua	8.6	9.0	9.5	10.0	10.4	10.9	11.4	11.9	12.5	13.1	13.8	14.4
Santa Rosa de Copán	8.3	8.4	8.7	9.0	9.3	9.7	10.0	10.4	10.7	11.1	11.5	11.9
Siguatepeque	6.2	6.4	6.7	7.1	7.5	8.0	8.5	9.0	9.5	10.0	10.6	11.3
T O T A L	318.7	335.2	353.8	373.4	393.9	415.8	438.9	463.3	489.0	516.1	544.9	575.5

Tegucigalpa, D.C., 23 de Septiembre de 1983

VRO/anded.

BANCO CENTRAL DE HONDURAS
Depto. de Estudios Económicos

POBLACION URBANA POR PRINCIPALES CIUDADES
1960 - 1985
(Miles de personas)

SECTOR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Distrito Central	265.6	280.7	293.5	312.2	332.2	353.5	376.1	400.2	425.0	451.8	479.8	509.0	539.6	571.4
San Pedro Sula	139.5	149.9	162.7	175.9	190.2	205.6	222.2	240.0	259.0	279.2	300.7	323.5	347.4	372.8
La Ceiba	39.3	40.7	41.3	43.0	44.6	46.4	48.3	50.1	52.0	54.0	56.0	57.9	59.9	61.9
El Progreso	27.0	28.5	30.1	31.9	33.8	35.8	37.9	40.2	42.6	44.9	47.4	50.0	52.7	55.5
Puerto Cortés	25.6	26.5	27.5	28.5	29.5	30.6	31.7	32.9	34.0	35.2	36.4	37.6	38.8	39.9
Choluteca	24.7	26.4	28.1	30.1	32.2	34.4	36.8	39.3	41.9	44.7	47.6	50.7	53.9	57.2
Tela	19.2	19.7	20.2	20.8	21.5	22.1	22.7	23.2	23.7	24.4	25.0	25.6	26.2	26.7
Danlí	10.5	10.9	11.5	12.1	12.6	13.2	13.8	14.4	15.0	15.6	16.2	16.9	17.5	18.2
Juticalpa	10.2	10.4	10.7	11.0	11.3	11.6	12.0	12.3	12.5	12.9	13.1	13.4	13.6	13.8
Olanchito	6.7	7.0	7.9	8.2	8.6	8.9	9.3	9.7	10.1	10.5	11.0	11.4	11.9	12.4
Comayagua	15.2	15.9	17.0	17.9	18.9	19.9	20.9	22.0	23.0	24.1	25.3	26.4	27.6	28.8
Santa Rosa de Copán	12.3	12.8	13.2	13.8	14.4	14.9	15.5	16.0	16.6	17.2	17.7	18.3	18.8	19.4
Siguatepeque	11.9	12.6	13.4	14.1	15.0	15.9	16.8	17.8	18.8	19.8	20.8	21.9	23.0	24.1
TOTAL	607.7	642.0	677.1	719.5	764.8	812.8	864.0	918.1	974.2	1,034.3	1,097.0	1,162.6	1,230.9	1,302.1

Tegucigalpa, D.C., 23 de Septiembre, 1983

MRO/anded.

RECOLECCION Y DISPOSICION DE DESECHOS SOLIDOS EN SAN JOSE DE COSTA RICA

Mario Gomar Antolínez

SUMMARY

This paper presents a detailed account of the collection and disposal of solid wastes in the capital city of San José, Costa Rica.

Detailed information is given regarding the amount of bitter and its composition during a given period of time.

Moreover, the activities and responsibilities of the organizations entrusted with these tasks are thoroughly described.

Date on garbage collection are contained in well tabulated tables. Thus, the paper attempts to present the quantitative aspects of this problem and not merely qualitative descriptions. Al matters are well documented.

El tiempo fijado para mi intervención es bastante corto, por lo que entregaré a la mesa que preside una copia de esta charla, con el ruego de que haga llegar copias de la misma a los que se interesen por ella.

Ing. Mario Gomar Antolínez, Director de Sanidad Municipal, Costa Rica.

De viva voz, platicaré de mis experiencias personales

ORGANIZACION

La Dirección de Sanidad como oficina encargada de el barrido, recolección y disposición de desechos esta organizada en la forma siguiente:

DIRECCION

- 1 INGENIERO
- 1 SECRETARIO
- 1 CONSERJE

SEC. ASEO VIAS

- 1 SECRETARIO
- 13 CAPATACES
- 22 CUAD. DIURNOS (+)
- 1 CUAD. NOCTURNA (+)
- (+) 21 CUAD. BARRIDO
- (+) 1 LIMP. TRAGS.
- (+) 1 LIMP. CHAPEAS
- 1 JEFE

11 BODEGAS

SEC. RECOLECCION

- 1 JEFE
- 1 INSP. DIURNO
- 1 INSP. NOCTURNO
- 45 CHOFERES (++)
- (++) 5 NOCTURNOS
- 146 PEONES

SEC. RELL. SANITARIO

- 1 JEFE
- 3 CHEQ. REVS.
- 1 COBRADOR
- 4 GUARDAS (+++)
- (++) 2 DIA, 2 NOCHE
- 4 PEONES
- 5 OPS. Y AYUDS.

Sección Aseo de Vías

Tiene a su cargo el barrido de calles, chapea de áreas verdes incluyendo algunos parques y limpieza de alcantarillas.

La distancia recorrida barriendo la ciudad equivale en un año a 2 veces y media la distancia de la tierra a la luna.

La ciudad de San José tiene 45 Kms^2 de superficie y un estimado de 45 Kms^2 de calles.

La distancia asignada a cada barredor es de 1.6 Kms., esta distancia es menor en zonas de alta producción peatonal.

El total de hombres asignados es de 307 peones en 11 bodegas, el número de peones por cuadrilla oscila entre 6 y 30.

Hay 1 cuadrilla de chapea, 1 de limpieza de tragantes, (15 y 17 hombres respectivamente), 20 barrido diurnas, 1 de barrido nocturna de 16 hombres.

El horario diurno es de 6:00 a.m. a 14:00 y el vespertino de 15:00 a 21:00.

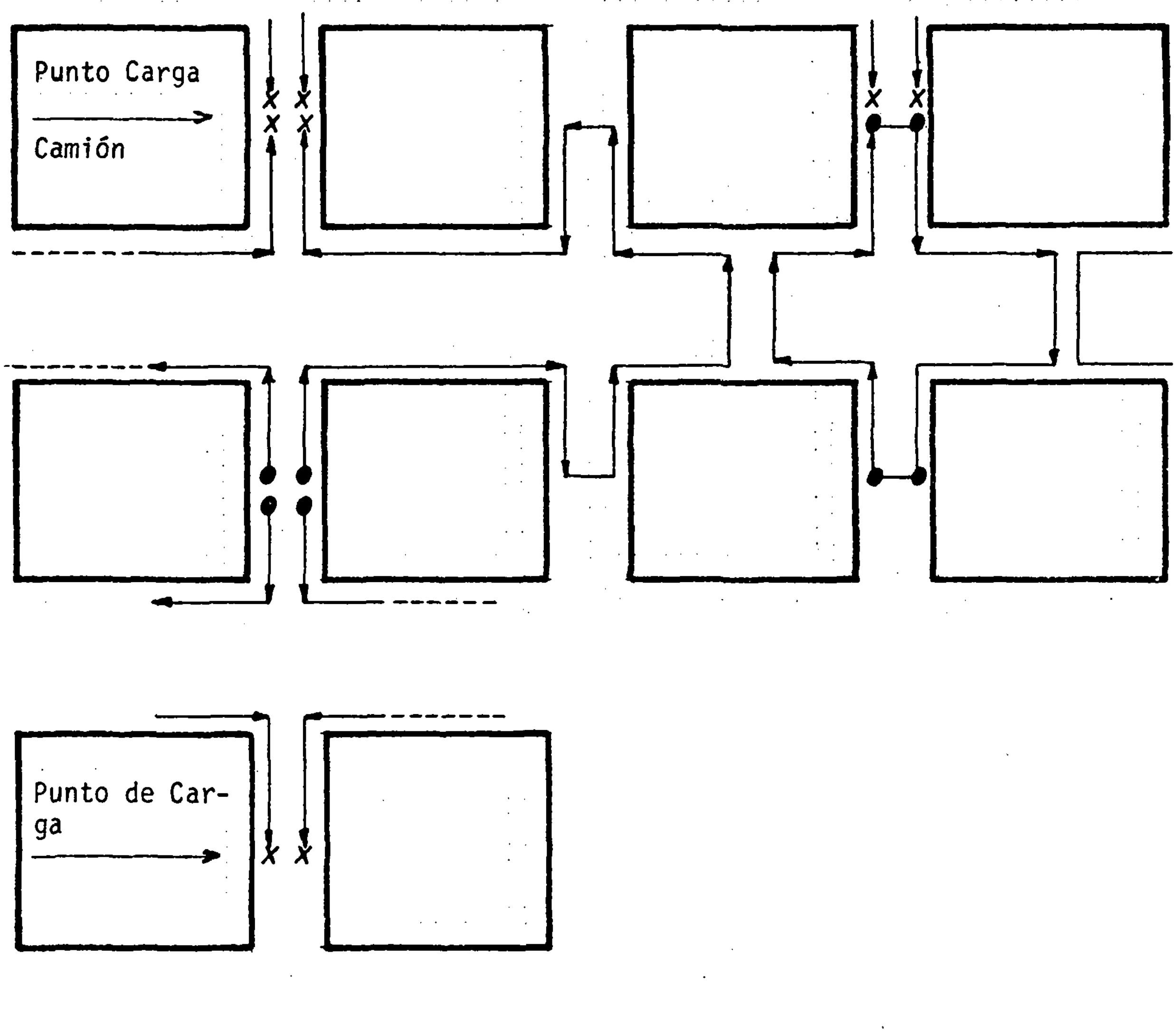
Además a esta sección se la ha dotado con un cargador 930 CAT. y una vagoneta de 10 M3 para limp. de lotes y montones de basura en las calles.

Cobro

El servicio de barrido se cobra según el número de metros lineales de frente que tenga la propiedad. Las propiedades con 2 frentes pagan por los dos lados.

TARIFA POR TRIMESTRE

COMERCIAL	==================================	22.60/m Lineal
NO COMERCIAL	==================================	9.15/m Lineal



● INICIO BARRIDO

X FINAL BARRIDO

Cuando el Recolector de barrido se descompone se usan bolsas con una capacidad igual al del carretillo.

Implementos de Barrido

Carretillos: De una rueda batea alta
De 3 ruedas con tonel

Escobones:

Destaqueadores de madera y bronce
Ganchos para cargar heno

Palas:

Carrileras con mango
Bolsones de plástico

Recolección:

Trabaja con un jefe, 2 inspectores - choferes (diurno y nocturno) 45 choferes y 146 peones, un Pickup 3/4 Ton.

Rutas

El servicio doméstico se lleva a cabo en cada ruta 2 veces por semana y el nocturno diariamente (Centro de la ciudad).

La ciudad se cubre con 36 rutas de servicio domiciliar diurno, 4 de servicio central, (Comercial y Domiciliar), 2 especiales (Mercados, Hospitales, Fábricas, Instituciones, etc.).

Vehículos Necesarios:

Conviene que cada chofer opere su propio vehículo para que se interese en su cuidado y responsabilizarlo por descuidos.

Nota: Solo se utilizan recolectores de carga trasera, de 10, 13 y 20 M3. de capacidad.

SERVICIO	CANT. RUTAS	CANT. RECOLEC.	RUTAS C/U	FRECUENCIA
DOM. DIURNO	36	12	3	2/SEM.
DOM. Y COM. - NOCTURNO	4	4	UNA	DIARIA
ESPECIALES	2	2	UNA	DIARIA
TOTAL	42	18		

REC. ADIC. AVERIA 7 (30 %)

TOTAL NECESARIO 25 RECOLECCION

5 ASEO VIAS

TOTAL 30 RECOLECTORES

NOTESE:

20 M3 = 2 X 10 M3

40 M3 = 3 X 13 M3

Cobro: TRIMESTRAL EN LA MISMA FORMA QUE EN ASEO DE VIAS

COMERCIAL EN CENTRO CIUDAD ---------------- ₡ 22.65/M Lineal

COMERCIAL EN OTROS LUGARES ---------------- ₡ 11.60/M Lineal

RESIDENCIAL ------------------------------- ₡ 4.65/M Lineal

Otros Sistemas:

(hablar sobre ellos)

Producción por Distritos:

Prorrateada por No. de Habitantes

DISTRITO	POBL.	TONS.	KM.2 AREA.
CARMEN	10678	2272	1.45
MERCED	24435	5200	2.69
CATEDRAL	34681	7382	2.48
HOSPITAL	43344	9209	3.27
ZAPOTE	21553	4589	2.72
SAN FCO.	13643	2912	2.63
URUCA	10509	2248	8.26
MATA RED.	9668	2069	3.65
HATILLO	43197	9177	4.38
SAN SEBASTIAN	48444	10311	3.87
PAVAS	25120	5345	9.33

Los 4 primeros distritos corresponden al centro comercial de la ciudad con mayor producción doméstica.

Un control exacto de zonas permitirá corregir adecuadamente el prorrateo anterior. Para planear adecuadamente las rutas.

Pueden usarse factores empíricos o prácticos tomando en cuenta los factores socio económicos, tráfico peatonal, zona comercial, follaje etc.

Otra forma es relacionando un censo de viviendas con la producción de desechos.

Relleno Sanitario:

El Relleno Sanitario de San José es nuestro mayor fuente de información estadística en él se reciben los desechos sólidos de 12 Municipalidades que forman un Convenio Cooperativo Intermunicipal.

Por conveniencia y sistema de cobro estos desechos se clasifican en 3 orígenes Municipalidad de San José que aporta el 46.53 %, otras Municipalidades con el 39.28 % y basuras de origen particular con el 13.72 % (Año 1983).

Producción Desechos Durante 6 años

X	AÑO	SAN JOSE	OTRAS MUNICS.	PARTS.	TOTAL
0	1978	60718	45610	19429	125757
I	1979	66036	50872	27650	144558
2	1980	66923	54055	27642	148620
3	1981	65116	54305	22521	141942
4	1982	59667	47751	15081	122529
5	1983	59082	50300	17594	126976
6	1984	58999	56980	21317	137296

CALCULO DE POBLACION ATENDIDA DURANTE EL AÑO 1983

Datos de población / Estadística y Censos al 31 de diciembre 1983

CANTONES	POBLACION	PRDO.TONS	KGS/CAP	% COMP.	POB.ATENDIDA
SAN JOSE	277.754	59.082	212.71	100	277.754
ASERRI	27.662	1.046	37.81	17.78	4.936
ALAJUELITA	31.763	1.985	62.49	29.37	9.329
CURRIDABAT	21.297	3.646	171.20	80.48	171.39
CORONADO	13.370	1.644	122.96	57.78	7.727
DESAMPARA	84.899	10.162	119.70	56.27	47.772
ESCAZU	32.976	3.036	92.07	43.28	14.272
GOICOECHEA	77.425	9.735	12.57	5.91	4.576
LA UNION	31.714	1.370	43.20	20.30	6.438
MONTES D'OCA	4.107	5.826	13.208	62.09	27.386
MORAVIA	20.418	4.454	218.14	102.55	20.418
TIBAS	50.291	7.396	147.06	69.13	34.766
TOTAL:	713.676				

El cuadro IV. B. es un procedimiento ideado por el autor para determinar en una forma bastante aproximada cual es la verdadera población atendida en base a la premisa de que en San José se atiende al 100%.

El cuadro de 1983 es especialmente interesante, ya que por primera vez aparece un cantón (Moravia) en el que la producción per-cápita es mayor que San José (+).

(+) NOTA: Hasta el año 1982 se trabajó con proyecciones calculadas - por la oficina de Sanidad.

USO DE LA INFORMACION PARA CALCULAR CURVAS DE PROYECCION

Previamente es conveniente comentar que la crisis económica de los años 81 y 82 se reflejó dramáticamente en una baja de la producción de desechos sólidos al pletear la curva correspondiente a la producción por años (TOTAL) esta resultó en una forma muy parecida a la de una hipérbola con rama descendiente hacia el futuro, lo cual es imposible ya que Q - 0 o sea que llegaría el momento en que no se producirían desechos.

En el año 1983 hubo un ligero incremento, pero al calcular una recta por el método de mínimos cuadrados, la pendiente de dicha recta sale con signo negativo.

Usando el cuadro que aparece en el siguiente cuadro para calcular una recta ajustada por mínimos cuadrados tendremos:

AÑO	X	Y	XY	X"2
1978	0	125757	0	0
1979	1	144558	144558	1
1980	2	148620	297240	4
1981	3	141942	425826	9
1982	4	122529	490116	16
1983	5	126976	634880	25
N=6	15	810382	1992620	55

$Y = a+bx$

$EY = Na+bEX$

$EXY = aEX+bEX^2$

$Y = 137286-888.93X$

E = E

Eg= Nat bEX

Como se vé el cálculo indica una pendiente negativa lo que es imposible.

Para una estimación de la vida de un relleno sanitario convendría eliminar los años anómalos. El planificador debe usar su propio criterio.

El ploteo de la producción anual y los descensos que se notan a partir del año 81 con una ligera recuperación en el año 1983 pueden indicar:

a) La crisis vivida y una lenta recuperación

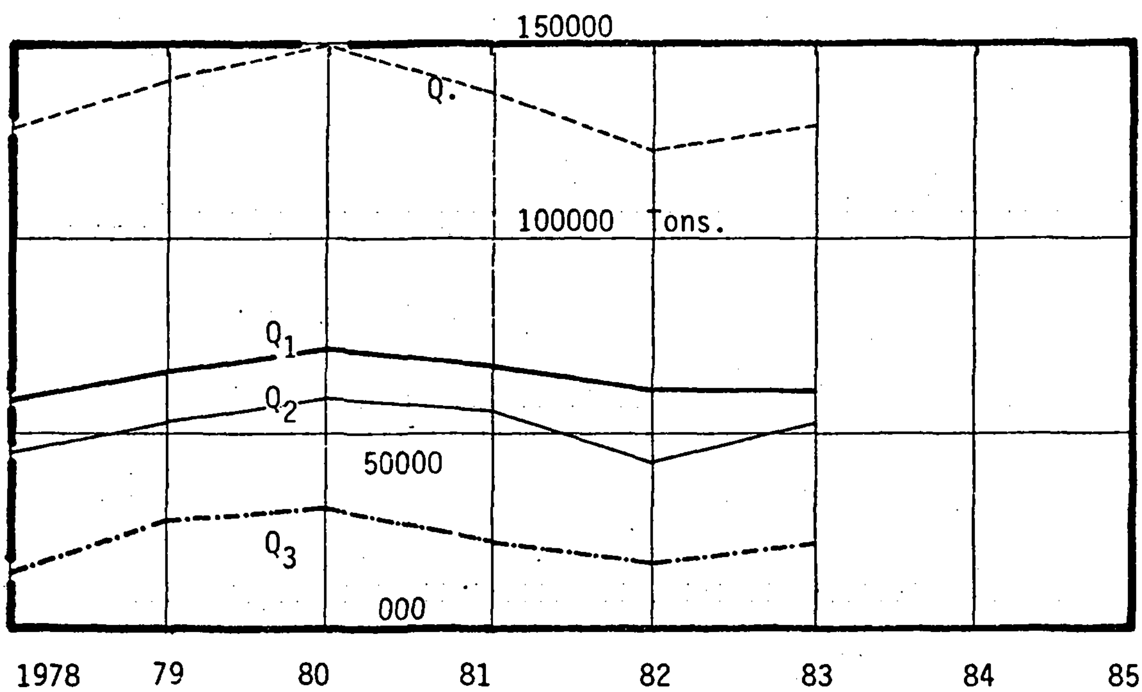
b) Tomándolo por el lado positivo, que la gente ya aprendió a ahorrar y que las industrias se esfuerzan por disminuir su desperdicio.

Otras Estadísticas:

Ingreso de vehículos:

Este dato es interesante para el caso de que se planifique una industrialización de desechos o para planear el tamaño de la playa de vertidos, este dato debe utilizarse junto el de meses de mayor y menor ingreso.

La procedencia es interesante y de ser posible los desechos industriales debieran clasificarse, ya que en gran parte son reaprovechables.



Q = Producción Total Q_1 = Prod. San José; Q_2 = Prod. Otros Munic.; Q_3 = Bas. Part.

Ingreso de Vehículos:

PROCEDENCIA	1978	1979	1980	1981	1982	1983
.SAN JOSE	11789	13211	13870	15173	15369	
OTRAS MUN.	7997	9773	11029	11104	9751	
PARTICULARES	19521	22197	23650	20571	15891	
TOTAL	39307	45181	48549	46848	41011	

Meses de Mayor y Menor Ingreso de Vehículos:

	1978	1979	1980	1981	1982	1983
MAYOR	NOV.10815	JUL.13463	JUL.13107	JUL.13015	JUN.10643	
MENOR	FEB. 9892	ABR.10588	ABR.11202	ABR.10593	FEB. 9555	

Ingreso Promedio Diario en Tons. año de 365 días

1978	1979	1980	1981	1982	1983	1984
344.54	396.05	406	388.64	335.70	347.87	

También puede usarse el año de 300 días en el caso de planificación de plantas industriales que deban almacenar lo producido en días hábiles.

Año de 300 Días

1978	1979	1980	1981	1982	1983	1984
419	481.86	494	473	408	423	

Los asistentes a este Congreso saben que no hay nada que sea menos homogéneo que los desechos sólidos, por consiguiente las investigaciones que aparecen a continuación deben tomarse con la reserva del caso.

No hay que ser dogmático y recordar que somos técnicos y no científicos. Incluso en el presente trabajo se encontrará con los resultados de varias investigaciones que arrojan resultados distintos y a veces con variaciones muy grandes.

Cada información debe tomarse para el propósito que sirve, por ejemplo en lo referente al peso, lo mas importante es el de la basura compactada en el recolector para efectos de compra de equipo y el peso específico colocado en relleno para los efectos de volúmen ocupado para duración del relleno.

Características de los Desechos de San José:

Muestreos año 1980: (Datos Municipales)

Peso Específico

1. Compactado en Colector -------------------- 500 Kg/M3 (A)
2. En Calle ---------------------------------- 225
3. Colocado en Relleno ----------------------- 400

(A) Muestreos: 1o. a 12 Feb. 1979 ---------- 400 Kg/M3 (tiempo seco)

Nov. 1979 ---------- 500 Kg/Me (tiempo humedo)

(B) Muestreo Enero 1980

Los valores anteriores con oscilaciones de ± 10 % para desechos compactados y ± 15 % sin compactar.

Composición Desechos en %

Papeles ================	30-45
Metales ================	1-3
Plásticos================	6-12
Putrecibles =============	35-50
Chapeas ================	8-12

Características Fisicoquímicas: (Univ. C. R. Mayo 1980)

% Humedad --------------	70
Ph. ---------------------	5

Calor combustión de acuerdo a fórmula $\frac{C.C.H.}{g.m.a.} \times \frac{100\ \%h}{g.m.h.} = C.C.S.$

C.C.S. = 1558Kcal/Kg. se puede usar 1500 Kcal/Kg.

Brown Boveri = 1500 Kcal/Kg

Los proyectos pirolíticos no son rentables.

En el año 1983 con nuestra colaboración se elaboró una tesis previa a optar el título de Ings. Químicos por los hoy Ingenieros: María Elena Jiménez y Allan Zúñiga Morales.

Esta tesis fué elaborada con la ayuda de computadoras, se extrae de esa tesis los datos más interesantes.

Muestras Analizadas: 52

Mat. Org.	56 -	100	Cant. Muest.	
Papel	51 -	100	44	
Vidrio	0.7 -	9.3	15	
Metales	0.6 -	100	24	
Bultos	1.5 -	19.4	24	(pedazos madera, tubos, zapatos, productos varios).
Plásticos	1.7 -	100	45	

Propiedades Físicas:

			PROMEDIO	No. MUES.
% Humedad	7.1	89.9	60.7	52
Grav. Esp. en calle	1.04	2.10	1.41	52

Poder Calorífico:

S/ M.E. Jímenez ---------------------------- 800 Kcal/K.

S/ U.C.R. 1980 ----------------------------1558 Kcal/K.

$$P.C. = \frac{C.C.H.}{g.m.s.} \times \frac{\%h}{g.m.h.}$$

S/Brown Boveri -----------------------------1500 Kcal/K

S/I.C.E. -----------------------------------8073 B.Y.U.

Residuos ----------------------------------- 11.98

(1 Caloría = 0.252 B.T.U.)

Comp. M.E.J. -------------------------------1630 Kcal/K.

I C A I T I

Análisis Químicos en %: 52 Muestras

	LIMITES	ESTIMACION S. INCIDENCIA EN CURVAS
Cenizas	5.17 - 36.88	14
Cloro	0.27 - 6.86	3.0
Azúfre	0.80 - 1.15	1.15
Carbono	5.33 - 50 (?)	50 (?)
Mat. Org.	9.33 - 94.47	70
Nitrógeno	0.13 - 2.00	1.1
PH.	4.02 - 8.30	5.4

Comparación entre Desechos de EEUU y C.R.

	EEUU	C.R.
GRAV. ESP.	0.3	1.40
HUMEDAD	20	60
CLASIF.ALREC.	SI	NO

Gasto Dir. Sanidad

Lo gastado por Renglones en el año 1984 (en %)

Dirección	0.74	
Aseo vías	38.24	
Limp. Fum. Pozos	2.43	
Recolección	43.54	
Rell. Sanit.	10.98	
Trans. A. C. Salud	1.07	(No maneja Dir. Sanidad)
	100.00	

La operación representa aprox. U.S. $ 1,125,000/Año.

Lo anterior representa las cifras de la Dirección de Sanidad de la Ciudad de San José.

Por su posible utilidad a otras direcciones de sanidad de países amigos se incluye el valor de compra de algún equipo:

Tanques de Lámina:

Nuestra experiencia no recomienda su uso en áreas públicas, recomendable para empresas e instituciones (A Marzo 1980).

Capacidad	Costo $
2 M3.	932.00
1 M3.	743.00

Recolectores carga posterior Cap. 13 M3 o Cap. neta a 6500 Kgs--$47,872.71, Marca G.M.C. con cajón EZ Pack. También se usan para tanques.

Recolectores carga lateral para toneles Cap. 4.5 M3 (Esta capacidad resultó muy pequeña) Marca Mercedes Benz con cajón TYMCO ------ $24,230.00.

Barredoras a succión Mercedes Benz con equipo de succión TYMCO--$60,630.00 (no se recomienda este equipo).

Cobro a cuenta Trat. ₡ 12.00/M3 Trimestre

Problemas:

Con Personal:

Los inherentes a la indiosincrasia en cada país y a sus leyes o convenios laborales.

Con Equipo:

Muchísimos ocasionados por la intervención directa y obstaculizante de personas con mando que no entienden los problemas

Con Climatología y Terreno:

Ocasionados principalmente por excesos de lluvias, carencia de materiales granulares en el Relleno Sanitario.

Lluvia San José 1983-------- 704.30

1984--------1254.5

Con el Público:

Por mala educación cívica , exageración en sus quejas y personas que las reciben y aumentan.

Datos Interesantes para diseño de rutas:

Velocidad de Recolección (por volúmen)

De 24 a 40 Kgs/min. (en ruta recolectando)

Para tomar café 15 mins. generalmente después del 1er. recorrido

Un recolector se llena en:

De 10 Ms3	---------------------	125 a 208 minutos
13 Ms3	---------------------	162.5 a 270 minutos
20 Ms3	---------------------	250 a 416 minutos

Cobros en Relleno Sanitario:

A	Municipalidades	₡ 34.67 / Ton. Met. tratada
A	Particulares	₡ 12.00 / Met. Cub. intresado.

Vehículos asignados y uso

TIPO	CANT.	CAP.	FREC.	LABOR	HORARIO	ZONA
REC.C.T.	3	10 M3	DIARIA	REC. CARR.	DIURNO	CENTRAL
REC.C.T.	1	10 M3	DIARIA	REC. CARR.	NOCT.	CENTRAL
PICK-UP	1	1/4 TON.	DIARIA	INSPEC.		TODAS
BARRED.	4 (+)	3 M3.	FERS. DOMS.	BARR. CALL	DIURNO	VARIAS
R.C.L.	4 (+)	5 M3.	DIARIA	REC. CARR.	DIURNO	VARIAS
VAGONETA	1	10 M3.	DIARIA	MONT. Y ESC.	DIURNO	VARIAS
CAMIONCITOS	4	3 TONS.	DIARIA	MONT. Y ALC.	DIURNO	VARIAS
CARGADOR	1 CAT.930	1 1/2	DIARIA	MONT. Y LOT.	DIURNO	VARIAS
R.C.T.	1	13 M3.	DIARIA	TANQUES	DIURNO	TODAS

R.C.T. = Recolector Carga TRAS.

R.C.L. = Recolector carga Lat.

(+) (++) Equipo no Rec.

FERS. = Feriados

Carr. Carretillos

Barr. Call = Barr.Calles

Mont. y Esc. = Mont. y Ecs.

GENERAL ASPECTS OF INDUSTRIAL WASTE MANAGEMENT

- Laws and Regulations -

Jürgen Orlich

RESUMEN

Requisitos que debe cumplir la legislación para manejo de desechos. Diferencias entre la disposición de desechos domésticos y la disposición de desechos industriales.

Administración y legislación para manejo de desechos. Requisitos legales básicos para un programa de manejo de desechos: Definición de "desechos", delimitación de las responsabilidades, autorización y planificación para instalaciones (rellenos; plantas incineradoras; instalaciones de reciclado; plantas para tratamientos químicos, físicos y biológicos).

Instalaciones para traslado y almacenamiento. Otros aspectos relativos a la legislación. Temas especiales;control de flujo de desechos, importación de desechos.

Aspectos administrativos del manejo de desechos.

INTRODUCTION

Industrial Waste Management and specially hazardous waste management has developed increasingly to a central issue in the overall environmental policy in most industrialized countries. This development reflects the growing awareness that in no other field of environmental protection on is faced at the same time with such high quantities and high concentrations of hazardous pollutants as in the form of solid and liquid hazardous waste arisings.

Jürgen Orlich, GTZ, Alemania

Moreover, the dimension of the problem ist evident from the fact that the generation of hazardous wastes is an imminent cosequence of many, if not most industrial activities. Even the intensive efforts to clean and safeguard the environment in terms of air and water pollution abatement lead to many and mostly negative consequences on the waste front. All this demonstrates that the hazardous waste problem is a permanent and in the long term probably still growing problem both form the point of view of generation and disposal.

Waste management is a rather complex matter. Although the technical aspects are of prime importance there is a number of non-technical questions that have to be addressed to give a complete picture of the issue.

Waste management differs substantially from "normal" industrial activities. The main reason that calls for a specific approach is the fact that waste generally has a negative value. Unless society organizes waste disposal it would basically follow economic principles. Waste would therefore be disposed of at the lowest possible costs. There is quite a number of places where this still seems to be the principle for waste disposal.

Proper waste management is rather costly affair. Mismanagement can be costly, too. Clean-up costs for improper dumping of hazardous waste can sum up to millions of Dollars. The health risks connected with pollution caused by dumping of wastes are high. There are numerous cases where improper waste disposal led to the pollution of ground water tables used for the production of drinking water, even in countries, where drinking water is a rare good.

For all these reasons waste management cannot follow simple market principles.

The role of legislation is basically to provide a framework for organizational decisions. Legislation has to assure that

- public responsibility for waste management is established,
- that management decisions can be made at the appropriate level of government,
- that duties, necessary to make the system work can be enforced,
- that control can be executed.

It is very difficult to establish generally acceptable principles with regard to administrative and legislative questions. The reason for this difficulty is selfevident: the need for and the enforcement of administrative and legislative patterns for waste management depends on the situation of the country in question. Considerations such as the constitution of the state, whether or not it is an unitarian state or a federation, its distribution of administrative powers, i.e. centralization or devolution of administrative functions, have a strong influence both on the extent to which legislation is possible and on the form in which legislation can be enacted, implemented and enforced. The economic constitution of a state may equally have a strong influence on legislation.

In the following remarks, only basic needs for administrative and legislative decisions will be discussed and indications will be given of difficulties that have to be expected organizing waste management.

There has to be a clear distinction made between disposal of municipal waste as compared to other types of waste, in particular to industrial or hazardous waste. Whereas the legal and administrative needs to organize municipal waste disposal are already clearly established, this is not the case with regard to industrial waste disposal. Each of these issues should therefore be looked at separately. It might be useful to pinpoint the most important differences between municipal and hazardous waste disposal before giving recommendations on organizational issues, in order to demonstrate that what applies to one group does not necessarily apply for the other.

- Municipal refuse is generated everywhere where people live. This is not the case with industrial waste and particularly not with hazardous waste. The organization of municipal waste disposal is a necessity for every community on the local level. Industrial waste disposal can only be done on a regional, supraregional or even national level.

- To avoid unnecessary, long distance transportation of municipal waste, facilities for the disposal of such waste should be within reasonably close distance of the municipality. This can be achieved in most cases.

- Industrial waste disposal needs special precautions, technically and with regard to control, to assure proper disposal. To be cost-effective, facilities will need large "catchment areas".

- Hazardous waste, when generated in large quantities, needs specially designed disposal facilities. To establish suitable facilities will generally be beyond the financial and technical capacities of local authorities.

ADMINISTRATION AND LEGISLATION

The term "administration" covers both, the private and the public sector. It is not limited to state, regional or local authorities. In cases where responsibility for waste disposal is left to the waste generator, he will have to carry part of the administrative burden.

Other than the term administration, the term "legislation" refers to central and local governments as well as legislative bodies, only, i.e. to the public sector. However, the term "legislation" should not be understood too narrowly. Scope and nature of legislation required for waste management depend strongly on the individual state's constitutional and administrative requirements.

There might be states which do not need any legislation in the strict sense of the word. There must be, however, some binding principles. Some states may require laws, others might operate under statuatory or even administrative regulations.

Many aspects of waste management would be hampered rather than improved by binding laws. This is particularly true for the technical sector of waste disposal. It has, therefore, to be borne in mind that these areas can often be better regulated by the use of guidelines.

All these instruments will be regarded as "legislation" in this paper. Where appropriate, indications will be given as to the legal quality of regulations required.

BASIC LEGAL REQUIREMENTS

There are a number of basic legal requirements which have to be provided when establishing a waste management scheme. A law has to regulate

1. What is to be regarded as waste
2. Who is responsible for waste disposal
3. Where can waste be disposed of, and
4. How shall disposal take place?

These materrs should be regulated on a national basis, i.e. by national laws and/or regulations. There are other matters which sould be addressed on the regional or rather local level, such as frequency of collection, usage of containers etc.

Definition of Waste

At the first glance, a definition of what is regarded as waste seems to be superfluous, as waste is a commonly understood term. There are situations, however, where a definition of the term "waste" can be helpful.. It is quite clear that material which its owner wants to get rid of by means of waste disposal should be regarded as waste without considering its value. This does not necessarily mean that it has to be disposed of. This principle only means that the decission to regard material as waste should in the first instance be a decission of the owner of the material in question. There are cases where material is not handed over to waste disposal but can either per se or by the actual way of storage be a public nuisance or even danger. If someone is collecting empty tins in his backyard without having any further plans for them, and if this material attracts rats and insects, there should be a way to dispose of this material even if the owner objects. The same should be true for abandoned cars left alongside streets or on public land or in the extreme for hazardous material leaching away in the backyard of a factory.

In these cases, it might be useful to have regulations that allow for the disposal of such materials even against the will of the owner. An objective definition of the term waste can be dispensible if the law grants sufficient power to the authorities to remove items from their owners on the grounds that the items have no value and are, by their condition, a clear public nuisance.

Designation of Responsibility

The most important issue to be regulated is who is to be responsible for waste disposal. With regard to municipal refuse, responsibility should lie with the city administration or other comparable public institutions. It is important to mention that responsibility to organize waste disposal does not necessarily mean that the public institutions have to provide the service themselves. In certain cases it can be technically and economically favourable to use a third party, for example a private enterprise particularly for the collection and transport of the waste. Joint ventures of different local authorities should be encouraged, especially when these authorities aim at operating a common disposal stie or facility. Private investments for waste disposal facilities may be difficult to get unless there is compulsory use of the service.

The "waste disposal authorities" should have the power to issue bylaws regulating details of the local waste disposal scheme, such as the use, size, and type of containers, fees for the service and its frequency. They should be in a position to decide which waste can be accepted for municipal waste disposal.

As mentioned before, the duty of the local authorities should be limited to municipal waste disposal, including the waste of small shops and enterprises, market-generated waste, etc. Additionally, industrial waste can be accepted, provided it does not impose greater risks during transportation and disposal than household waste.

Waste disposal covers three different phases:

- collection
- transportation
- treatment and/or disposal (in the narrow sense of the word).

With regard to municipal refuse, the responsible authorities should be required to cover all three phases. If industrial waste of certain types and quantities can be accepted for treatment and disposal, this does not imply that the local authorities should also take care of collection and transportation. This should be done by the respective industrial enterprises or by special transportation firms, as it often requires special equipment.

Whereas the designation of responsibility for municipal waste is quite easy (as there is generally only one organization that would be acceptable for this task), the same does not apply for industrial or hazardous waste.

There are different ways to organize hazardous waste disposal.

- The responsibility can remain with industry, which will then have to organize its own disposal scheme or use "third parties", i.e. private enterprises for disposal.

- It can be designated to a particular public authority, who can then share the responsibility through the use of joint ventures between industry and public bodies.

Which of these options will suit a given situation best cannot be predicted in general terms. It is therefore advisable, through legislation, to refrain from promoting one particular pattern of organization without investigating the suitable options in the given situation.

The advantages and weaknesses of the different organizational options for hazardous waste management can be summarized as follows:

Advantages

- The participation of public corporation can ensure directly the adequate utilization of certain facilities, a direct influence can be used to assure the observation of certain disposal standards.

- The government's duty to eliminate dangers to the general public can be met directly and effectively if the government participates in hazardous waste disposal enterprises or if it establishes facilities itself. By means of strong governmental involvement, the creation of a comprehensive hazardous waste disposal system becomes feasible. Such a comprehensive system will not develop on the market.

Problems

- Strong government influence will result in a reduction of private investment and would be regarded as a takeover of responsibility. This would inevitably result in a lack of participation and cooperation of industry. Waste generation and waste disposal would be in separate hands. This could lead to a loss of coordination and cooperation. In the case of industry-owned facilities, adjustment of waste disposal to the production process and the technical know-how of the operators, however, can be an additional advantage.

- The willingness of waste-generating industries to develop and utilize waste reduction techniques might be diminished, if all responsibilities were taken over by public corporations.

The establishment of disposal scheme for industrial waste requires thorough planning. The necessity and scope of such a scheme depends on the types and distribution of industries and the quantities and kinds of wastes generated. Co-disposal of industrial waste together with municipal refuse can be an viable option unless particular hazards of industrial wastes or other factors prohibit the use of this method.

In cases of low industrial density or monoculture it may be advisable to leave responsibility for industrial waste disposal with industries but provide tight control by government authorities with regard to disposal operations.

The waste disposal aspect should in any case be considered in the planning phase for industrial settlements, already. Industrial developments should only be realized if appropriate waste disposal is provided for.

To summarize the findings on the designation of responsibility, it can be concluded:

1. The responsibility for municipal waste disposal should be with the appropriate local authorities.

2. Cooperative efforts of local authorities should be encouraged, particularly on the treatment and disposal side.

3. Municipal refuse disposal schemes have to consider to include waste from small shops and businesses in their service. Industrial and hazardous waste should generally be excluded from this service, unless it can be proved that co-disposal is acceptable in environmental terms.

4. Means to ensure cooperation of industry should be exhausted to make use of industrial know-how and financial contributions from industry.

5. Wherever possible, the establishment of industry owned facilities should be encouraged. Government control of such facilities, however, should be provided (of. below 5).

6. The distribution of responsibility for organizing waste disposal should be regulated in national law.

The Licensing and Planning of Facilities

Waste should only be disposed of in facilities licensed for this purpose. This principle should be subject to national law, which has to provide regulations for licensing and planning for such facilities. The law should include a provision regulating that all types of waste disposal facilities need a license prior to construction and operation. Licensing should therefore cover:

- landfills
- incineration plants
- recycling facilities (if not covered by other legislation on the production of goods including provisions necessary for environmental protection)
- chemical, physical and biological treatment plants
- transload and storage facilities.

Special considerations should be given to the storage of industrial waste, as storage often slides into ultimate disposal, which may result in high cleanup and removal costs.

Licensing of industry owned disposal facilities may not be necessary if there is a comprehensive licensing scheme for industrial facilities as a whole, which also covers the waste disposal aspect. It can be generally noted that licensing of waste disposal activities should be looked at in the same way as licensing of potentially hazardous industrial activities.

To ensure that given standards are met, it can be helpful to distribute responsibilities for facility planning and licensing of facilities to different government authorities. Facility planning can be done on the local level, provided the necessary technical know-how is available. Licenses should be issued by a different, preferably a higher administration to guarantee control of local authorities, the harmonization of planning decisions and the consideration of overall planning requirements. Licensing by non-local authorities may also help to avoid local pressures which otherwise could influence administrative decisions.

The licensing procedure as such will have be regulated by law. The technical side of site selection, equipment of facilities, safety precautions etc. needs only be regulated in a very general form, stating the basic principles. To assure uniform practice, guidelines or administrative regulations on these issues can be helpful. They should be binding for planning and licensing authorities. It has to be underlined that licensing of facilities particularly of landfills can only be done on a case to case basis, as local conditions and local needs tend to differ very much.

This fact has to be considered when drafting guidance documents. It is essential to make the system flexible enough to keep it working under different conditions. The most important factors that have to be considered for planning and licensing of waste disposal facilities - particularly landfills - can be summarized as follows:

- location of facility, geological conditions
- size of the site
- capacity of the site
- possibility of expansion
- availability of the site (ownership etc.)
- waste that can be disposed of (municipal refuse, industrial waste, hazardous waste)
- extent and kind of construction work necessary
- technical and safety equipment
- access to transportation (road, railways, canals)
- proximity to similar facilities
- proximity to possible users (important to both municipal refuse and industrial waste disposal facilities)
- site characteristics with regard to water management
- background level of air pollution (incineratior plants)
- climatology
- site conditions that could impose particular hazards
- contingency plans
- monitoring and control devices
- particulars on financing of the facility (where appropriate, including insurance and long term care).

Looking at this long list of determining factors for planning and licensing of a facility, it becomes clear that it is not reasonable to include provisions on site selection and particulars of the licensing of a facility in laws and regulatios. These should only regulate the basic principles. Guidance documents, however, can be extremely helpful.

With regard to the list given above it has to be emphasized that it is by no means exhaustive. Many more factors have to be considered when licensing a facility. Particularly landfill disposal sites will require a fairly comprehensive study of local, particularly hydrogeological conditions. The following subject areas should, therefore, be particularly carefully examined when a license for a landfill site is applied for:

- geological conditions including hydrogeological situations to avoid groundwater or surface water pollution.
- assessment of the impact of landfill operations particularly of attenuation, leachate migration, and leachate management.
- climatology
- proximity of settlements and water supply facilities
- environmental impact control (control boreholes or wells).

Legislation in the field of planning and licensing of facilities should give regard to the fact that the controlling authorities will need broad competences to insure proper construction and maintenance of facilities. To this end the following principles should be regulated by law:

- principle of licensing of facilities
- purpose of the licensing procedure, stating the matters that have to be considered in broad terms
- right of access to the facility by control authorities
- right to issue or alter conditions of the license even after start of operations.

The answer to the question how waste disposal should take place is closely linked to the licensing of facilities as described above. Facilities should only be licensed for the disposal of <u>certain</u> waste which are acceptable in terms of technical equipment and safety precautions. The answer as to <u>how</u> waste and particularly how certain types of waste have to be disposed of cannot be given in a general way. A commonly accepted state of the art does not yet exist with regard to waste disposal techniques. It can be said that, for some industrial waste, incineration is a safer method of disposal than landfilling. However, using highly developed technology is very costly, and facilities might not be available. Still, the waste is generated. This calls for compromising. In trying to find the right compromise between economic needs and the protection of the environment, it should at least be aimed at minimizinging the risks for environmental damages on a large scale. Therefore, hazardous waste should -when disposed of in landfills- be transferred to sites where there are favourable site conditions, particularly with regard to climatology and ground water protection.

On the other hand, it has to be said that an environmentally neutral form for waste disposal does not exist. The aim should be to reduce the residual risk as much as possible. This principle should find an appropriate expression in legislation.

Whenever the structure of local government and the distribution of competences allow, a regional, and, for industrial waste, even supraregional planning for site selection purposes should be aimed at. Waste disposal plans should at least give guidance to the local authorities on suitable sites for waste disposal facilities.

It has to be mentioned, however, that the development of a comprehensive waste management system cannot start at zero. Existing facilities have to be considered for intermediate use and will have to be the basis of any future disposal scheme.

Other Aspects of Legislation

In some countries, waste legislation is already a highly sophisticated and specialized matter. It is always very tempting to make good use of others experiences. This will not work in the field of waste management legislation. Legislation as such and particularly environmental legislation which will be regarded as very remote legislation by its addressees should aim at the feasible. There is nothing worse than detailed, sophisticated legislation which nobody obeys. This has to be borne in mind when drafting laws and regulations. Legislation only makes sense, when enforcable. Waste legislation should therefore, in the first place, be directed towards people that are actively involved in waste management, like operators of waste disposal facilities, regional and local governments as opposed to the public in general. To be complete, I should at least mention some areas which are subject of legislation in some countries which already have a comprehensive waste management system. In these countries, laws and regulations do exist on i.a.:

- Waste management planning (planning principles, aims of planning, procedural questions).

- Waste management principles (priority of waste generation avoidance and material and energy recovery as againt "simple" disposal).

- Control procedures, including such on licensing transportation, import and export of waste.

- Special legislation for certain types of waste like:

  . waste oils and lubricants

  . hazardous waste (including definitions, hazardous waste lists, special requirements for disposal, special control procedures like waybill or tripticket procedures),

  . sludges (regulations on agricultural use of waste water treatment sludges etc.).

When introducing waste legislation, it should be kept in mind that the transmission of problems into other media should be avoided as far as possible. If the disposal of waste on land is regulated but there its no regulation on incineration of waste, incineration would be used and may cause severe air pollution problems. Imposing regulations on the disposal of sewage sludges, where there is no obligation for waste water purification, can lead to unpurified discharge of waste water to avoid costly disposal of sludge. It has to be borne in mind that waste management legislation has to have its proper place within the framework of general legislation and of environmental legislation in particular. Rather than developing a whole set of new legislation it can be recommended to use existing patterns to also cover the waste aspect. Existing laws and regulations on hazardous industrial activities can, for example, also cover the hazardous waste aspect. Public cleansing laws can be extended to also regulate municipal waste management. Such a coordinated approach can reduce problems of enforcement and make the establishment of new administrations superfluous, as existing authorities can be used to take care of the new legislation. Waste legislation should - in so far as it is possible for legislation - take into account the social, cultural and economic background and should give due regard to the problems of public acceptance that have to be faced.

Special Control Issues

There are two control issues that need special mentioning particularly with regard to developing countries, i.e. waste stream control and import of waste.

Many of the industrialized countries have already established specialized legislation on waste stream control including so called trip-ticket-procedures for potentially hazardous wastes to insure that wastes reach their ultimate destination. These control procedures are rather costly and personnel consuming. However, they have to be introduced if there is a free, open market for hazardous waste disposal enterprises and a large number of waste transports. To make best use of control capacity it can be recommended to concentrate control on the waste generators and on disposal facilities and reduce the use of "third parties" as much as possible. Records on waste generation and waste disposal should be obligatory. These records should be subject to inspection by the control authorities. Wherever an "open market" for disposal firms is aimed at, these firms will be a weak point in the system with regard to control and have to be subject to specific control measures.

Rising standards and rising prices for waste disposal in industrialized countries have led to increasing "transborder trade" with wastes, even to developing countries. This issue is worked on by a number of international organizations including i.a. UNEP and OECD.

As disposal costs on the basis of comparable standards generally will be very much the same, transborder movements of wastes tend to be directed to low price/low standard countries. Long distance transportation is no longer a limiting factor when disposal prices differ by some 100%. There have been waste exports to developing countries where no adequate disposal system existed. The danger for pollution in the recieving country cannot be overestimated in such cases.

Unless internationally agreed principles are developed with regard to transborder movements of wastes, countries that have not yet established a disposal system and adequate control procedures should not allow waste importation. To insure control of waste imports, the customs authorities should be informed of the problems connected with waste imports and should be put in a position to refuse waste transports at the border unless they are properly declared and the import is sanctioned by an appropriate government authority.

Administrative Aspects of Waste Management

Waste management legislation would be useless without an administration that enforces the law. Additionally, trained personnel has to be provided to organize and execute waste management operations and enforce legislation. Both these aspects call for trained, specialized administrators (if not administrations) with sufficient insight into the problems of waste management. The right distribution of adminstrative powers is of prime importance for the establishment of a comprehensive waste disposal system. The same is true for the establishment of information lines.

Waste management cannot be ordered by central government. It has to consider local needs and options. Therefore, central (government) authorities should only be responsible for the enactment of relevant legislation. Regional, as opposed to local, authorities should be responsible for waste disposal planning. Local authorities however should at least be heard in the planning process. It can be advisable to base planning procedures on proposals made by local authorities.

The prime responsibility of local authorities should lie in the field of municipal waste collection, transportation, and operation of facilities. Cooperation of different local authorities should, where appropriate, be encouraged to reduce costs and promote capable centralized facilities.

Money is a very important aspect for waste management. Financing should therefore be considered with regard to all stages of administrative action. Organizing waste management will require public funds not only for investments for car parks and facilities but also for current operations unless the public is prepared to pay fees for the service to cover the expenses. Where fees are not imposed on waste disposal, the costs must be born out of public funds or from the budget of the municipality. Costs may very well be a limiting factor in establishing a "streamlined" modern waste management system. However, it has to be emphasized taht technical investments can pay off in the long run, provided that costs and benefits are evaluated before investments are made.

Finally it should be mentioned that a system would not work properly without control. Control will not only be necessary for industrial enterprises and private waste disposal companies but also to ensure proper operation of communal disposal facilities. Experience shows that control cannot effectively be exercised within the same administrative bodies that are responsible for providing the disposal service.

The establishment of a centralized advisory agency for technical matters of waste management can be a strong incentive for the establishment of a comprehensive waste disposal system. Such an agency need not necessarily have executive powers but should provide the necessary technical information and advise local authorities.

RECYCLING OF SOLID WASTES

Peter Kolbusch

RESUMEN

Describe los métodos básicos de reciclado a partir de desechos sólidos mixtos; menciona los tratamientos previos que se dan a los desechos antes de disponer de ellos o de reciclarlos. Detalla qué son los centros de recuperación de materiales, los procesos de recuperación, el procesamiento de combustibles contenidos en los desechos, la incineración y el composteo (simple y con escogido preliminar).

Hace énfasis en la ventaja de prevenir y de reducir hasta donde sea posible la cantidad de desechos que tienen que ser dispuestos finalmente en un relleno.

Se muestran tablas con la composición de los desechos de varias ciudades. Se indica que un sistema de recolección separada es muy ventajoso debido a que todo material que se puede reciclar se separa antes de entrar a formar parte de un material mixto en el que la selección de material reciclable se hace más complicado.

INTRODUCTION

Besides prevention recycling is a successful method of solid waste management.

This paper will provide an overview on basic recycling methods. Starting with sorting systems and description of recycling processes for the basic fractions.

Dr. Peter Kolbusch, GTZ, Germany

As shown in table 1, composition of wastes varies from country to country and even from city to city, therefore it will be necessary to find specific solutions which are strictly oriented to the existing composition of the solid waste.

The following table shows some examples for solid waste compositions.

Table 1.

Composition of solid wastes from various waste disposals, figures given as weight %

	Hamburg FRG	Stuttgart FRG	FRG Average	Bangkok Thailand	Britain Average	Singapore
Glass	22,7	9,9	11,5	1,0	9,0	1,3
Paper	23,1	14,7	19,9	24,6	37,0	43,1
Metals	4,5	5,2	3,9	1,0	9,0	3,0
Textiles etc.	3,7	4,1	3,8	3,0	3,0	9,3
Plastics	4,6	6,2	6,1	7,0	3,0	6,1
Vegetables	30,0	52,4	26,8	44,0	28,0	4,6
Unidentified + others	11,4	7,4	24,2	11,0	19,4	32,6

Another significant aspect is due to the costs, e.g. to the cost benefit of the complete system as well as the specific recycling operation.

It is readily apparent that the absolute costs of waste management are governed very much by the environmental standards we set. There are also various processing methods for treating and/or recovering useful products from solid wastes which, given the environmental standards aimed for and the constraints imposed by local circumstances, require economic comparison before any decision on waste handling can be taken.

In other words, it is these comparisons that will primarily influence the choice of a waste disposal strategy that achieves the required standards at the least cost and with the optimum use of scarce resources. Here is an outline of the main options for achieving recovery of valuable resources from solid wastes and an examination of some of the key criteria which are usually used to determine whether resource recovery from waste might be worthwhile.

Reclamation from waste is, of course, not a new idea, either in developed or developing countries, for man has always attempted to reclaim waste in many diverse ways whenever it seemed attractive to do so.

The position is very different in the case of potentially mixed wastes which make up most of the solid waste currently disposed of without any recovery. It is these types of solid waste, e.g., household refuse, mixed are of major concern to the waste management planner and on which prospects for increasing the amounts of waste recovered must largerly be founded.

The main options presently available for recovering useful products from potentially mixed solid waste therefore form the essential subject matter of what follows.

Review of Methods for Treating and Recovering Useful Products from Potentially Mixed Solid Waste

The reason for including the notion of treatment in the above heading is that treating the waste is almost always a prerequisite for efficient recovery of products from waste, though not all forms of waste treatment are aimed at resource recovery. In practice, it is difficult to draw a hard and fast distinction between waste treatment for recovery and waste treatment for disposal, for both objectives are often achieved simultaneously.

For instance, incineration, with recovery of the heat generated, converts (and thus effectively destroys) a substantial proportion of the waste feed, releasing heat which may then be applied for a variety of purposes. However, there remains a comparatively inert residue, amounting to about 10% by volume or about 40% by weight of the original refuse feed, which must usually be landfilled unless an opportunity exists nearby for long-term utilisation. Hence, some part of the waste is to all intents and purposes disposed of by incineration, while at the same time a potentially valuable resource (energy) is recovered.

Even conventional sanitary landfill, which is often thought of solely as a means of disposal, can serve a potentially useful purpose in reclaiming derelict land. Certain kinds of mixed solid waste, e.g., demolition waste and industrial slags, by their nature offer only a limited potential for materials recovery, and so the vast bulk of such wastes can only be landfilled.

Conventional methods for treating and disposing of most mixed solid wastes may be genera-ly summarised as follows:

- landfilling (with or without various forms of pre-treatment, and with varying degrees of site control);
- incineration (with or without heat recovery, and with possible recovery of ferrous metals and residual slag);
- composting (with varying degrees of pre-treatment and product refinement, with or without ferrous metals recovery).

The less conventional methods being developed or under consideration for recovering valuable materials and/or energy from potentially mixed wastes can be broadly divided into:

- separate collection systems in which specified materials are separated from other wastes by the originator of the waste, and are collected by a municipal or commercial organization;
- centralised mixed waste recovery systems, in which mixed waste is delivered to a centralized plant, where it is mechanically, thermally, chemically or biologically processed to produce various valuable materials or energy. (This broad definition is presented conceptually in fig. 1.)

Mixed waste recovery systems can be further sub-divided as follows:

- Recovery centres: centralized stations to which the originator brings his waste, generally in a pre-separated form.
- Materials recovery processes in which mechanical systems are applied to extract useful or valuable materials from the waste.
- Solid fuel recovery processes which extract a solid fuel which may be used as a substitute for conventional fossil fuel in an existing process (refuse-derived fuel).
- Pyrolysis processes which thermally convert the waste into combustible gases or oil, useful chemicals and slag.

- Composting processes in combination with one of the above systems.
- Chemical and other biological processes which convert waste into, for example, alcohol, methane or other chemical products.

Separate Collection Systems

Separate collection systems aim to reclaim valuable materials before they become part of a mixed waste stream. This obviates the need for later manual or mechanical separation from the mixed waste, and ensures that the reclaimed materials are relatively uncontaminated. This requires the segregation of the materials concerned from other wastes by the originator.

Many such schemes have recently been started in Western Europe by local authorities by industrial groups and by voluntary organisations. The materials reclaimed vary from scheme to scheme, the main ones being: paper, cardboard, plastics, glass and tin cans. Such schemes have been widely used for recovering valuable industrial wastes for many years.

The main advantage of separate collection as a method of initial recovery is that a waste material can be recovered in a form which closely resembles that of the original product of raw material. Separate collection as a method of recovery is likely to be technically most suitable where:

- wastes of different types arise in an essentially separate form (e.g. old newsprint);
- waste products are easily separated by their owners and are not seriously contaminated in use (e.g. glass bottles);
- a substantial amount of the waste arisses at one point to make separation and collection worthwhile.

Referring to these technical conditions it will be appreciated that only certain kinds of post-consumer solid waste meet these conditions. There are also inherent limits on the extent to which a material can be separated out from consumed waste prior to collection. Many consumer goods contain closely mixed materials (e.g. laminated packaging) while some are heavily contaminated in use (e.g. food packaging).

In addition, the materials which may be most readily collected separately from households are generally of low density and available only in small quantities, which make collection very expensive. Recent experience with such schemes around Europe has shown that two critical factors for the success of a scheme are:

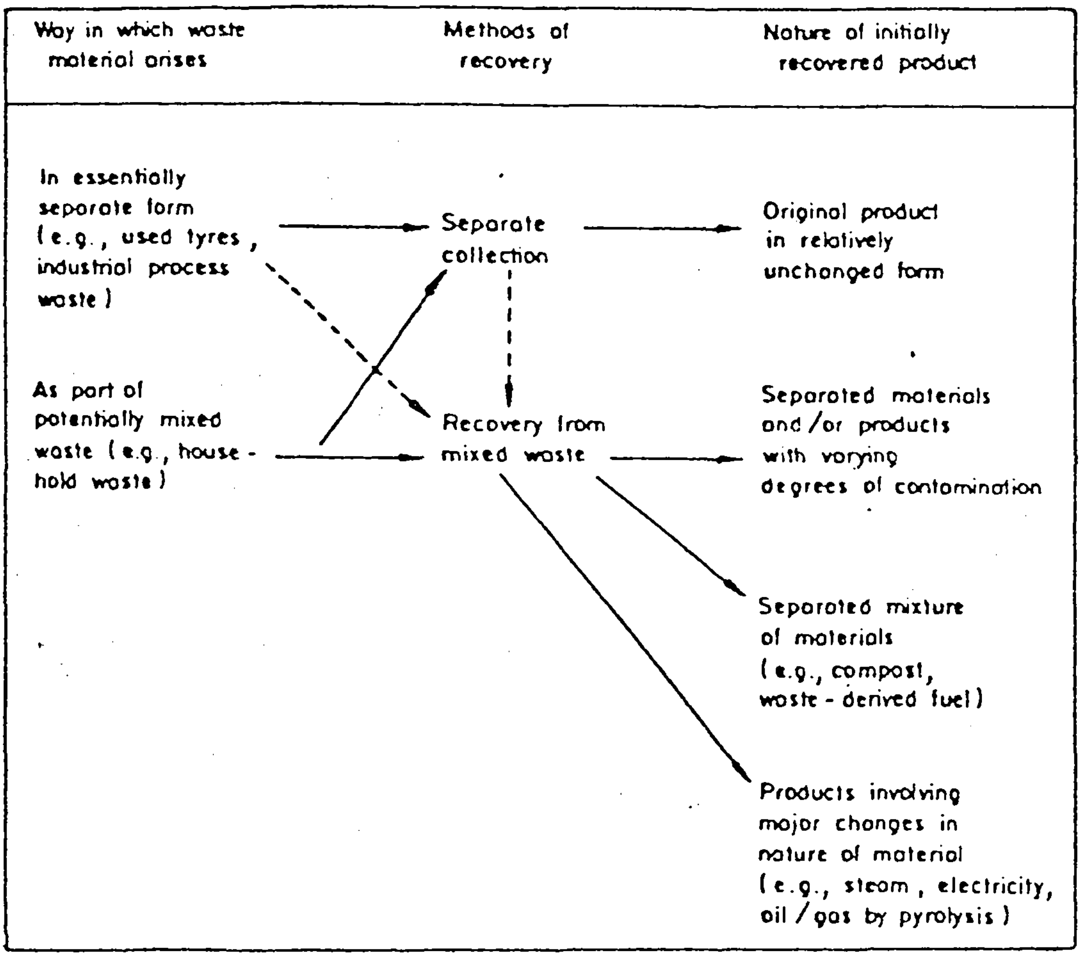


Fig. 1:
Initial recovery methods and nature of initially recoverd product

- gaining the sustained co-operation of householders;
- the existence of local markets for the reclaimed material.

The main advantages of using separate collection as a method of recovering domestic waste are that such schemes may be quickly put into effect and that a relatively small capital expenditure is required.

Mixed Waste Recovery Systems

Recovery Centres

A recovery centre is a facility that will receive, store and sometimes process specific wastes from domestic consumers and/or industry for later use. Such centres can range from the simple skip placed temporarily in a supermarket, which seeks to recover small quantities of low value material, e.g. glass containers, to the large, permanent centre incorporating one or more processes for treating a variety of recovered materials. The main advantages of a recovery centre are:

- a recoverable material is prevented from entering a mixed or contaminated waste stream;
- the costs of delivery to the centre do not (normally) form part of the costs of recovery.

The viability of recovery centres is generally hindered by:

- the difficulty of maintaning a high level of public response;
- the low value of the wastes recovered, and,
- the problems of securing a stable market for the reclaimed materials.

Nevertheless, numerous schemes are currently in operation to provide simple collection points for glass containers, and sometimes tin cans and plastic containers. Where public response is forthcoming (and there is much evidence to show that it is), such simple collection points are preferable to trying to recover these types of material from mixed waste. As in the case of separate collection schemes, recovery centres can provide a useful contribution towards recovering certain postconsumer wastes, but do not representa a long-term solution for managing large quantities of solid waste.

The landfill which is operated in Guatemala City may be called an example for mixed waste recovery. Antoher more famous example is the landfill in Alexandria, Egypt.

Materials Recovery Processes

A variety of processes have been developed in Europe and the USA for physically removing useful or valuable materials from household and similar solid wastes. A summary of such processes either in operation or under development is shown in table 2. .

The materials recovered vary from process to process but typically, products would include a fibre product consisting largely of paper, board and some textiles; ferrous metals and a mixed organic fraction consisting of vegetable and putrescible matter. Further process steps (found particularly in the USA) aim to recover nonferrous metals (predominantly aluminium) and glass (frequently colour sorted). The materials recovered by these processes are, generally, of low grade and often need further treatment before they can be marketed.

This is a major disadvantage of materials recovery systems because:

- the initial sorting steps produce very low quality products, which are very difficult to sell at an economic price;
- further process steps can be added to upgrade the recovered products, but this leads to a more complicated and costly process layout which is frequently difficult to justify in terms of the marginal value added to the recovered product.

Fuel Recovery Processes (Refuse-Derived Fuel)

What may be viewed essentially as a variation on mechanised materials recovery processes are those processes which recover a solid, potentially transportable (and to varying degrees storable) fuel from refuse. The primary aim of RDF processes is to separate the combustible fraction of refuse, and process these in a variety of ways to produce a fuel which may be substituted for other fossil fuels, particularly coal and lignite, and possibly heavy fuel oil. The advantages of processing domestic refuse into RDF are primarily twofold:

- the separating efficiencies required of the process need not be so high as those for materials recovery processes, and hence the process configuration tends to be simpler and less energy consuming;

- if necessary, the fuel product may, within limits, be transported to distant consumers and used in commercial combustion facilities, which generally have a significantly higher thermal efficienty than refuse incineration plants.

Incineration

Incineration is a well-established and comparatively reliable method of treating many mixed wastes prior to disposal. This status is demonstrated in the fact that there are now some 200 incineration plants in operation in Western Europe for household and similar kinds of waste. This method of treatment also affords the recovery of part of the energy content of the waste, which may be applied for a variety of purposes, e.g. power generation, district and/or process heating, water distillation.

A part of the energy so recovered can also be used for different functions within the plant itself. However, incinerator technology has as its prime aim the substantial reduction in volume of the waste to produce a virtually inert residue. The recovery of heat (and frequently the recovery of ferrous metals and the residual slag as well) are usually secondary activities which can provide a useful credit for offsetting against the operating costs of the plant .

Incineration, with or without heat recovery, is the most expensive form of conventional solid waste treatment due largely to the very high capital costs involved in building a plant. This is particularly the case with plants having a small capacity, or where refuse throughput falls consistently short of design capacity.

Composting

Composting has - as the oldest and most natural system of waste treatment and recovery utilised by nature as well as by man - many attractive points which might catch the attention of the waste management planner to serve as viable alternative to other treatment and reclamation systems. Above all, in recent years with movements of the green or ecological groups in western industrialised countries and a growing awareness of interdependence between technology and culture in the developing world, composting seems to become more attractive as a method which is very much "in harmony with nature". This process of decomposition of organic matter in or on soil is carried out by microorganisms and enzymes.

Of significant concern is the possible survival of pathogenic organisms in the compost. Viruses, bacteria, protozoa, fungi and other organisms capable of causing human, plant or animal diseases may persist in the compost due to improper treatment for whatever reason. The possible hazards involved during production or use of the compost have also not yet been fully assessed. Further research in this area must be undertaken. Some control of these pathogens appears to be possible, but no definite statement can be made at this time.

In addition to the persistence of pathogenic organisms in compost, a problem may also exist with disease vectors. Flies are attracted by and may develop in raw compost, particularly when the composting operation is of the windrow type. Another problem may be the existence of rodents and cockroaches in compost heaps if the composting operation does not include adequate housekeeping. However, some amelioration of the rodent problem has been attained through the use of grinders which intermingle the edible portions of the compost intimately with inedible portions and reduce the size of the material to the point where rats and other large animal vectors are unable to secure harbourage within the material.

In addition to these problems, there are those of odours, noise and visual nuisances. However, with proper operation most of these nuisances can be controlled. With the public eye being focused on environmental problems today, little sympathy will be extended by the public to a composting operation which offends the senses with objectionable odours, noise or unsightly appearance.

Plastic films, tinfoil and other inclusions can only be removed from the composted material at high cost; and these visible inclusions in the end product may make it more difficult to sell the compost. They remind a costumer of the original source of the compost and might prejudice him against using it. This should be kept in mind when considering composting as a means for recycling of community refuse.

The most severe problem of compost quality is the presence of heavy metals in compost which can, if unchecked, develop into severe environmental and health hazards. Experience has shown that heavy metals present in compost or sewage sludge may be accumulated in the soil and may be taken up by crops or removed by surface runoff to receiving surface and groundwaters. This problem of further environmental impacts has to be carfully examined before decisions are taken to apply compost in large quantities for soil enrichment. Special attention to heavy metal content and subsequent preventive measures are essential if foodstuff is to be produced on compost-treated land, taking into consideration the absorption and self-cleaning capacity of soil and plants, type of produce and quality of compost.

Besides the quality problem, an even more important problem for the feasibility of composting may be the local market potential for solid waste compost. Before starting the planning of a composting plant, the marketing situation has to be studied carefully. In many cases this has been omitted and, as a consequence, the produced compost is now brought to a disposal site or used for sanitary landfilling.

It is necessary to check at first:

- if there is a demand for compost application;
- if there is a short distance from producer to consumer (high transport costs);
- if the consumer is open-minded for compost application (early information).

It must be seen as a fact that the present development of composting as a waste disposal system has been primarily directed toward semi-rural areas where a rather small-population city is surrounded by an area with high potential for sales of the final compost end-product. Little likelihood exists for greater development of composting as a means of handling refuse in very large urban areas.

Before the decision is to be made for the installation of a composting plant, the following selection criteria should be taken into account:

- transport distances to waste collection area and/or transfer stations;
- transport distances to areas of application of compost (farmlands, etc.) and to landfill site;
- general traffic conditions - accessibility of the composting plant site;
- distance of the plant to nearby residential areas (noise, odours);
- geological and geohydrological factors (construction, site situation, groundwater protection);

- connection to existing sewerage systems (leachate from windrows);
- size of available area (also for future extensions of the plant);
- meteorological conditions.

When doing the planning, it has to be considered that conventional methods (windrow systems) require a large space for the preparation and storage of the compost for six months in moderate climate. However, the retention time can be greatly reduced in hot humid climate. In table 2 the land requirement, the removal and transport equipment and the water requirement necessary for mechanised conventional composting plants (windrow systems) are demonstrated (minimum requirements).

Table 2:

Mechanised composting plant requirements, Windrow Systema (POLPRASERT & MUTTAMARA, 1979)

Plant Capacity, tonnes/day	40*	80	200
Removal Capacity, trailer loads/ day	-	20	50
Removal Equipment:			
a) tractor shoveis	-	½	2
b) towing tractors	-	1	2
c) trailers of 6 m^3	-	2	4
Transport of Products:			
a) trailers	1	3	6
b) towing tractors	2	1	2
Water Requirement, m^3/day	20	100	100
Land Requirement, ha	0.7	1.5	2.5

* Only manual methods are used.

The energy requirements for more sophisticated "dynamic" composting systems are shown in tables 3 and 4. Detailed costs for electricity are not given

Table 3:

Necessary electric capacity of equipment for the several stages in a dynamic system, in kW (Jaeger, 1975).

Capacity (tonne/yr)	Preparation	Composting	Maturing	Other Equipment	General Consumption
15 000	200	50	90	20	10
30 000	350	90	170	30	20
60 000	600	150	310	50	30
120 000	1 100	280	580	90	40

Table 4:

Energy consumption of composting plants, in kWh/yr (Jaeger, 1975)

Capacity (tonne/yr)	Compost Quality			
	1	2	3	4
15 000	501 000	501 000	627 000	627 000
30 000	888 000	888 000	1 126 000	1 126 000
60 000	1 495 000	1 495 000	1 929 000	1 929 000
120 000	2 760 000	2 760 000	3 572 000	3 572 000

Note: Quality Criteria:
1 - Coarse Fresh Compost
2 - Fine Fresh Compost
3 - Coarse Mature Compost
4 - Fine Mature Compost

For a small-scale composting plant with windrow systems and more or less manual methods with a capacity of approximately 20 tonnes of waste/day, a staff of about 15-20 persons would be necessary (1 tonne of waste=3 - 5m^3).

Manpower requirements of larger plants of semi-dynamic or fully mechanised type vary according to annual throughput of waste. While a plant with a capacity of 15 000 tonnes/year needs 6-9 persons, bigger plants with a capacity of approximately 120 000 tonnes/year will need between 17-25 staff. For mechanised plants, especially the dynamic type, roughly one-third of the staff must be skilled workers to ensure professional and safe operation and necessary maintenance; otherwise, the losses in production time, product quality and equipment may become unbearable for the running budget of the local authority.

The following table 5 provides an overview on advantages and disadvantages of various composting systems.

Table 5:

Advantages and disadvantages of composting methods

Basic System of Composting	Advantages	Disadvantages
Traditional manual method	- Simple to handle (little training required). - More reliable (almost no breakdown). - Comparably cheap (low cost). - Locally available (saving of foreign exchange) - Labour-intensive (more employment opportunities.	- Products usually contain other materials, e.g., stones, glass fragments, plastic utensils and bags, etc. which reduce market value. - Large land areas required; therefore not suitable in large cities. - Some odour and insect problems unavoidable. - System can pose health risks for workers. - Vehicle movement is difficult on unpaved areas after heavy rainfall. - Stacks and pits on unpaved areas are very difficult to keep clean.
Mechanical method (static or dynamic system)	- High product quality if properly operated and maintained. - Almost no nuisance by odour and insects. - Relatively small land areas required. - Equipment can be kept clean. - Practically no problem for vehicle movement.	- High capital and operating cost (cost of heavy equipment, operation, maintenance). - 1/3 of staff has to be skilled workers. - High energy consumption (a pulveriser of 20 tonnes/hour requires a 300 Hp motor). - Loss of volatile nutrients through ventilation in fermentation vessels.

Composting Processes in Combination with some Form of Preliminary Sorting

As pointed out earlier, certain fractions of municipal solid waste are more suitable for composting than others. The application of composting in combination with some form of preliminary sorting (e.g., materials recovery or RDF production) has distinct potential advantages over the more conventional composting systems. The main advantages are:

- composting the more suitable, pre-sorted waste fractions allows a greater degree of control over the homogeneity and mixing of the compost raw material, leading to a better quality compost product and a greater likelihood of being able to introduce standard specifications;
- the total yield of a combined sorting and composting plant is substantially improved (to 70-80%), and therefore smaller quantities of residue to be landfilled;
- total operating costs per tonne of waste processed might be noticeably reduced;
- such a plant would allow greater flexibility for composting certain other types of wastes (e.g., sewage sludge, bark, some types of agricultural waste).

This form of composting therefore removes some of the difficulties associated with conventional composting of refuse, and could be expected to benefit both the value of the compost product and the development of the required markets.

Plastic Recycling

Plastics wastes arise at all stages of plastics manufacturing, processing and further processing resp. application up to commercial or private consumption. Thereby the waste amounts and the shares of plastics in wastes are varying. Figure 1 is illustrating the diversity of plastics sources.

The survey on plastics wastes is complicated by the variety of different plastics types. About 50 plastics differing in their properties have economic relevance, including bulk plastics such as polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC) and polystyrene (PS) that account for more than 60% of total consumption.

At the application and consumption level the plastics wastes amount is highest but at the same time also subject to the highest degree of mixing and contamination. Accordingly difficult is the recycling of the plastics share in municipal refuse that is varying between 4 and 6 percent in region and time.

As against that, higher plastics wastes could be expected at the previous stages that were more likely to allow a separate concentration, collection and thus an economically more efficient availability for recycling processes.

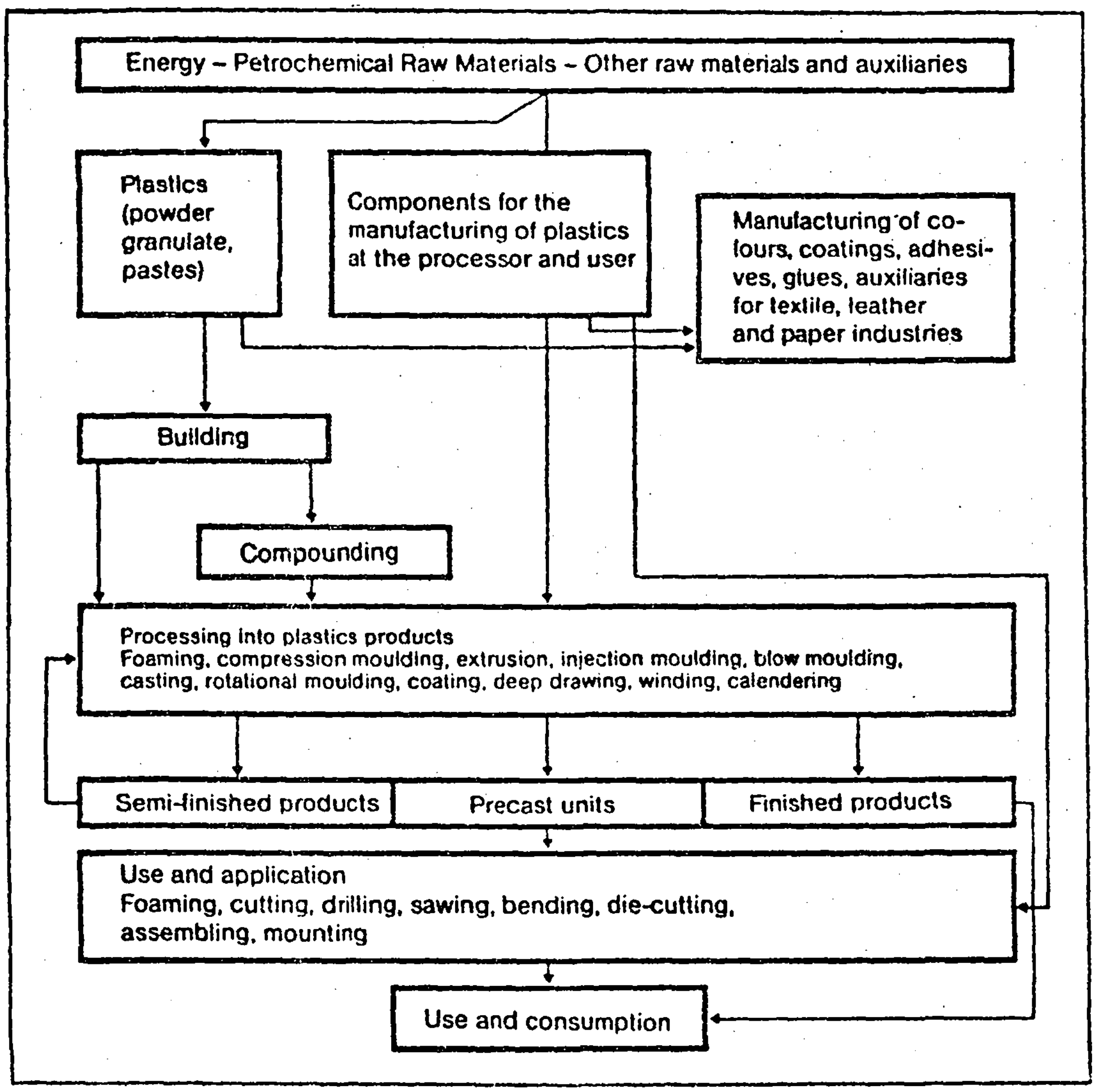


Figure 2:

Manufacturing of plastics and plastics products

In Germany, 2,86 million tons of plastics are used on the plastics processing level. This figure is the result of the plastics amount (consumption) of 4,76 million tons used in the Federal Republic of Germany reduced by the non-typical plastics applications where plastics wastes do not arise (plastics application in adhesives, glues, fillers, paints, coatings, auxiliaries for the paper, leather and textile industry).

40% of the plastics residues determined in plastics processing could be sold or usefully applied as secondary materials so that the remaining waste amount attained 96 000 tons. This corresponds to a waste rate of 3% (fig. 3).

On the following levels of further processors and users as well as on the level of commercial and public end users, complete registration of flow rates and waste rates if not possible. Spot checks and empirical correlations showed a plastics amount of about 400 000 tons per year.

Municipal wastes from private end consumers contain about 1,1 million tons of plastics wastes according to refuse analyses and extrapolations. Considering all levels about 1,65 million tons of plastics wastes had thus to be disposed of in 1974.

The recycling rates of about 40% (tending to the upward) on the raw material manufacturing and processing level reflected the state of the then technical possibilities.

The recovery of plastics wastes from further processors as well as from commercial and public end consumers had to be viewed with much more difficulties. This is on the one hand due to the scattering of places of incidence with simultaneously low amounts of incidence. On the other hand the heterogeneity of the wastes requires technical sorting processes, since organizationally arranged separation has in most cases not been feasible.

Tests have shown that hammer mills are principally applicable in the crushing of plastics wastes. The plastics are completely crushed so that metal entrapped in bags, sacks and bottles are uncovered.

Proper grain sizes can however only be produced by double-stage crushing whereby the separation of metal shares is necessary between the first crushing by hammer mill and the second crushing by cutting mill.

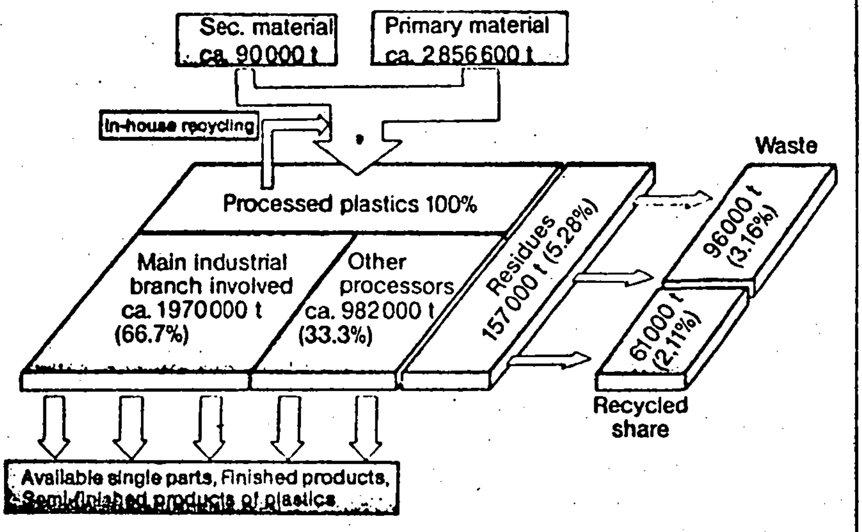


Figure 4: *Material flow at the plastics processor level in the Federal Republic of Germany in 1974*

Figure 3:

Material flow at the plastic processor level in the Federal Republic of Germany in 1974.

Due to the high costs of hammer mill crushing, cutting mills remain an alternative for hammer mills despite high susceptibility to wearing of the cutting tools.

Classification and Sorting

Investigations on classification and sorting have shown that the application of a process combination of screening and air classification results and improvements over the basic operations.

Since narrow grain spectrums (about 80% between 2mm and 4mm) were produced in the course of crushing, air classification alone already results in upgradings between 60% and 85% whereby the results are depending on the material pairing. The upgradings achieved by process combinations of screening and air classification, i.e. by multistage classification processes coupled in series and in parallel attained between 70% and 92%

In case of heterogeneous plastics wastes with strongly varying forms, dry sorting by screening and air classification cannot attain the efficiency of wet sorting processes with upgradings and yields up to more than 95%.

The classification costs are low. On the basis of an annual mass flow rate of 10 000 tons/year they only amount to about 1 DM/ton to 2 DM/ton.

The overall retreatment costs for plastics wastes without taking into account product drying should thus clearly range below 100 DM/ton, provided it is not material from domestic refuse that is contaminated by metals.

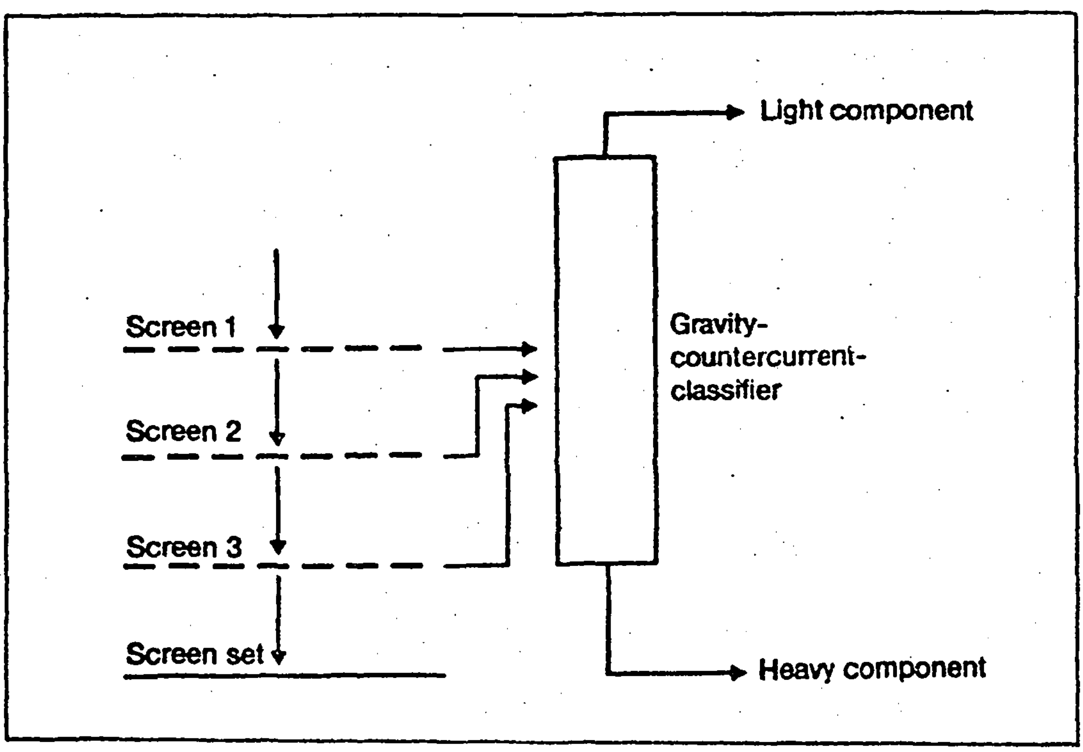


Figure 4:

Base unit of the process combination screening-classification

Density Separation

Although density differences of the various plastics types are only varying in a relatively narrow range - polyolefins 0,90 - 0,98, polystyrenes 1,0 - 1,1, polyvinyl chlorides 1,2 - 1,4 g/cm^3 - process based on density as a parameter of separation were still promising the fairest chances if compared e.g. with electric separation or flotation.

Very pure products (more than 98%) can certainly be produced from plastics mixtures in static float-sink separators of expensive construction to avoid turbulences, but the results are nevertheless not satisfactory because of the high contamination of floating fractions with fine components from heavier plastics. Such static processes are furthermore only difficult to realize on a large industrial scale.

Hydrocyclone

This process that had hitherto been considered as inadequate on the basis of theoretical considerations is highly improving density separation in a liquid phase by centrifugal acceleration. In the hydrocyclone the flow rate referred to the separation area is 100 times higher than in a static float-sink separator. The contamination of the plastics is only of minor relevance in this process compared to flotation.

The obvious advantages and technical prospects of realization appeared to be high enough to intensify and emphasize these tests in addition to the original program. This entailed the necessity of multistage hydrocyclone plants in continuously operated plants in accordance with the number of components contained in the starting mixture. For the separation of an n-component mixture n-1 separation stages are necessary (cyclone plants). Continuously operated plants must furthermore be equipped with a feeding device and screens for dehydration purposes according to fig. 5.

In completion of the investigations, the results achieved with model mixtures were verified with plastics sorted out of domestic refuse that had been crushed to a grain size of ≈ 10 mm.

In this context the cyclone of the first stage separated 99,9% of the fed polyethylene with a purity of 99,7% (2,3% polystyrene). The PS/PVC mixture from the underflow is fed to the next stage. It is separated by cyclone into polystyrene with a purity of 92,5% and into PVC with a purity of almost 100% (99,6%).

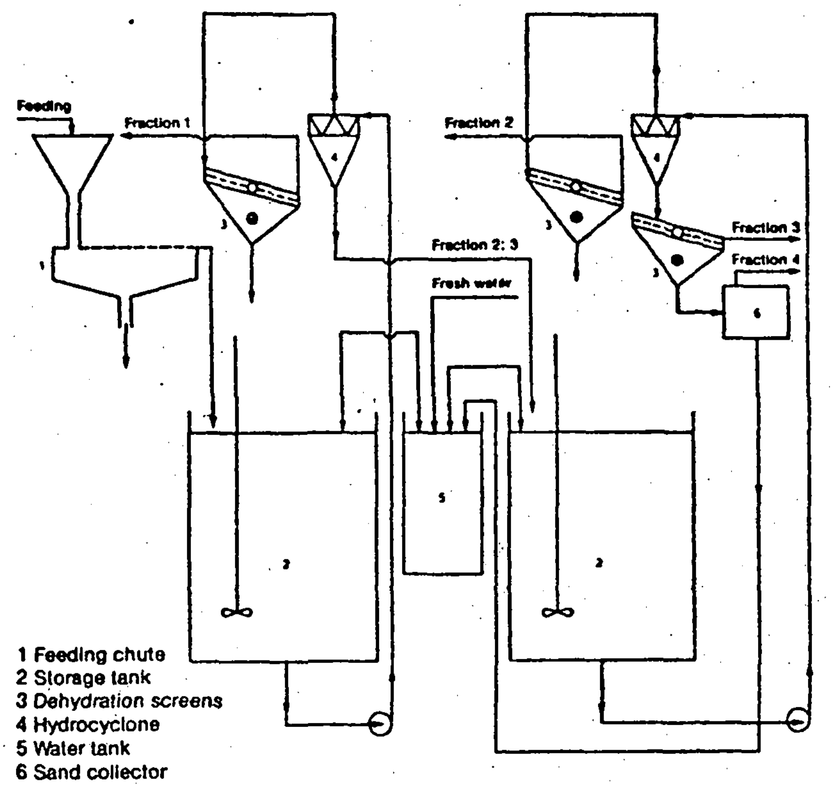


Figure 10: *Process scheme of the treatment plant with hydrocyclone*

Figure 5:

Process scheme of the treatment plant with hydrocyclone

The hydrocyclone process has impressive advantages:

- The separation effect of practical plastics wastes is extraordinarily good; the resulting fractions are likely to be processable with minimum property loss.

- The separation process is not expensive in terms of technology, it is not susceptible to disturbance and easy to operate which last not least shows up in low specific costs of less than DM 50 per ton.

- Metallic and mineral contaminants can be safely screened out. At the same time the process enables a rough cleaning of the plastics fraction.

- The separation is rather improving with a growing flow rate by increasing the dimensions. At the same time the crushing effort can be reduced with larger dimensions.

- Disadvantages could not yet be identified so that the results of this project turned out to be an important technological, economic and practical solution of the significant sorting problem for mixed plastics wastes.

Melt Recovery

The expression "plastics recycling" referred exclusively to the recovery of thermoplastics wastes via structural changes up to the time of the tackling of chemico-physical recovery processes such as the pyrolysis and the hydrolysis. These plastics are melting by heat action and are then mouldable into semi-finished and finished products after the different processing steps.

Duromer plastics are not suited for this, since - once cured - they are no longer plastizisable. Their recovery occurs to a certain extent by powder obtained from the grinding of e.g. cured moulding materials (e.g. defective batches) that is added to virgin material prior to processing. Since the amount of duromer plastics is comparatively small in comparison with thermoplastics, their share in wastes is almost imperceptible.

As opposed, pure grade wastes of the main thermoplastics polyethylene, polypropylene, polystyrene, polyvinyl chloride are reprocessed to a considerable extent. Thus e.g. the planting pots in horticulture consist almost completely of reclaimed polystyrene and polyethylene wastes.

Polymer mixtures were however hardly yielding sophisticated products. The "incompatibility" of several plastics types - or to put it more precisely, their immiscibility in the limit range of polymer phases - entailes a strong loss in important property values.

In accordance with the objectives of the research program, the mechanical behaviour of mixtures of several plastics types was to be investigated despite these unfavourable premises, whereby the project was to focus on plastics wastes in municipal refuse.

Due to investigations at the Institute for Plastics Processing in Aachen a mixture of

60 weight - % polyethylene with a small propylene share
20 weight - % polystyrene
15 weight - % polyvinyl chloride
5 weight - % other plastics.

corresponds to the one of the plastics fraction in domestic refuse.

The contaminations in domestic refuse show about 5 weight - %. This is due to the fact that the contaminated shares are partially evenly distributed as a filling and partially removed by degasification in the course of the homogenization of the mixtures in the melt.

Tests where different virgin materials (PS, PE, PVC, PP) were admixed to this waste mixture showed a clear improvement in mechanical properties only with virgin material shares that were too high to make this route appear economically expedient. The admixture of low waste material amounts to virgin material resulted in a clear deterioration of properties and therefore it is also not recommendable.

Existing data allow the conclusion that promising applications for plastics waste mixtures are above all to be found in the field of large-sized mouldings. A survey on the investigated processes for the recovery of plastics from domestic refuse is provided by fig. 6.

A new sintering process was tested in Germany with the objective of elaborating an as simple process as possible. The crushed waste mixture was plasticized by hot air and infrared radiation at the particle surface to be subsequently moulded. The process has a low energy demand and is suited for thick-walled parts with its short cycle times.

Crushed plastics wastes can moreover be used in mixtures with clay for the manufacturing of porous bricks. This process no longer ranges within the frame of melt recovery, since the plastics wastes are thermally decomposed. The compression strength of the bricks is decreasing with an increasing plastics share; therefore the plastics share is limited to 10%. Tests showed that the use of domestic plastics refuse in the burning of bricks is entailing the release of acid gases. Therefore the process is only suited for non-halogen-containing plastics wastes.

For the manufacturing of thick-walled mouldings, the application of pore-forming agents that are foaming during processing has been more or less obvious. This technique prevents from sink marks in the course of cooling.

Foam sheets that are manufactured in a special moulding press, show properties suggesting their use as compression-proof thermal barriers (e.g. in road building). The process is still economically unefficient in the form that has been tested on a laboratory scale. The integration of the single steps that were first separately carried out in the moulding press and in the kneader, in one single machine is also likely to represent an interesting further development in terms of economic efficiency.

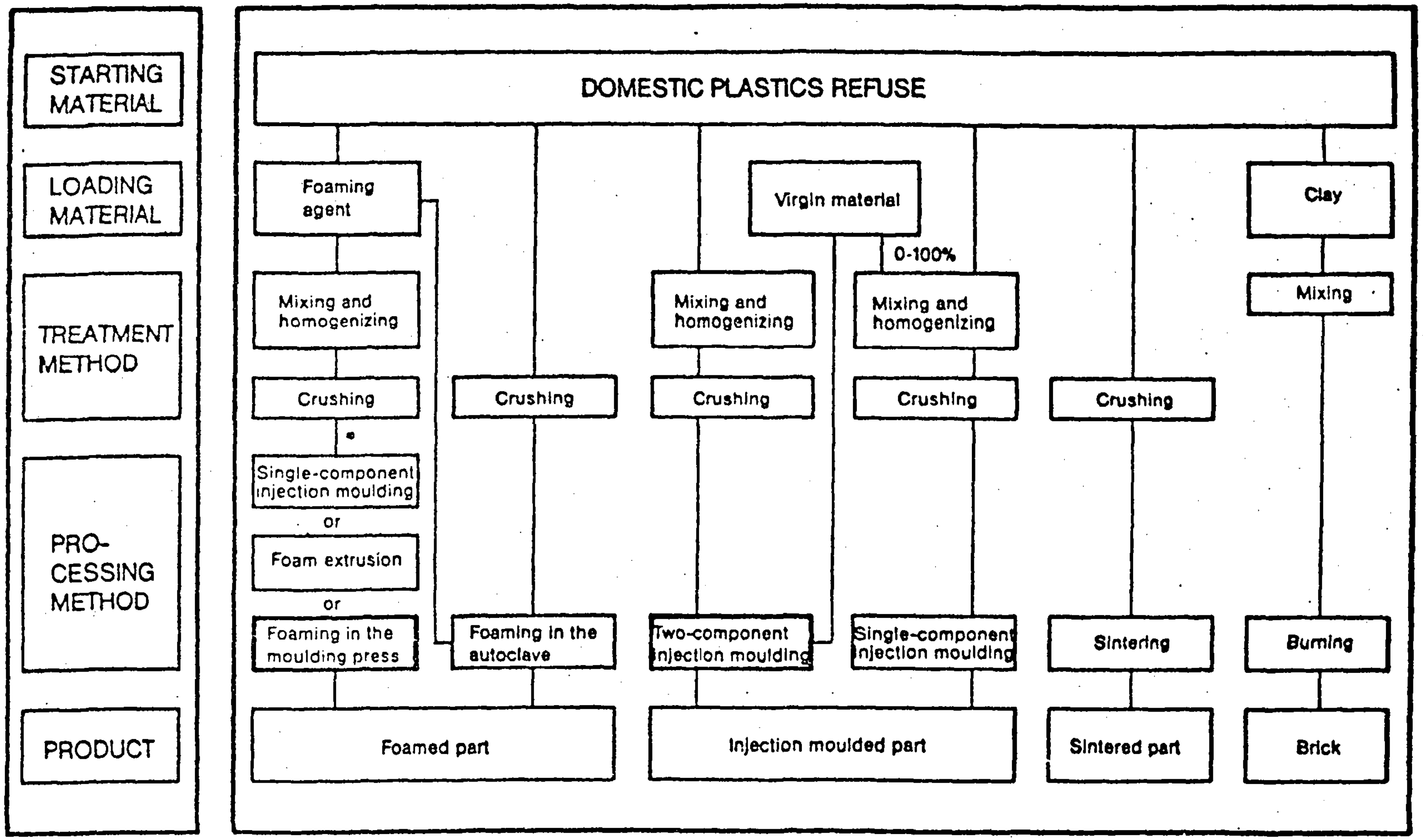


Fig. 6 :

Processes for the recovery of domestic plastics refuse

If treated plastics wastes are contrasted with a comparable virgin material or non-contaminated and pure grade production wastes (e.g. flexible PE), the following cuts have to be made in the quality requirements of the first materials:

- Even with an expensive treatment and the application of upgrading additives, the strength and surface quality of the materials recovered from plastics wastes are slightly lower than for virgin materials.
- The waste material can be dyed, but only dark colours are possible.
- A stable quality is hardly achievable because of the variable composition of the starting material; therefore the observation of quality standards is rather difficult. This entails that the treated plastics wastes cannot complete with virgin materials.

Other Chemical or Biological Processes

Under this heading, one could include such processes as hydrolysis, methanation, ethanol production, single cell protein production, etc. Some of these processes have traditionally been used for converting and recovering certain types of industrial waste, e.g., in the sugar and pulp and paper industries.

However, the application of these processes for treating and recovering domestic refuse poses conditions and operating requirements very different from those prevailing in industry. Apparently there are no large-scale processes of this type being built for processing domestic refuse, though methanation is finding increasing use as a method of treating sewage sludge.

The very limited information available suggest that the capital costs are likely to be quite high because of the elaborate process controls required. Even though research is being conducted with the eventual aim of introducing these processes into large-scale operation, it is likely to be many years before they achieve a practical role in resource recovery from highly contaminated, mixed solid wastes.

References

(1) Betts, M.: Options for resource recovery from solid waste in: Environmental management for developing countries, Vol. 1, Waste and water pollution control, Edited by Tharun, G., Thanh, N. C., Bidwell, R., Asian Institute of Technology, Bangkok, Thailand, 1983.

(2) Verband kunststofferzeugende Industrie: Research Program - Recycling of Plastic Wastes, Frankfurt 1982.

(3) Oeltzschner, H.: Problems of composting in: Environmental management for developing countries, Vol. 1, Waste and water pollution control, Edited by Tharun, G., Thanh, N.C., Bidwell, R., Asian Institute of Technology, Bangkok, Thailand, 1983.

MANAGEMENT OF PRIMARY SLUDGE FROM INDUSTRY

Dr. Klaus Pöppinghaus

RESUMEN

El presente trabajo es un resumen de ingeniería y diseño de las facilidades necesarias para el tratamiento y disposición de los lodos provenientes de las aguas de desecho de plantas procesadoras.

Se incluye en el trabajo y se hace una descripción detallada de varias de las tecnologías para la estabilización de los lodos; se discute sobre los métodos de oxidación por cloro, estabilización con cal, tratamiento térmico, digestión anaeróbica y digestión aeróbica.

En los resultados de digestión anaeróbica y digestión aeróbica se hace una descripción amplia de ambos y se estudian sus ventajas.

Se describen igualmente las variaciones que existen en el proceso aeróbico, tal como el proceso que usa oxígeno puro en lugar del aire.

SUMMARY OF THE WASTE WATER ENGINEERING FOR DESIGN OF FACILITIES FOR THE TREATMENT AND DISPOSAL OF SLUDGE

Sludge Stabilization

Sludges must be stabilized to

- reduce pathogens,
- eliminate offensive odors, and
- inhibit, reduce, or eliminate the potential for putrefaction.

Dr. Ing. Klaus G.H. Pöppinghaus, GTZ, Germany

The success in achieving these objectives is related to the effects of the stabilization operation or process on the volatile or organic fraction of the sludge. Survival of pathogens, release of odors, and putrefaction occur when microorganisms are allowed to flourish in the organic fraction of the sludge. There are four means to eliminate these nuisance conditions through stabilization.

They are:

- the biological reduction of volatile content,
- the chemical oxidation of volatile matter,
- the addition of chemicals to the sludge to render it unsuitable for the survival of microorganisms, and
- the application of heat to disinfect or sterilize the sludge.

The technologies available for sludge stabilization include

- chlorine oxidation,
- lime stabilization
- heat treatment,
- anaerobic digestion, and
- aerobic digestion.

CHLORINE OXIDATION

The chlorine-oxidation process involves the chemical oxidation of the sludge with high doses of chlorine gas, which is generally applied directly to the sludge in an enclosed reactor for a short period of time. The process is followed by dewatering. Sand bed drying is an effective means. Belt-filter-press dewatering following conditioning with the addition of polyelectrolytes is also used.

Most chlorine-oxidation units are of a prefabricated modular design, completely self-containes. Application of chlorine oxidation as an exclusive means of sludge stabilization has been limited to small plants on the order of 0.2 m^3/s (5 Mgal/d) and less. The process may be used for treating any biological sludge, for treating septage, and as an auxiliary means of stabilization to supplement existing overtaxed facilities. The sludge should be ground to ensure proper contact.

Because of the reaction of chlorin gas with the sludge, significant quantities of hydrochloric acid are formed. The acid can also solubilize heavy metals. Consequently, supernatants and filtrates from chlorine-oxidized sludges may contain a high concentration of heavy metals. It has been reported that the release of heavy metals is dependent on pH, sludge metal content, and the species of metal found in the sludge. Supernatant and filtrate from the process may also contain high concentrations of chloramines.

Implementation of chlorine oxidation requires the installation of chlorinators to feed chlorine to the process. Other chemical requirements may include sodium hydroxide and polyelectrolytes to condition the sludge prior to dewatering.

LIME STABILIZATION

In the lime-stabilization process, lime is added to untreated sludge in sufficient quantity to raise the pH to 12 or higher. The high pH creates an environment that is not conducive to the survival of microorganisms. Consequently, the sludge will not putrefy, create odors, or pose a health hazard so long as the pH is maintained at this level.

Lime addition to untreated sludge has been practiced for many years as a conditioning process to facilitate dewatering; however, the use of lime as a stabilization agent has only recently gained recognition. Lime stabilization requires more lime per unit weight of sludge processed than that necessary for dewatering. The higher lime dose is required to attain a higher pH. In addition, sufficient contact time must be provided before dewatering to effect a high level of pathogen kill. Lime treatment at a pH higher than 12 for a period of 3 h has been reported to achieve pathogen reduction beyond that attainable with anaerobic digestion.

Because lime stabilization does not destroy the organics necessary for bacterial growth, the sludge must be disposed of before the pH drops significantly, or it can become reinfested and putrefy.

It is recognized that chemical stabilization with lime does not reduce the organic material in the sludge or result in its permanent stabilization. Only a prolongation of the time required before microbial breakdown takes place can be expected. However, in many cases temporary stabilization is sufficient and lime stabilization is therefore favoured at several treatment plants.

The quantity of lime necessary to increase the pH to 11.0 was investigated for: primary sludge requires 20-50g $Ca(OH)_2$ per kg suspended solids (SS) to reach pH 11.0 while sludges obtained by precipitation with iron and aluminium compounds requires 75-100 and 200-300 g $Ca(OH)_2$ kg^{-1} SS, respectively.

HEAT TREATMENT

Heat treatment is a continuous process in which sludge is heated in a pressure vessel to temperatures up to 260°C (500°F) at pressures up to 2.75 MN/m^2 (400 lb_f/in^2 gage) for short periods of time. It essentially serves as both a stabilization process and a conditioning process. It conditions the sludge by rendering the solids capable of being dewatered without the use of chemicals. When the sludge is subjected to the high temperatures and pressures, the thermal activity releases bound water and results in the coagulation of solids. In addition, hydrolyses of proteinaceous materials occurs, resulting in cell destruction and release of soluble organic compounds and ammonia nitrogen.

ANAEROBIC SLUDGE-DIGESTION PROCESS

The history of sludge digestion and its precursors can be traced from the 1850s with the development of the first tank designed to separate and retain solids.

The first person to recognize that a combustible gas containing methane was produced when waste water solids were liquefied was Donald Cameron, who built the first septic tank for the city of Exeter, England, in 1895.

In 1904, a patent was issued to Dr. Karl Imhoff in Germany for a dualpurpose tank now commonly known as the Imhoff tank.

Process Description

Standard-rate digestion

Standard-rate (conventional) sludge digestion is usua-ly carried out as a single-stage process. The functions of digestion, sludge thickening, and supernatant formation are carried out simultaneously. The sludge is heated by means of an external heat exchanger. As gas rises to the surface, it lifts sludge particles and other materials, such as grease, oils, and fats, ultimately giving rise to the formation of a scum layer.

As a result of digestion, the sludge becomes more mineralized, and it thickens because of its gravity. In turn, this leads to the formation of a supernatant layer above the digesting sludge. As a result of the stratification and the lack of intimate mixing, not more than 50 percent of the volume of a standard-rate single-stage digester is used. Because of these limitations, the standard-rate process is used for small installations.

High-rate digestion

The high-rate digestion process differs from the conventional single-stage process in that the solid loading rate is much greater. The sludge is intimately mixed by gas recirculation, pumping, or draft-tube mixers, and it is heated to achieve optimum digestion rates. With the exception of higher loading rates and improved mixing, there are only a few differences between the primary digester in a conventional two-stage process and a high-rate digester. The mixing equipment should have greater capacity and should reach to the bottom of the tank, the gas piping will be somewhat larger, fewer multiple sludge drawoffs replace the supernatant drawoffs, and the tank should be deeper, if practicable, to aid the mixing process for the high-rate digester.

Sludge should be pumped to the digester continuosly or by time clock on a 30-min to 2-h cycle. Because there is no supernatant separation in the high-rate digester, and the total solids are reduced by 45 to 50 percent and given off as gas, the digested sludge is about half as concentrated as the untreated sludge feed.

Two-stage digestion

In the two-stage digestion process, the first tank is used for digestion. It is heated and equipped with mixing facilities. The second tank is used for storage and concentration of digested sludge and for formation of a relatively clear supernatant. The tanks are made identical. In other cases, the second tank may be an open tank, an unheated tank, or a sludge lagoon. Tanks may have fixed roofs or floating covers. Any or all of the floating covers may be of the gas holder type. Alternatively, gas may be stored in a separate gas holder or compressed and stored under pressure.

Process Design

Ideally, the design of anaerobic sludge-digestion processes should be based on an understanding of the fundamental principles of biochemistry and microbiology. Because these principles have not been appreciated fully in the past, a number of empirical methods have also been used in the design of digesters. The methods are based on

- the concept of mean cell residence time,
- the use of volumetric loading factors, and
- loading factors based on population.

Mean cell residence time

Digester design based on mean cell residence time involves the respiration and oxidation end products of anaerobic digestion (methane gas and carbon dioxide).

Table: Suggested mean cell residence time for use in the design of continuous-flow stirred-tank digesters

Operating temperature °C	$^{M}_{c}$, d	$^{d}_{c}$, d suggested for design
18	11	28
24	8	20
30	6	14
35	4	10
40	4	10

Loading factors

One of the most common methods used to size digesters is to determine the required volume on the basis of a loading factor. Although a number of different factors have been proposed, the two that seem most favored are based on

- the kilograms of volatile solids added per day per cubic meter of digester capacity and
- the kilograms of volatile solids added per day per kilogram of volatile solids in the digester.

The similarity between these loading factors and the food-to-microorganism ratio is apparent. In applying these loading factors, another factor that should aldo be checked is the hydraulic detention time, because of its relationship to organism growth and washout and to the type of digester used.

Ideally, the conventional single-stage digestion tank is stratified into three layers with the supernatant at the top, the active digestion zone in the middle, and the thickened sludge at the bottom. Because of the storage requirements for the digested sludge and the supernatant, and the excess capacity provided for daily fluctuations in sludge loading, the volumetric loading for standard-rate digesters is low. Detention time based on cubic meters on untreated sludge pumped vary from 30 to more than 90 d for this type of tank. The recommended solids loadings for standard-rate digesters are from 0.5 to 1.6 kg/m^3. d of volatile solids.

For high-rate digesters, loading rates of 1.6 to 6.4 kg/m^3.d of volatile solids and hydraulic detention periods of 10 to 20 d are practicable. The six high-rate digestion tanks are designed for a volatile-solids loading of 3.43 kg/m^3.d and a detention period of 17.6 d with an untreated sludge concentration of 8 percent solids. The tanks are also designed so that four tanks can handle the entire load and the other two can be used for storage and residual gas extraction. Under these conditions, the volatile-solids loading becomes 5.13 kg/m^3.d and the detention period 11.7 d.

The degree of stabilization obtained is also often measured by the percent reduction in volatile solids.

Table: Effect of sludge concentration and hydraulic detention time on volatile-solids loading factor

Sludge Concentration %	Volatile-solids loading factor, kg/m^3.d 10 d	12 d	15 d	20 d
4	3.06	2.55	2.04	1.53
5	3.83	3.19	2.55	1.91
6	4.59	3.83	3.06	2.30
7	5.36	4.46	3.57	2.68
8	6.12	5.10	4.08	3.06
9	6.89	5.74	5.59	3.44
10	7.65	6.38	5.10	3.83

Population basis

Digestion tanks are also designed on a volumetric basis by allowing a certain number of cubic meters per capita. Detention times of 35 to 45 d are recommended for design based on total tank volume, plus additional storage volume if sludge is dried on beds and weekly sludge drawings are curtailed because of inclement weather.

Based on 120g of suspended solids per capita in the untreated waste water, these requirements translate into the number of cubic meters per capita.

Table Digestion-tank-capacity requirements

		Wet Sludge		Volume required
Type of plant	Dry solids, g/capita.d	Percent solids	$m^3/10^3$capita.d	35- to 45-d detention $m^3/10^3$ capita
Primary	72	5	1.44	50-65
Primary and trickling filter	108	4	2.70	95-122
Primary and activated sludge	114	3	3.8	133-171

Gas Production, Collection, and Utilization

Waste water gas contains about 65 to 70 percent CH_4 by volume, 25 to 30 percent CO_2, and small amounts of N_2, H_2, and other gases. It has a specific gravity of approximately 0.86 referred to air.

Gas production

The volume of methane gas produced during the digestion process can be estimated. For example, the volume of methane gas produced from 1 kg of cells in equal to about 0.5 m^3. This value is obtained by multiplying the kilograms of cells by 1.42 to convert to ultimate BOD and then by multiplying by 0.35 to obtain the cubic meters of methane.

Total gas production is usually estimated from the volatile-solids loading of the digester or from the percentage of volatile-solids reduction. Typical values are from 0.5 to 0.75 m^3/kg of volatile solids added, and from 0.75 to 1.12 m^3/kg of volatile solids destroyed. Gas production can fluctuate over a wide range, depending on the volatile-solids content of the sludge feed and the biological activity in the digester.

Gas production can also be crudely estimated on a per capita basis. The normal yield is 15 to 22 $m^3/10^3$ persons.d in primary plants treating normal domestic waste water. In secondary treatment plants, this is increased to about 28 $m^3/10^3$ persons.d.

Digester Mixing

Proper mixing is one of the most important considerations in achieving optimum process performance. Various systems for mixing the contents of the digester have been used. The most common ones involve the use of single- or multiple-draft tubes through which the sludge is circulated by a turbine mixer located within the tube and gas recirculated through diffusers in the base of the digester or by means of drop pipes.

Digester Heating

The heat requirements of digesters consist of the amount needed

- to raise the incoming sludge to digestion-tank temperatures,
- to compensate for the heat losses through walls, floor, and roof of the digester, and
- to make up the losses that might occur in the piping between the source of heat and the tank.

Digestion-tank walls may be surrounded by earth embankments that serve as insulation, or they may be of compound construction consisting of approximately 300 mm of concrete, corkboard insulation, or an insulating air space, plus brick facing or corrugated aluminium facing over rigid insulation.

AEROBIC SLUDGE-DIGESTION PROCESS

Aerobic digestion is an alternative process for stabilizing organic sludges produced from various treatment operations. It may be used to treat only (1) waste activated sludge, (2) mixtures of waste activated sludge or trickling-filter sludge and primary sludge. To date, aerobic digestion has been used primarily in small plants, particularly those using extended aeration and contact stabilization.

Advantages claimed for aerobic digestion as compared to anaerobic digestion are as follows:

- volatile-solids reduction is approximately equal to that obtained anaerobically;
- lower BOD concentrations in supernatant liquor;
- production of an odorless, humuslike, biologically stable end product that can be disposed of easily;
- production of a sludge with excellent dewatering characteristics;
- recovery of more of the basic fertilizer values in the sludge;
- fewer operational problems; and
- lower capital cost.

The major disadvantage of the aerobic digestion process appear to be the higher power cost associated with supplying the required oxygen, but some recent process developments may invalidate this objection. That a useful by-product such as methane is not recovered may also be a disadvantage. Comparing the advantages and disadvantages, it appears that aerobic digestion will increase in popularity as more reliable information on process kinetics and economics is developed.

Process Description

Aerobic digestion is similar to the activated-sludge process. As the supply of available substrate (food) is depleted, the microorganisms begin to consume their own protoplasm to obtain energy for cell-maintenance reactions. When this occurs, the microorganisms are said to be in the endogenous phase. In actuality, only about 75 to 80 percent of the cell tissue can be oxidized; the remaining 20 to 25 percent is composed of inert components and organic compounds that are not biodegradable. The ammonia from this oxidation is subsequently oxidized to nitrate as digestion proceeds.

A pH drop can occur when ammonia is oxidized to nitrate if the alkalinity of the wastewater is insufficient to buffer the solution. Theoretically, about 7.1 kg of alkalinity, expressed as $CaCO_3$, are destroyed per kilogram of ammonia oxidized. In situations where the buffer capacity is insufficient, it may be necessary to install chemical feed equipment to maintain the desired pH.

Where activated or trickling-filter sludge is mixed with primary sludge and the combination is to be aerobically digested, there will be both direct oxidation of the organic matter in the primary sludge and endogenous oxidation of the cell tissue. Aerobic digestors can be operated as batch or continuous flow reactors.

At presente, two proven variation of the process are available:

- conventional aerobic digestion, and
- pure-oxygen aerobic digestion.

A third variation,

- thermophillic aerobic digestion,

is currently under intensive investigation.

Conventional-Air Aerobic Digestion

Factors that must be considered in designing aerobic digesters include

- hydraulic residence time,
- process loading criteria,
- oxygen requirements,
- energy requirements for mixing, and
- environmental conditions.

Hydraulic residence time

The amount of volatile solids in sludge is reduced more or less up to a value of about 40 percent at a hydraulic detention time of about 10 to 12 d. Although volatile-solids removal continues with increasing detention time, the rate of removal is reduced considerably. Depending on the temperature, the maximum reduction ranges between 45 and 70 percent. The required time and degree of volatile-solids removal also varies with the characteristics of the sludge. Typically, volatile-solids reductions vary from about 35 to 45 percent in 10 to 12 d at temperatures equal to or above 20°C.

Loading Criteria

Limited information is currently available on appropriate loading criteria to use for this process. Because the hydraulic and mean cell residence times are nominally equivalent for this process, loading criteria based on mean cell residence time would appear to be most satisfactory. The maximum solids concentration would be governed by oxygen-transfer and mixing requirements.

Table: Design criteria for aerobic digesters

Parameter	Value
Hydraulic detention time, days at 20°C	
Waste activated sludge only	10-15
Activated sludge from plant operated without primary settling	12-18
Primary plus activated or trickling-filter sludge	15-20
Solids loading, kg volatile solids/m^3 .d	1.6-4.8
Oxygen requirements, kg/kg destroyed	
Cell tissue	2,3
BOD_5 in primary sludge	1.6-1.9
Energy requirements for mixing	
Mechanical aerators, kW/10^3 m^3	20-40
Air mixing, $m^3/10^3$ m^3 .min	20-40
Dissolved oxygen level in liquid, mg/l	1-2

Oxygen requirements

The oxygen requirements that must be satisfied during aerobic digestion are those of the cell tissue and, with mixed sludges, the BOD_5 in the primary sludge. The oxygen requirement for the complete oxidation of cell tissue is equal to 7 mol/mol of cells. The oxygen requirements for the complete oxidation of the BOD_5 contained in primary sludge varies from about 1.7 to 1.9 kg/kg destroyed.

On the basis of operating experience, it has been found that if the dissolved-oxygen concentration in the digester is maintained at 1 to 2 mg/l and the detention time is greater than 10 d, the sludge dewaters well.

Energy requirements for mixing

To ensure proper operation, the contents of the aerobic digester should be well mixed. In general, because of the amount of air that must be supplied to meet the oxygen requirement, mixing should be achieved; nevertheless power mixing requirements should be checked.

Environmental conditions

Of the many environmental factors, temperature and pH play an important role in the operation of aerobic digesters. It has been observed that the operation of aerobic digesters is temperature-dependent, especially at temperatures below 20°C.

Depending on the buffering capacity of the system, the pH may drop to a rather low value (5.5 $\pm$) at long hydraulic detention times. Although this does not seem to inhibit the process, the pH should be checked periodically and adjusted if found to excessively low.

Pure-Oxygen Aerobic Digestion

Pure-oxygen aerobic digestion is a modification of the aerobic digestion process in which pure oxygen is used in lieu of air. The resultant sludge is similar to sludge from conventional-air aerobic digestion.

The aerobic process is exothermic. Normally, the heat generated is not retained in conventional-air aerobic digesters because of the vigorous aeration in the open tank. Maintenance of these higher temperatures in the digester results in a significant increase in the rate of volatile suspended solids destruction.

Pure-oxygen aerobic digestion can be used only by large installations when the incremental cost of oxygen-generation equipment is offset by the savings obtained by reduced reactor volumes and lower energy requirements for dissolution equipment. In this regard, the process is most compatible with a treatment facility using the pure-oxygen activated-sludge process, because of the potential for oxygen availability on an incremental basis.

Thermophilic Aerobic Digestion

Thermophilic aerobic digestion represents a refinement of both the conventional-air and pure-oxygen aerobic digestion. It has been shown in large-scale pilot studies that thermophilic aerobic digestion can be used to achieve high removals of the biodegradable fraction (up to 70 percent) at very short detention times (3 to 4 d). Thermophilic digestion without external heat input can be achieved by using the heat released during microbial oxidation of organic matter to heat the sludge. It has been estimated that more than 25 kcal/L of heat energy are released in the aerobic digestion of primary and secondary sludges. It has also been demonstrated that this quantity of heat is sufficient to heat wet slurries containing from 95 to 97 percent water to the thermophilic range 45°C if sufficently high oxygen-transfer efficiencies can be obtained so that air or oxygen stripping of the heat does not occur.

Although it would appear that pure oxygen would be best in this application, it has been shown that thermophilic digestion can be achieved with a simple air aeration system. Typically, the process operates from 25 to 50°C above the ambient air temperature. Because of the high operating temperatures, the digested sludge is pasteurized as well. Ideally, the feed sludge should contain more than 4 percent solids to optimally support thermophilic digestion.

Benthal Stabilization of Waste Activated Sludge

The operating cost of stabilizing waste activated sludge solids in aerobic digesters is a matter of increasing concern. Biological oxidation requires significant quantities of oxygen. Furthermore, the power required to maintain the solids in suspension during aerobic digestion generally exceeds the power required to meet the oxygen demand.

Benthal stabilization provides a low-energy alternative to aerobic digestion. In benthal stabilization, solids are stabilized in a deposit at the bottom of an aerobic water column. A large fraction of the organic carbon is converted to methane and released to the atmosphere, thereby reducing the requirement for oxygen and avoiding the need of power for solids suspension.

In benthal stabilization, solids are stabilized in a sludge deposit by anaerobic or by a combination of aerobic and anaerobic mechanisms. If dissolved oxygen is maintained in the water column above the deposit at concentrations greater than 2 mg l^{-1}, a thin aerobic layer will exist at the top of the deposit in which the decomposition mechanisms are supported by dissolved oxygen transported from the overlying water. Below the aerobic layer, anaerobic conditions prevail in which methane gas is evolved, as well as other products of anaerobic decomposition. Methane gas escapes from the deposit, rises through the column and is released to the atmosphere. Ammonia and some of the less reduced products produced in the anaerobic layers (primarily organic acids) are transported upward to the aerobic layer by means of diffusion and advection induced by the consolidation of the deposit. There, the reduced products are oxidized or escape into the water above where they contribute to the soluble BOD concentration. New solids joining the deposit at the top can be expected to be decomposed by one, or both, of the two mechanisms, depending upon the rate at which the solids are being deposited.

Petroleum Sludges

Oily sludge is characterized by the presence of oil, solids, and water. Its consistency varies from that of a fluid slurry to a greasy semisolid. It is encountered when cleaning oil storage vessels, removed from the waste water oil-water separator, and it is collected as a residue from oil-water emulsion-breaking operations.

The disposition had been to dump the sludge into open earthen pits. To conserve land, the volume of sludge was reduced by burning the hydrocarbon that migrated to the surface, with a billowing black cloud of smoke. This method was unsatisfactory.

Spent caustic results from treatment of petroleum products for the removal of naphthenic acid, cresols, mercaptans, and hydrogen sulfide by caustic soda. These compounds emit intense disagreeable odors. Disposal of spent caustic by neutralization and by trickling into waste water treating system released odors during neutralization and the waste overtaxed the bio-oxidation pond.

When the spent caustic was dumped into an earthen pit, the caustic leached through the earth with contamination of the natural ground water. When the pit was lined with plastic sheets, it rapidly became full. The volume of spent caustic was increased by rainfall. The only reduction of the waste occurred from evaporation which produced an undesirable odor.

Various incineration systems were considered. The oxidation of spent caustic alone would require a prohibitive quantity of supplemental fuel. The incineration of oily sludge appeared more feasible. When oily sludge is subjected to high temperatures, the oil evaporates. Should the resulting hydrocarbon vapors fail to ignite, they could create hazardous explosive mixtures with combustion air.

Conditions offered by the fluidized bed incinerator were high heat-transfer efficiency, mixing, and stable combustion conditions. A bed of inert fluidized solids acting as a heat sink reduced the hazard of unburned hydrocarbon vapor an air.

The fluid bed incineration process has been demostrated to be practical and effective for the disposal of petroleum refinery generated spent caustic and oily sludge. The process creates no atmospheric pollution problems, emitting only carbon dioxide, nitrogen, and water vapors, the odor of the off gas being slight to nonexistent. The ash produced contains sodium carbonate, sodium sulfate, other soluble inorganic salts and inert material such as sand, clay and rust, and is readily buried.

STATE OF ART OF BASIC WASTE MANAGEMENT TECHNIQUES FOR MUNICIPAL WASTES

Dr. Ousman Sillah

RESUMEN

Describe el estado actual de las técnicas más utilizadas que se emplean en el manejo de los desechos por las municipalidades.

Incluye los sistemas de almacenamiento y recolección de los desechos; el transporte, las técnicas de disposición tradicionales y también describe las "nuevas" tecnologías, tales como el uso de rellenos sanitarios, los procesos de incineración, el composteo, el reciclaje, la obtención de combustibles a partir de desechos, los procesos de pirólisis y de biogasificación.

Se hace énfasis en la composición de los desechos, lo cual tiene una influencia directa en la selección del proceso que mejor convenga seguir desde el punto de vista de su factibilidad económica.

Finalmente describe la forma de llevar a cabo el proyecto de tratamiento de los desechos que sea la selección óptima.

INTRODUCTION

Waste disposal was probably mankind's first environmental problem.

Solid wastes management is an important element of public health and

Dr. Ousman Sillah, GTZ, Germany

environmental protection. Its purpose is to provide a hygienic, efficient and economic service organization to collect and transport solid wastes rapidly to treatment or disposal points without transferring pollution to the atmosphere, the soil or water system.

In developing countries, high population density in cities, industrialization, change in the composition of solid wastes have raised the problem of refuse collection and disposal in or around urban areas.

Careful identification of both present and future waste problems provides the basis for determinating the objectives of adequate management, be it at local, regional or country level.

MUNICIPAL WASTE CHARACTERISTICS

Composition

The composition of urban waste depends largely on the lifestyle and standard of living of the inhabitants and the degree of industrialization. Some typical examples are given in Table 1.

Table 1: Refuse composition in percentage by weight for different cities / 1 /

	Lagos	Jakarta	Stuttgart
Vegetable	60	82	41
Paper	14	2	26
Metals	4	4	4
Plastics	-	3	5
Textiles	-	1	2
Glass	3	1	12
Miscellaneous	19	7	10

The composition of the solid wastes also determines to a large scale the type of treatment that would be technically and economically feasible.

Quantities

The values for urban waste generation rates in developing countries are low compared to refuse generation in developed countries, because of the inhabitants' attitude and the standard of living.

In a town, the quantities of waste are greatly dependent on the income structure of the population. In addition to the source density, the quantities occurring at certain times (short-term, long-term) will characterize and dimension the disposal systems and subsystems.

The average quantities of waste are listed for some countries in the following table.

Table 2: Quantities of waste in some Third World towns Source: (Dr. Bidlingmaier; the author's own research)

Town	Country	Quantity of waste in t/I/a (ton per inhabitant and year)
Libreville	Gabon	0.15
Algiers	Algeria	0.15
Onitsha	Nigeria	0.17
Cairo	Egypt	0.17
Abidjan	Ivory Coast	0.2
Niamey	Niger	0.16
	West-Germany	0.4

REFUSE STORAGE AND COLLECTION

Refuse storage and collection is the essential prerequisite for the effective handling of waste.

In developed countries most refuse is collected by house to house methods, the remaining small percentage being special collections from markets and other civic points.

Storage methods in developing countries can be divided into two major groups, namely the household storage methods and the communal storage methods.

Some of the household storage containers that are available in most countries are:

- plastic bracket
- plastic bins
- galvanized steel or plastic bins
- expendable plastic sacks.

In the communal storage methods, wastes are stored in communal containers provided, in most cases by government officials. Some of the typical communal storage methods are:

- Depots (storage buildings)
- Enclosures
- Fixed Storage Bins
- 200 Litre Drums
- Portable Steel Bins

Basic collection systems, employed in many countries, are collection from communal storage container, block collection, kerbside collection and door to door collection.

The most employed system is the collection from communal site. In this system, the collectors just collect the waste from the communal storage which may thus require delivery of the wastes by the householder over a certain distance.

TRANSPORTATION

In developed countries trucks and loaders are used for the transportation. Some of the typical means of transportation of solid waste in developing countries are:

- Handcarts
- Pedal-Tricycle
- Motor-Tricycle
- Tractors and Trailers
- Tonne Truck
- Barrier Loader
- Container-Hoist

Frequency of collection must be much higher than in e.g. western countries. High temperature and humidity cause refuse to decay and decompose very quickly and this introduces health and hygiene considerations.

CLASSICAL WASTE MANAGEMENT TECHNIQUES AND "NEW" TECHNOLOGIES

Urban waste utilization options are described in Fig. 1.

Sanitary Landfill

Sanitary landfilling has been widely used for land disposal of wastes. The selection of a waste disposal site is a complex procedure involving many factors ranging from social acceptance and economics, to air and water pollution. Geological, hydrological and hydrogeological factors are of great importance in the selection of a safe site.

A controlled landfill means a systematic, compacted depositing of layers of refuse and daily covering of the surface thereof. The ground water should thereby not be affected.

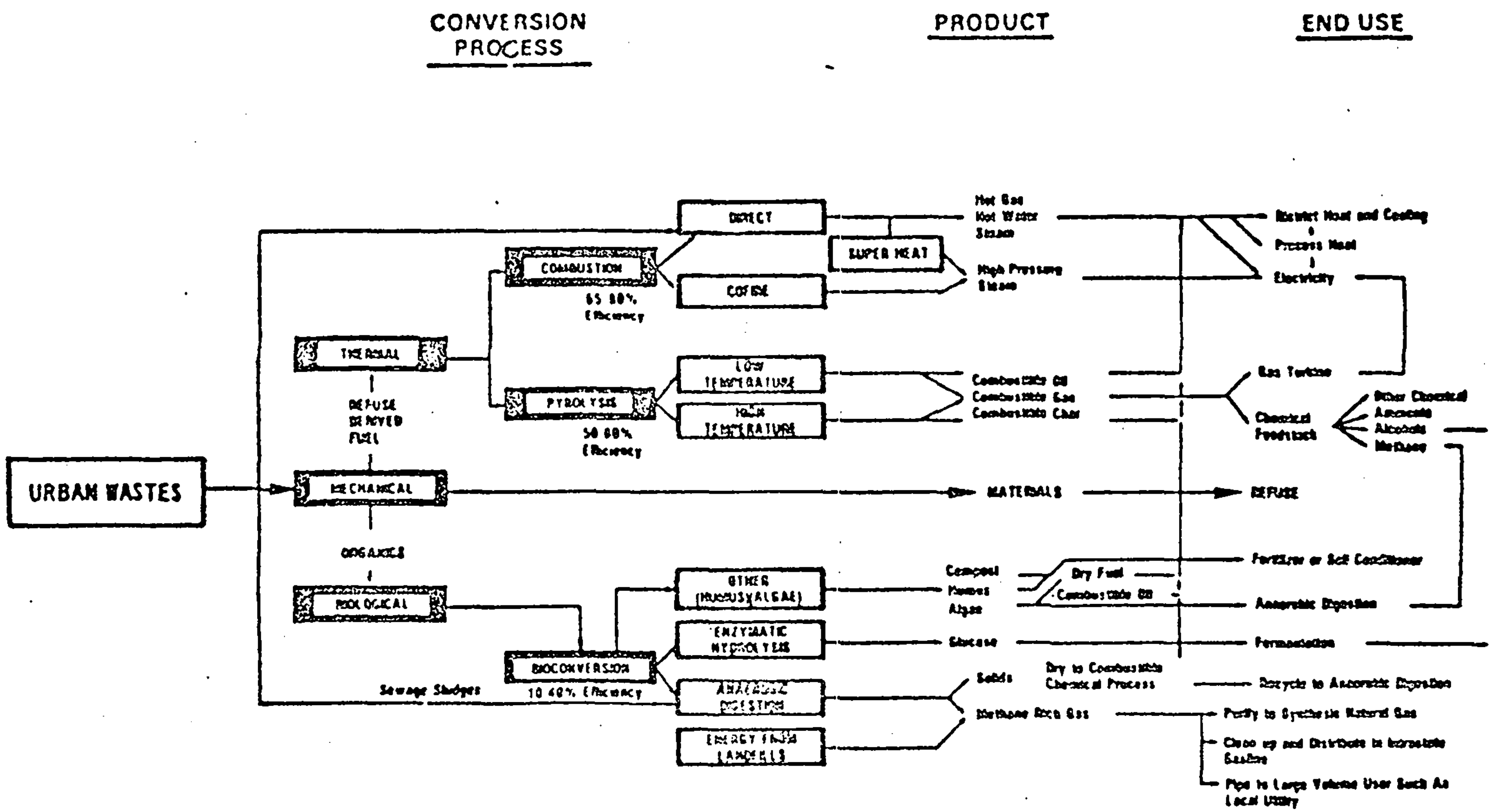


Figure 1. Urban Waste Utilization Options

The area fill method (Fig. 2) is used where canyons, open pits, quarries or ravines exist. The waste is dumped into the opening, and earth-moving equipments takes soil from the walls of the depression to cover the waste material. In the trench methods (Fig. 3), trenches are excavated, solid waste is dumped into the trench and the excavated soil is used to cover the waste. Both methods use tractors to spread and compact the waste on an inclined face, in layers no more than 2 feet thick . A portable fence is used to catch any blowing debris.

A landfill site is necessary even if composting plants or incineration plants are operated, for the disposal of their residues.

The most important environmental problems of landfilling of municipal waste is the formation of leakage and landfill gas. Solid waste deposited in a landfill degrade chemically biologically to produce solid, liquid and gaseous products.

The process of leachate production begins when rain water percolates through the soil directly over the landfill. The production of leachate is greatly accelerated at open dumps, where the solid waste is not covered with soil.

Landfill gas is produced by the process of anaerobic digestion of the organic material contained in the municipal solid wastes.

Variables affecting gas generation are pH, moisture content, oxygen concentration, temperature, waste composition.

Although it must be emphasized that it is quite difficult to generalize expected rates of landfill gas production, a fairly typical generation rate curve for a one-million-ton landfill is illustrated in Figure 4. The curve assumes that the solid waste was emplaced at a fairly constant rate (100 000 tons per year) for ten years. It also assumes a maximum generation rate of 0.07 scf of methane per pound of MSW per year, and that the generation of gas decreases exponentially with a half-life of 2o years.

Landfill gas is typically comprised of about one-half methane and one-half carbon dioxide, although the percentage by volume of both the methane and the carbon dioxide can vary widely. The gas composition remains relatively constant during the period of gas production.

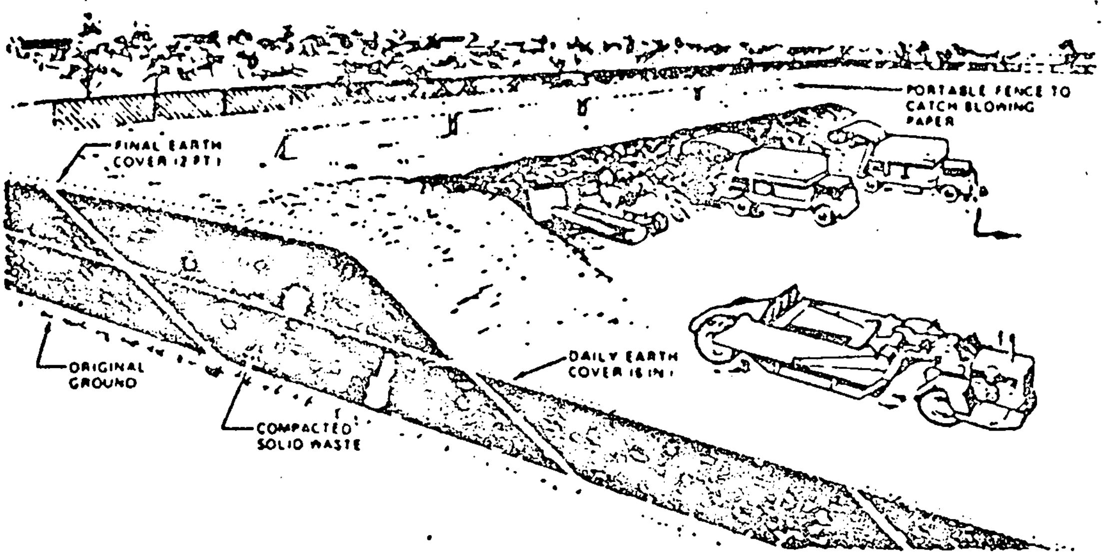


Figure 2 Area Method of Landfilling

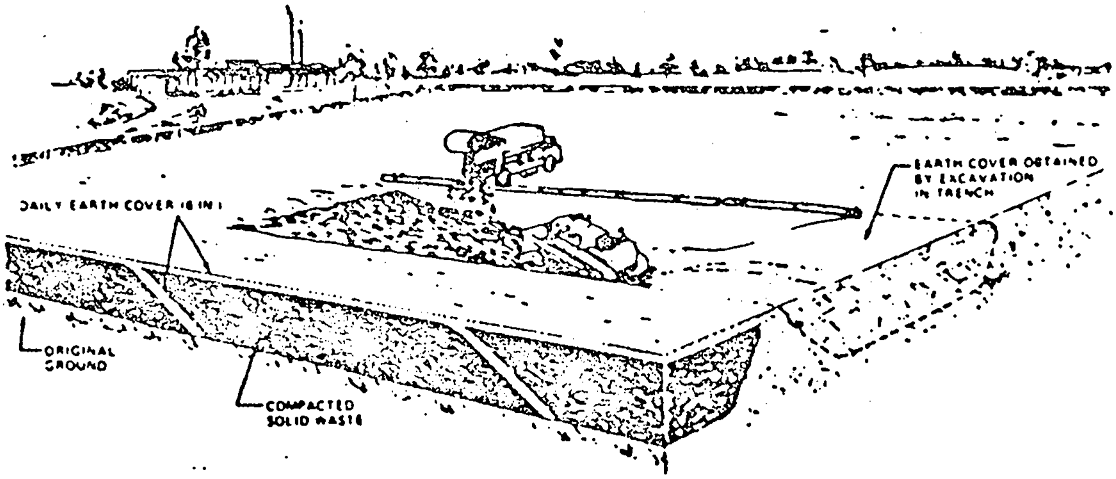


Figure 3 Trench Method of Landfilling

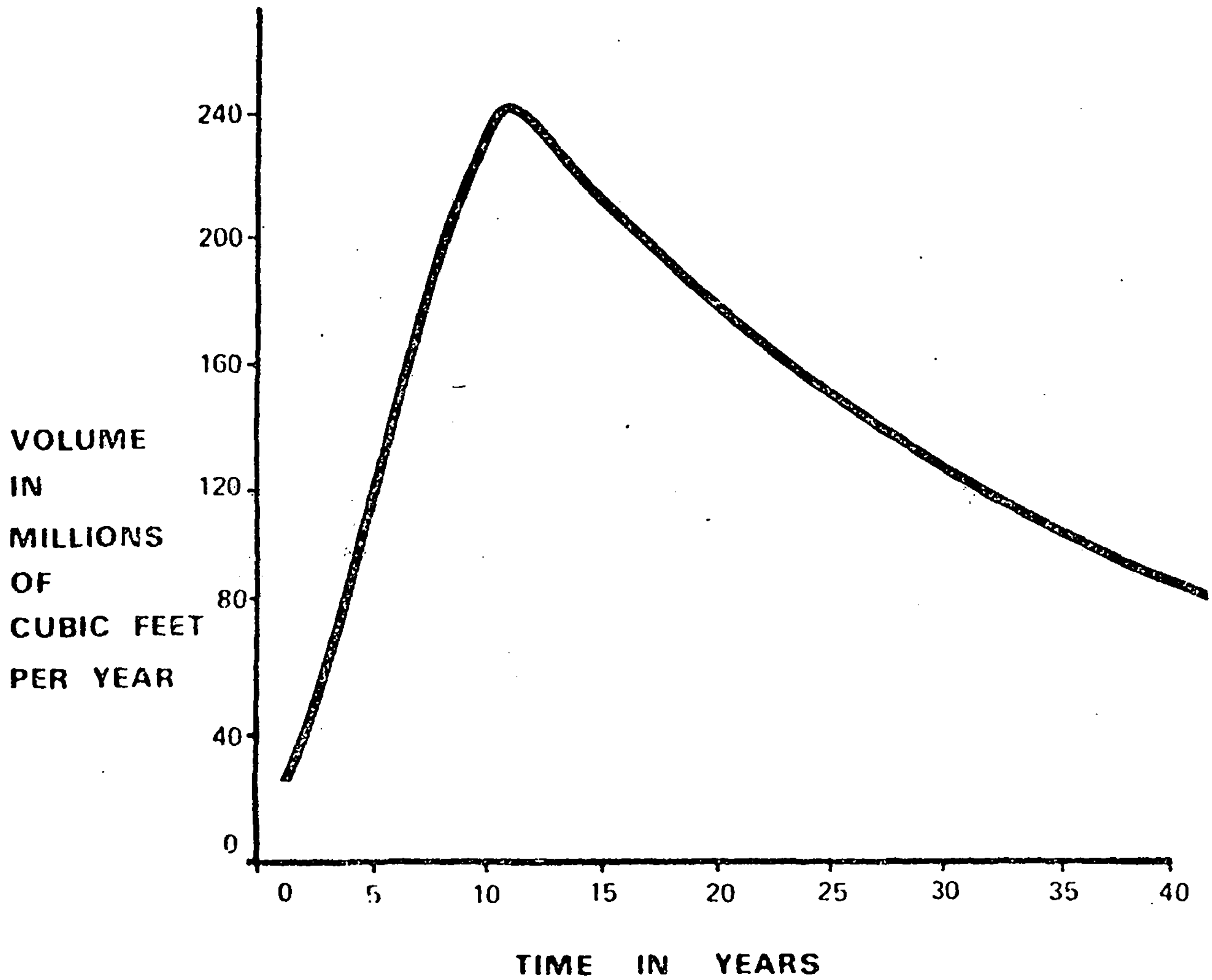


FIGURE 4

TYPICAL GAS GENERATION PROFILE FOR ONE MILLION TONS OF SOLID WASTE LANDFILLED OVER A TEN-YEAR PERIOD

TABLE 2 TYPICAL LANDFILL GAS COMPOSITION AND CHARACTERISTICS (HAM, et al. 1979)

Component	Component percent (dry volume basis)
Methane	47.5
Carbon Dioxide	47.0
Nitrogen	3.7
Oxygen	0.8
Paraffin Hydrocarbons	0.1
Aromatic & Cylic Hydrocarbons	0.2
Hydrogen	0.1
Hydrogen Sulfide	0.01
Carbon Monoxide	0.1
Trace compounds*	0.5
Characteristic	**Value**
Temperature (at source)	41°C
High heating value	17727 kJ/std cu m†
Specific gravity	1.04
Moisture content	Saturated (trace compounds in moisture)‡

* Trace compounds include sulfur dioxide, benzene, toluene, methylene chloride, perchlorethylene, and carbonyl sulfide in concentrations up to 50 ppm.

† Landfill gas (as received) from Palos Verdes landfill has HHV of 21646 to 21832 kJ/std cu m (3). Landfill gas (as received) from a Mountain View landfill test well has a HHV of 16420 to 16794 kJ/std cu m with a 20-21 percent nitrogen content by volume (1, 2).

‡ Trace compounds include organic acids(7.06 mg/cu m) and ammonia (0.71 mg/cu m).

Typical landfill gas composition and characteristics of the gas are shown in Table 2.

In the case of closed landfills, the sinking of perforated tubes (wells) into the refuse body produces satisfactory results for the gas collection. By generating under-pressure artificially the reach and the volume of collected gas can be increased. The gas households of landfills to be opened can be controlled from the very beginning by providing preferred outlets in the form of vertical wells or horizontal ducts.

Because of its methane content, landfill gas is an energy carrier. which can be burned to generate hot steam or hot water for heating purposes, or burned in a gas engine with generator for the generation of electricity and heat (cogeneration), or feeded into the public system, or liquefied to be used as fuel.

At the end of the filling sanitary landfills can be recultivated. The configuration of the surface and the new vegetation arrangement should be discussed and worked out with a landscaping architect.

The costs for a sanitary landfill are about 3 to 15 US Dollar per t of refuse. It depends on local conditions.

Waste Incineration

Direct combustion consists of burning the combustible components or urban waste and using the heat released to generate steam. This steam is then used to generate electricity or is sold.

Incineration serves first of all as a method of reducing refuse volume and treating wastes prior to disposal. In developed countries, the use of heat from the incineration of household waste is becoming of increasing interest economically, because the municipal refuse in many areas already attains a calorific value which corresponds to that of brown coal.

In most developing countries, the low share of combustibles in solid waste implies low heating value of the waste and incineration with heat recovery can be ruled out.

There are a number of types of combustion units. The principal differences are in the construction of the walls of the firebox and in the method of burning the fuel.

Lastly, refuse may be burned on a grate.

Fig. 5 gives a sectoral view of a modern incinerator.

Environmental problems which can result from the incineration of waste are the dust and noxions gases contained in the fuel gases. Efficient air pollution control devices are clearly and necessary and must be carefully selected. The types of devices currently developed to the commecially operational stage and potentially capable of reaching the neccesary levels of efficiency are fabric filters, scrubbers and electrostatic precipitators (ESPS).

In Western Europe the costs for incineration are about 30 to 50 US-Dollar per t waste.

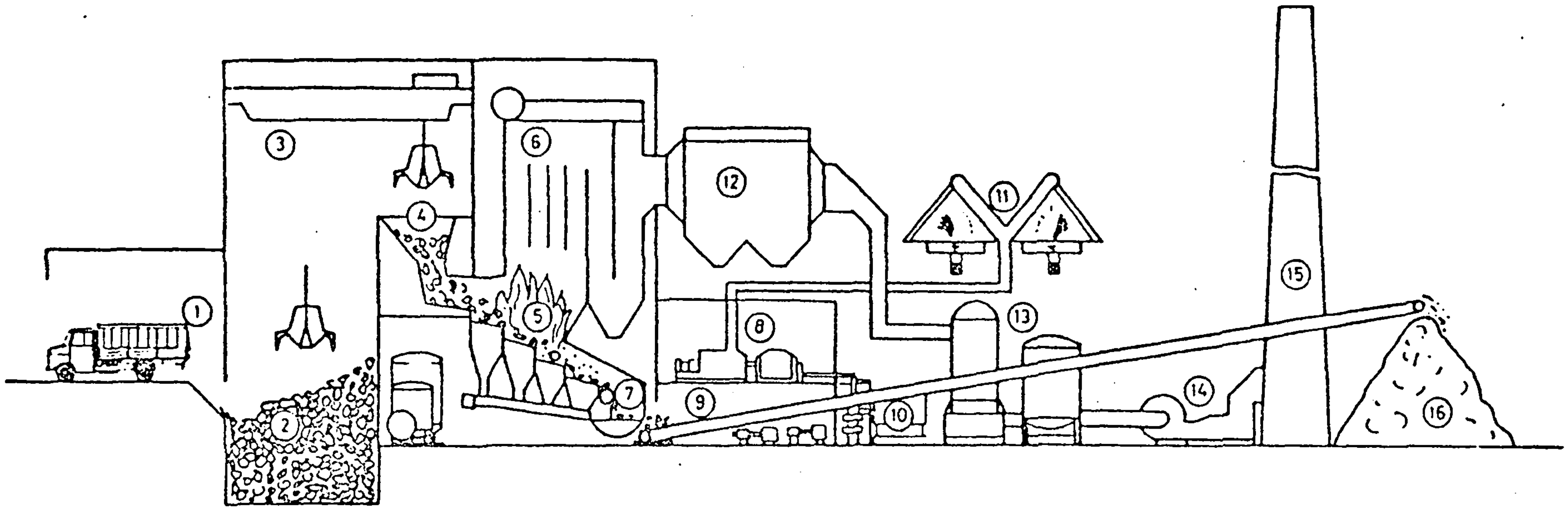
Composting

The basic biological process used in composting is the aerobic decomposition of organic material through microorganisms. Composting is a combination of mechanical and biological processing designed to turn wastes into a useful product, namely compost. Refuse composting is surely of great interest to many developing countries because of the low potential presence of toxic substances (heavy metals) in the raw waste.

The following arguments speak in favour of composting in developing countries:

- relatively simple technology
- process readily adaptable to local conditions
- waste composition (high organic content and moisture content)
- only small amounts of residue need be disposed of (landfilled).

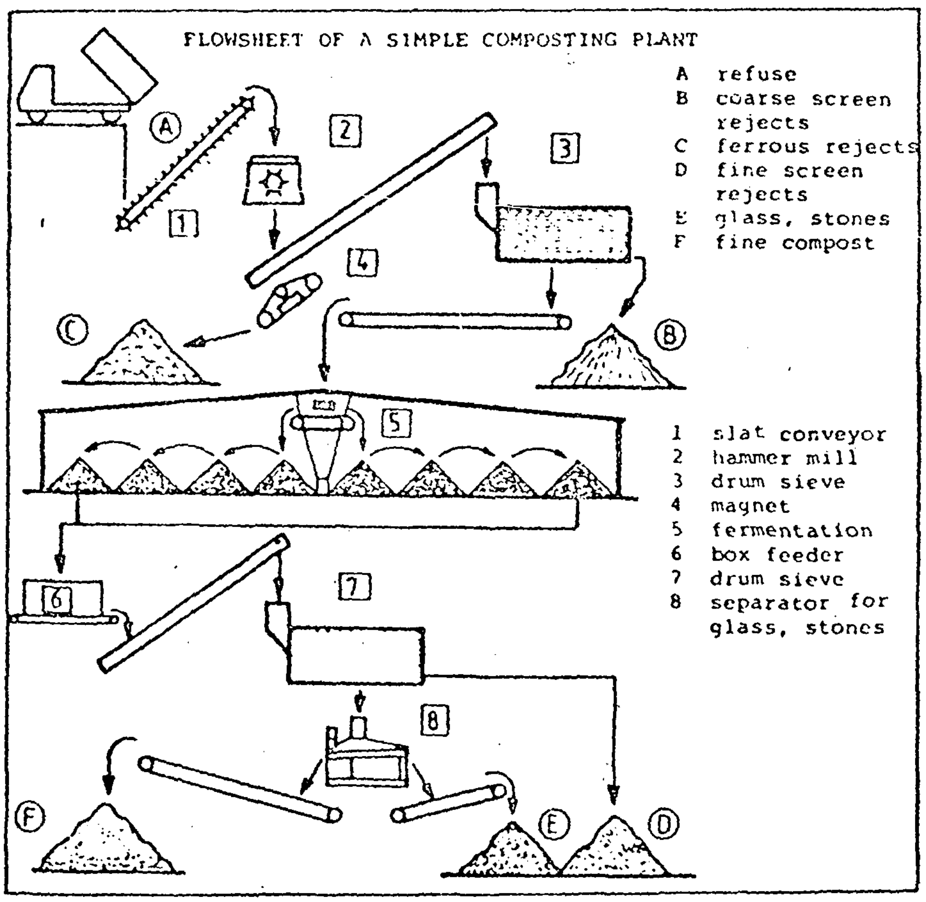
The flowsheet of a simple composting plant is shown in Fig. 6.



1. Waste discharge
2. Storage bunker
3. Crane
4. Hopper
5. Grate
6. Boiler
7. Slag quenching
8. Steam turbines
9. Turbine cellar
10. Transformer
11. Air condenser
12. Electric filter
13. Flue gas scrubber
14. Suction blower
15. Stack
16. Slag dump

Fig. 5 Sectoral view of a modern refuse incinerator /2/

The flowsheet of a simple composting plant is shown in Fig. 6.



Planning considerations for composting plants are:

- Suitability of wastes for composting (organic)
- Compost uses and marketability: some of the main application are landscapping, agricultural areas for e.g. fruits, vegetables, maize, cereals, horticulture, parks, foresty, revegetation of landfills, filter material for biological filters for control.
- Selection of composting system:
  - . composting in windows,
  - . composting in reactors, cells (static or dynamic system).

In Western Europe the cost for a composting plant range from 25 to 40 US-Dollar per t solid waste (approximately).

"New" Technologies

- Mechanical recycling facilities to recover secondary raw materials do not correspond to the situation in developing countries, as these materials (paper, glass, metal) do not generally even reach the waste bin.
- The production of refuse derived fuel (RDF) in a mechanical processing plant of urban waste is too inadapted to the local conditions of most developing countries. The essential stages which in various combinations permit the mechanical recovery of the secondary raw materials or the production of RDF are screening, crushing and sorting and for RDF-production converting to fuel pellets.
- Pyrolysis

  Pyrolysis is the thermochemical decomposition of solid waste in an oxygen-starved or oxygen-free atmosphere to produce solids, liquids, or gas (Ref. 32). Most pyrolysis systems supply the heat required for the pyrolysis reaction by partial combustion of the waste in the reaction chamber.

  These combustion gases are then part of the product. Hence, there are no significant gaseous emissions until the product is utilized. The products may be used as fuel but also have potential for chemical synthesis.

The principal components of any pyrolysis system include the reactor type (shaft, rotary kiln, fluidized bed), heating mode (direct, indirect), residence time and temperature. Chemical composition of raw waste materials and process heating rate are major process variables. All these factors determine the product character and quality and the associated air emissions resulting from its utilization.

- Biogasification of municipal solid waste

  A series of experiment on the anaerobic digestion of the organic fraction of municipal refuse was performed. This method can be of great interest for developing countries.

CONCLUSION

In developing countries waste collection and disposal services have been generally the concern of the local municipalities. Each municipality has tended to cope with the problem in its own way and within its corporate limits. There has been a general lack of central coordination and uniform standards of service. There is now a need for reviewing and up-dating past legislation and for promulgating new legislation and standards for environmental pollution control and environmental protection on a broader front. Effective implementation and enforcement of such legislation call for new organisational and administrative arrangements.

In most countries too, there have been signs of growing public awareness of these problems, and as standards of living rise, the demand for better and improved services is becoming more pressing. Public participation and cooperation is an essential prerequisite for the successful implementation of an efficient wastes management system and of an effective environmental protection policy, and needs to be encouraged.

The main prerequisite for the realization and successful further operation of a waste project in developing countries is the implementation of a training program dealing with waste handling and vehicle technology as regards the collection, transport and treatment of the waste. This, for example, can be carried out in a technology centre.

The optimum solution for realizing a project is to divide it into several phases:

1 Preliminary phase (contact between the developing country and the Federal Government, formation of a working group, clarification of organizational and administrative questions, preparation of resolutions).

2 Advance planning (concept phase)

2.1 Study of the requirements

- Inventory
- Prognosis
- Objectives

2.2 Feasibility study

- Collection and transport problems
- Possible sites
- Market analysis
- Comparison of methods
- Proposal
- Decission about the method

3. Executive planning

3.1 Advance technical project work

- Process comparison
- Process proposal
- Process decision
- Site determination

3.2 Project planning

- Call for tenders
- Examination and evaluation of the tenders
- Award proposal
- Award of contract

4. Construction and commissioning of the waste treatment plant

5 Concurrent research and development program (to be performed by the developing country).

The costs must be accurately estimated in the concept phase (advance planning).

LITERATURE

(1) K.J. Thomé-Kozmiensky (Editor), Recycling in Developing Countries Recycling Congress, Berlin, 1982.

(2) UNEP/BMFT-Symposium of Solid Waste Management C. Nels.

MANAGEMENT OF HAZARDOUS WASTES FROM THE INDUSTRY

Dr. Hans Sutter

RESUMEN

Diferentes tipos de riesgos de los desechos peligrosos. Efectos en la salud y el ambiente. Clasificación de desechos peligrosos. Tecnología para el manejo de desechos (sin costo y de bajo costo).

Los desechos peligrosos se dividen en dos grandes grupos: Desechos que producen peligro agudo a corto plazo por ingestión, absorción por la piel, corrosividad, etc. y Desechos peligrosos a largo plazo que sobre todo pueden producir toxicidad crónica por exposiciones repetidas, carcinogénesis, resistencia a los procesos de desintoxicación y también pueden contaminar las aguas subterráneas o superficiales.

HEALTH AND ECOLOGICAL ASPECTS

Nearly every production process yields both the product desired and a number of non-product outputs which are called residuals. When these residuals are reactive, corrosive, ignitable or toxic, and have to be disposed of, they are called "hazardous wastes". Hazardous waste is a waste that has physical, chemical or biological characteristics which require special disposal procedures to avoid risk to health and other adverse environmental effects.

Dr. Hans Sutter, GTZ, Germany

When defining hazardous waste, concern is essentially with waste that presents either:

(a) short-term acute hazards, such as acute toxicity by ingestion, inhalation, or skin absorption, corrosivity or other skin or eye contact hazards or the risk of fire or explosion; or

(b) long-term environmental hazards, including chronic toxicity upon repeated exposure, carcinogenicity, resistance to detoxification processes, such as biodegradation, the potential to pollute underground or surface waters.

The management cycle for any particular hazardous waste comprises its generation, transport, storage, treatment and final disposal. Clearly, many hazardous characteristics, such as corrosivity, flammability, and high toxicity by ingestion, inhalation or skin absorption, will cause potential problems at all these stages. For example, corrosive wastes are of two-fold concern. The primary concern is for the safety of the waste handlers (haulers and disposers). Waste capable of damaging tissue by corrosive action must be identified, and then properly labeled to insure that they receive cutious handling. The second concern is that if wastes which are to be stored for a period in a container are corrosive, they may corrode the container, leak out, and cause damage. The acute hazard posed by the waste may be expressed in terms of oral inhalation or dermal toxicity, flashpoint, explosivity, concentration of known corrosive species, etc. Physical characteristics, such as vapour pressure and boiling point, may be important. To avoid dangerous interactions with codeposited materials, highly reactive materials such as powerful oxidants should also be considered.

By contrast, many wastes that offer no significant short-term hazard may cause severe long-term hazards due to their physical or chemical properties. Such properties as volatility and solubility in water and organic chemicals will influence the mobility of waste deposited in landfill. The persistence of particular material will depend on its vulnerability to various natural breakdown mechanisms - microbiological, photochemical, oxidation/reduction, etc. The toxicity of a deposited material and its metabolites are all relevant. For example, certain halogenated hydrocarbon solvents are nonflammable and of a low order of acute toxicity. They can cause problems in landfill, however, because their slow rate of breakdown may consequently bring the risk of surface run-off or damage to ground water.

The long-term hazard posed by the waste will depend on the chosen disposal route, because a waste containing a contaminant can only be a hazard if there exists an exposure route by which this contaminant can be made available to the environment. Hazardous wastes have been and are still being handled and disposed of by various methods, many of which are not environmentally safe. A few of the environmentally unsatisfactory practices that have been employed include the following:

1. Disposal on-site without proper precautious to avoid groundwater and surface water contamination.

2. Disposal of sludges and slurries in landfills where leachate may contaminate groundwater.

3. Incineration without controlled emission of toxic or corrosive gases to the atmosphere.

4. Discharge to waterways or sewer systems without understanding the potential danger and harmfull environmental effects.

Many cases document the immediate and long-term danger to man or his environment from improper disposal of such hazardous wastes. Table 1 summarizes the results of a study which was done in the USA. An inventory of over 400 cases of damage resulting from waste-disposal practices was compiled. The majority of case studies in the inventory relate to industrial processing waste disposal, however, damages from the disposal of pesticides and pesticide containers have also been incorporated. Table 1 categorizes the damage involved in the analyzed case studies by disposal method. It indicates that ground water contamination is the most common type of damage reported, followed by surface-water contamination. Moreover, in most cases of established groundwater contamination, actual water supply we-ls (as compared to monitoring wells) have been affected. The table also shows that "other land disposal", which generally refers to promiscuous dumping on land not designated for this purpose, is the most significant source of damage.

The contaminants, listed in damage incidents by disposal method, comprise a wide range of harmful and potentially harmful substances (Table 2). The largest category, miscellaneous organics (identified in 88 separate incidents), includes some known and suspected carcinogens. It should be emphasized, however, that in most documented damage cases, chemical analysis of the contaminants is incomplete. This is mainly due to the expensive nature of thorough laboratory analysis, especially when organic contaminants are involved.

Table 1: Mechanisms Involved in Incidents of Damage by Disposal Method

Disposal Method	Surface Impoundments	Landfills Dumps	Other Land Disposal	Storage of Wastes	Smeltings Slag, Mine Tailings
Number of Cases	89	99	203	15	15
Damage Mechanism (Number of cases)					
Groundwater (259)	57	64	117	10	11
Surface Water (170)	42	49	71	--	8
Air (17)	3	5	9	--	--
Fires, Explosions (14)	--	11	3	--	--
Direct Contact Poisoning (52)	1	6	40	3	--
Wells Affected (140)	32	28	74	4	2

Table 2: Contaminants Involved in Damage Incidents by Disposal Method

Cases Studied: 421

Disposal Method Contaminant	Total	Surface Impoundments	Landfills, Dumps	Other Land Disposal	Smelting, Slag, Mine Tailings	Storage
As	19	5	4	10		
Cd	5	3	1	1		
Cr	33	11	9	12	1	
Cs	1		1			
Cu	20	6	4	7	3	
Fe	40	10	20	6	4	
Hg	11	1	1	9		
Mn	26	3	15	4	4	
Ni	13	5	2	5	1	
Pb	22	5	6	8	3	
Zn	22	9	5	5	3	
Cl	27	11	6	9	1	
CN	19	6	4	9		
F	8	5		3		
NH_3	14	6	2	6		
NO_3	6	6	2	7		1
SO_4	18	9	2	5	2	
Inorganic Acids	27	21	25	29	6	2
Misc.Inorganic PCBs	3		1	2		2
Petrochemicals	27	10	5	10		2
Phenols	31	9	10	12		
Misc.Organics	88	19	25	39		5
Bacteria	11	1	2	8		
Pesticides	71	1	6	57		7
Radioactive	9	2	3	1	1	2
Unspecified Leachate	25	5	18	1	1	
Tøtal	689	178	183	275	34	19

Two other interesting observations derived from the tabulation of case studies should be noted. One is that in 63 percent of the incidents of damage, the causative waste disposal action occured on the property of the waste generator, although in many instances the damage had spread off-site when it was discovered. The second observation relates to the time frame of discovery of damage. Sixty percent of the available damage incidents were discovered during the past 5 years; however, the acts of waste disposal responsible for the damage may have occurred years or even decades earlier.

CLASSIFICATION OF HAZARDOUS WASTES

The short-term acute and longer-term environmentally hazardous properties of a waste are a function of the chemical species present.

The majority of hazardous wastes are complex mixtures of different chemical compounds. For example, spent nonferrous metal pickling solution contains 13% nitric acid, 5% hydrofluoric acid plus dissolved nickel, chromium and iron salts.

The individual components of a waste should be known before a complete assessment of its hazard potential is made. This knowledge, however, is often very difficult (or even impossible in practical terms) to obtain particularly for solid waste. To demand, either directly or by implication, that all waste be analyzed for all potentially hazardous species is quite impractical. Nevertheless, good information on waste composition is needed, and in many cases broad compositional data will be adequate. In the case of waste cyanide heat treatment salts, for example, the presence of up to 5% sodium cyanide is sufficient to dictate appropriate handling and disposal conditions. The composition of the balance, i.e. the relative proportions of sodium or potassium nitrites, nitrates, chlorides or carbonates, or barium chloride, is a secondary consideration.

The overall objective of waste classifcation is to provide a means for relating specific wastes to varying levels of potential environmental impact. Factors that must be considered when classifying wastes as hazardous include:

1. Waste composition
2. Waste characteristics with respect to human effects (e.g.Toxic, carcinogenic, irritant, etc.)
3. Waste persistence and degree of stability, based on potential for biological and chemical reactions within the landfill.
4. Leachbility of the waste, and leachate characteristics.

5. Degree of attenuation of the leachate within the soil-water system.
6. Waste handling characteristics (e.g. Flammability, reactivity, explosive, etc.)

There are three basic approaches which can be taken towards the legal classification of hazardous waste: first, a pragmatic solution is achieved by describing the waste in a qualitative way, indicating type, origin and constituents of the waste; second, a more scientific approach defining hazardous wastes by certain characteristics usually involving standard testing procedures; and, thirdly, definition of the waste in association with concentration limits of harmfull substances. In the latter case, the presence of certain listed hazardous components in a waste beyond a defined concentration makes a waste a hazardous waste.

All three approaches can be justified. The first one has the advantage that a legal system, based on that type of definition, can more easily be administered and enforced. It does not involve the high cost of repeated waste testing. The approach is based on the concept of identifying or defining "hazardous wastes" by generic name or by materials which may be contained within a particular waste mixture. This concept is best applied for making a destination between the broad categories of hazardous and non-hazardous wastes.

The other two approaches have the advantage of presenting a clear and accurate description of wastes, theoretically leaving no doubt for the waste generator and waste disposer about how to deal with the waste. They have the disadvantages that they involve a high cost for testing particular wastes.

No common international definition or classification of hazardous waste currently exists. In most countries legal definition of hazardous waste remain relatively vague and refer to a list of the types of waste concerned. Table 3 list those types of industries that may generate potentially hazardous wastes. It is a "generic" waste listing. Potentially hazardous wastes are listed as easily recognizable wastes from certain processess or operations.

WASTE MANAGEMENT TECHNOLOGY

Depending on the waste composition, volume, economics and other factors, proper hazardous waste disposal procedures may involve one or more of the following methods:

1. Waste reduction by applying low- and non-waste technologies
2. Conversion of hazardous wastes to less or nonhazardous forms by chemical, thermal or other means of treatment.

Table 3: Listing of Potentially Hazardous Wastes

Category	Potentially Hazardous Waste Stream
Textiles	Dye and chemical containers.
	Wastewater treatment sludges.
	Solvent recovery sludges.
Inorganic Chemicals	Diaphragm cell process sludges.
	Mercury cell process sludges.
	Chrome colors wastewater treatment sludges.
	Hydrofluoric acid wastewater treatment sludges.
	Silicofluoride wastewater treatment sludges.
	Chromate waste treatment sludges.
	Phosphorus waste treatment sludges.
Plastic Materials and Synthetics	Phenolic resin wastes.
	Amino resin wastes.
	Polyester catalyst wastes.
	Still bottoms from solvent reclamation.
	Waste solvents
	Air pollution control dusts, spills.
	Cellulosic and non-cellulosic man-made fibers wastewater treatment sludges.
Pharmaceuticals	Halogenated waste solvents.
	Non-halogenated waste solvents.
	Organic chemical residues.
	High-inerts-contaminated waste.
	Activated ingredients in rejects and returned goods.
	Heavy metal washes.
Paint and Coatings	Cleanings, waste solvents.
	Wastewater treatment sludges.
	Raw materials bags and packages.
	Air pollution control residues.
	Spoiled batches and spills.
Organic Chemicals and Pesticides	
	Liquid heavy ends from perchloroethylene column.
	Nitrobenzene liquid heavy ends.
	Epichlorohydrin still bottoms.
Petroleum Refinery	Slop oil emulsion solids.
	Once-through cooling water sludge.
	Spent lime from boiler feedwater treatment.
	Exchanger bundle cleaning sludge.
	API separator sludge.
	Dissolved Air Flotation (DAF) float.
	Kerosene filter clays.
	Crude tank bottoms.
	Leaded tank bottoms.
	Cooling tower sludge.
	Neutralized hydrofluoric acid alkylation sludges.
	Storm water silt.
	Waste biological treatment sludge.
	FCC catalyst fines.
	Coke fines.
	Lube oil filter clays.
Rubber Products	Devulcanization wastes.
	Hose and belting process wastes.
	Solvent wastes.

Table 3: (continued)

Category	Potentially Hazardous Waste Stream
Leather Tanning and Finishing	Trimmings and shavings.
	Finishing residue.
	Wastewater treatment sludge.
	Unfinished leather trimmings.
	Buffing dust.
	Finished leather trim.
	Wastewater screenings.
	Chrome fleshings.
Metal Smelting	Electrolytic copper refining sludge.
	Tungsten digestion residue.
	Tungsten wastewater treatment sludge.
	Secondary copper blast furnace slag.
	Secondary aluminum air pollution control sludge.
	Ammonia liquor.
	Ammonia wastewater lime sludge.
	Ammonia decant tank car.
	Dust from electric furnaces (steel). air pollution
	Sludge from electric furnaces (steel). control residues.
	Steel mill sludges.
	Steel mill scales.
	Steel mill pickle liquors.
	Ferromanganese and silico manganese air pollution control dusts and sludges.
	Ferrochrome air pollution control dusts and sludges.
	Ferronickel skull plant tailings.
Electroplating and Metal Finishing	Wastewater treatment sludges.
	Process wastes
	Degreaser sludges.
	Salt precipitates from nickel baths.
Special Machinery Manufacturing	Machine shop coolants, oils, sweepings and grindings, solvents.
	Heat treating salts, oils, acids and alkalies.
	Electroplating solvents, acids and alkalies.
	Coating solvents, sludges, filters.
Electronic Components	Halogenated solvents.
	Non-halogenated solvents.
	Wastewater treatment sludges.
	Oils.
	Coating wastes.

3. Ultimate disposal in specially-designed hazardous waste disposal sites.

Low- And Non- Waste Technologies

Until recently, hazardous wastes were looked upon as unavoidable by-products of production requiring further treatment to render them harmless. However, with the increasing cost of raw materials and energy, the problem of avoiding wastes has gained in importance. A technical solution to the elimination of wastes at their source is the essence of non- and low-waste technologies.

There are two main approaches to low- and non-waste processes: The recycling of wastes generated and the development of new technologies which do produce less or no waste. The modification of existing technology by the installation of pollution equipment and the optimization of process parameters could considerably reduce waste generation.

Two main reasons exist for the present-day interest in low- and non-waste technologies.

- They permit the rational use of raw materials and energy; and
- They effectively protect the environment.

For example, in the electroplating industry a certain portion of the plating chemicals are lost to the waste streams. These wastes are considered being hazardous because they cause environmneteal damage when disposed in conventional sanitary landfills. The high cost of replacing and treating plating chemicals lost to the waste stream has resulted in the application of various recovery processess to reclaim these materials for reuse. The use of recovery processess can result in an essentially closed systems around a plating bath, no plating chemicals are consumed other than those plated on the ware and no-hazardous waste is given to the environment. There are more examples where reduction in the production of hazardous wastes has been achieved by applying those technologies: Recovery of used cutting oils, producing a clean metal swarf and oil for reuse, recycling of spent solvents, process modifications in the chemical industry etc.

The widespread adoption of such waste reduction technologies is, however, likely to occur but only where economic advantages are to be gained. For example, as raw materials costs rise, obtaining the maximum possible utilization of the raw materials becomes increasingly important. The cost of waste disposal is itself a further influence on the waste producer. The expense of waste treatment provides a considerable incentive to minimize the amount of waste produced.

Predisposal Treatment

Wastes that cannot be avoided or reused should be treated to convert them from hazardous into less- or non-hazardous materials. The residues that are produced in this processess must be disposed of permanently. The methods used to accomplish this conversion for hazardous wastes can be classified into three major treatments: physical, chemical and thermal. There is a variety of technologies in each of those groups.

Treatment prior to disposal has two main objectives:

- to reduce bulk of the waste, and thus reduce the landfill volume required
- to reduce the hazardous presented by the waste which may also reduce disposal costs.

Physical and Chemical Methods

Chemical and physical treatments usually involve processes that either convert or separate the hazardous wastes.

Physical treatments are largely concerned with separation of solids from liquids and liquids from liquids. Solid-liquids are usually based on simple settlement or on some form of filtration. If the liquid is water, then separation may produce an effluent that can be treated in an effluent treatment plant and a sludge which has to be disposed of.

Liquid-liquid separations are mainly applicable to immiscible liquids. On standing these will separate into two (or more) layers which can be separated by decanting. The process can be used to separate oil from water and certain solvent-water mixtures. It may be necessary to use special techniques to break emulsions, such as the addition of salts. Separations are rarely "clean".

Liquids can also be separated, in some cases, by destillation even when they are miscible, but unless one or more of the products is of high value and is reclaimed in a sufficiently pure form for reuse, it is usually too expensive to use this process for waste treatment.

Materials in a liquid form can also be separated by absorption or adsorption. Using suitable solid absorbents or adsorbents, dissolved materials can be removed from solution, and traces of immiscible liquids can be removed as well. The liquid waste will usually have to be free from suspended matter before it is passed through the absorbent.

Chemical treatments are almost always concerned with reducing the hazard of waste. There are a multitude of possible reactions that can be used to achieve this objective, but comparatively few have achieved much use in hazardous waste treatment. These methods are:

- neutralization of acids and alkalis
- heavy metal precipitation
- oxidation of cyanides and nitrates
- reduction of hexavalent chromium

Nautralization-precipitation reactions are the most widely used. Acids are neutralised with calcium hydroxide, limestone or sodium hydroxide, and alkalis are neutralised, usually with sulphuric acid. Acid wastes can be used to neutralise alkaline wastes. For many acid or alkaline wastes neutralisation will also cause precipitation of many inorganic substances. Thus many metals form insoluble hydroxides which precipitate. These reactions can be used for large volume bulk effluents and for small volume concentrated wastes, for example for dumped processing solutions from the metal finishing industries containing high concentrations of chemicals.

Some hazardous materials can be treated by chemical oxidation. The most widely used technique is the oxidation of cyanide with chlorine or sodium hypochlorite. This is quite efficient but is also fairly expensive because chlorine or sodium hypochlorite are consumed in the reaction, and the requirements of worker safety demand a fairly well engineered plant since both the waste and the reagents are hazardous. It remains the first choice method for inorganic cyanide treatment prior to disposal. There are many other methods of destroying cyanides, but they lack the established efficiency of chlorination.

Several different kinds of reduction processes have been used to treat waste. The most common is the reduction of hexavalent chromium. Hexavalent chromium can be smoothly and efficiently reduced in acid solution to the safer trivalent state by sulphur dioxide.

All these chemical treatment processess will produce a product which itself may require further treatment before disposal.

Incineration

Incineration is a treatment rather than a disposal process, because in all but a few special cases, residues remain after treatment that require disposal. It is a good technique for the disposal of hazardous wastes fro the following reasons:

- Incineration is an excellent disposal method for wastes containing solvents and other organic materials
- Incineration reduces the potential for ground water contamination from the land disposal of waste
- Incineration reduces the volume of many wastes so that the remaining residue (ash, non-combustible, etc.) will take up less room when disposed of at a landfill. Analyses have shown that residues from hazardous waste incineration may themselves be regarded as hazardous waste, examples being boiler and filter ash from electrolytic precipitators and vaporization residues from gas scrubbing systems.

The following basic crieteria for hazardous waste incineration should be considered:

1. Generally, only organic materials should be considered candidates for incineration, although some inorganics can be thermally degraded.
2. Chlorine-containing, and other halogenated form extremely corrosive hydrogen chloride gas upon incineration. Materials of construction should be suitable, and adequate emission scrubbers provided.
3. Organic materials contaning dangerous heavy metals (mercury, arsenic, selenium, lead, cadmium) should not be incinerated unless the fate of the metal components in the environment is known or can be satisfactorily controlled by air and water pollution control equipment.
4. Sulfur-containing organic materials will normally form sulfur oxides on incineration. Care should be taken ro remove these materials from the stack gas if sulfur is present in appreciable concentrations.
5. The destruction ratio of a givem material by incineration is dependent largely on the temperature, the dwell time at temperature, the air/feed ration, and the turbulence. Most organic hazardous materials can be almost completely destroyed in 2 seconds at 1.000°C.
6. The hazard posed by incineration of hazardous materials is largely a function of the amounts, nature, and distribution of the combustion products entering the environment. Care must be taken that these materials are not dispersed or disposed of in concentration capable of affecting health or damaging the environment.
7. Incineration can be employed for combustible solids, semisolids, and liquid wastes.

The following wastes are commonly treated in hazardous waste incinerators: solvent waste and sludges, waste mineral oils, varnish and paint wastes and sludges, plastics, rubber and latex waste sludges and emulsions, oil emulsions and oil/water mixtures, phenolic wastes, mineral oil sludges, resin wastes, grease and wax wastes, pesticide wastes, acid tar and spent clay and organic wastes containing halogen sulphur or phosphorous components.

The main technology for incineration of hazardous wastes is the rotary kiln. It has established itself as an universal incineration system. It is suitable for the simultaneous incineration of solid, liquid and semi-solid wastes of a wide range of calorific values. It is not, however, the best solution for the incineration of solely liquid wastes. There are numerous simple incinerators that can be used for liquid wastes which are much cheaper than solid waste incinerators.

Municipal solid waste incinerators, however, as they are currently installed and operated, are not designed to destroy hazardous material. Their shortcoming frequently include:

1. Inability to attain high enough operating temperaments and retention times to insure the destruction of hazardous wastes.
2. Lack of adequate emission-control equipment to remove hazardous wastes or breakdown products from flue gases.
3. Improper materials of construction for withstanding corrosive off gases, which may be generated during combustion.
4. Improper materials-handling equipment, which presents a safety hazard during operation.
5. Operators untrained in handling hazardous materials.
6. A design or operation that results in unburned or partially-burned residues.
7. Inadequate disposal techniques for potentially hazardous residues.
8. Lack of sufficient instrumentation to permit careful monitoring of operation condition and combustion efficiencies.

Incineration of hazardous waste as a pretreatment prior to land disposal could be a beneficial means of protecting the land environment by destroying the organic fraction and leaving only inorganic ashes. Volume reduction is frequently very high, depending on the relative concentration of organic and inorganic materials. Destruction of the organic molecular structure may also destroy toxicity unless the toxicity is due to the incorporation of toxic elements such as heavy metals. Many industries are using incineration as a comparatively expensive but effective method of eliminating hazardous wastes.

Secure Chemical Landfill

Treatment of hazardous wastes by various methods such as incineration or

Table 3: Typical Waste / Disposal Site Matrix

Site Classification	Waste Classification
I Secure Chemical Landfill	Group A: Hazardous Wastes (can accept group B and C Wastes)
II Sanitary Landfill	Group B: Industrial Non-Hazardous Waste, Municipal Wastes (can accept group C wastes)
III Inert Fill	Group C: Wastes only

other chemical, physical, or biological processess should lessen the quantity and leave the waste in its least harmful form. Then ultimate disposal in landfills may be a reasonable alternative. Landfill disposal is by far the most important method of disposal of waste in most countries.

The objectives of modern landfill practice are to dispose of waste, with minimal risk to ground- or surface-waters, with minimum nuisance or impact on the general public and to close the fill so that it can be restored to some, even if limited, uses. The approach to modern landfill practice is therefore to distribute those waste types with a higher potential for adverse impact on the environment to those sites with a higher degree of security. In turn, waste categories with lesser or minor potential impact may be directed to these sites with a lower level of security. In this fashion, the highly toxic, persistent hazardous residual wastes can be directed to the highest security sites, and wastes with a lesser degree of potential impact can be sent to sites with a lower level of security. The net result of this approach is not only protection of environmental quality, but also providing costeffective disposal. For example, the large quantities of non-hazardous domestic refuse can be sent to the lower-cost landfills which do not provide the high security feature necessary for toxic wastes.

Table 3 depicts a typical matrix matching waste classifications with disposal site classifications.

Basically three types of landfill sites may be considered to incorporate both natural site conditions (geology and soils, surface and groundwater use potential) and design features which pertain to the level of leachate containment and collection. Chemical landfills provide the higher security. Leachate collection must be used if natural conditions are not highly impermeable. Complete protection must be provided for all time for the quality of ground and surface water. Chemical landfills are designed especially for the ultimate disposal of hazardous wastes. Liquids and semiliquids must be treated prior to disposal.

Sanitary landfills provide a lower lever of security than chemical landfills. Leachate control through natural attennation or leachate collection is generally required. They accept wastes consisting of or containing chemically or biologically decomposable materials which does not include toxic substances or those capable of significantly impairing the quality of usable water. Generally these are industrial non-hazardous and municipal wastes. Class B (industrial wastes) includes those industrial wastes and residues that are not hazardous and are generated from industrial sources. This may include such waste as sludges, off-spec product, contaminated product, packaging wastes, and other residuals. Municipal wastes, class C, include those wastes which are generated as a result of municipal associated activities. This typically includes: domestic refuse, commercial waste, garbage, municipal dewatered stabilized sewage sludge.

In an inert fill protection is provided from group D wastes by location, construction and operation which prevent erosion of deposited material. Only inert wastes, i.e wastes consisting entirely of non-water soluble, non-decomposable inert solids are accepted. These may include such materials as rock, brick, concrete, demolition, debris, etc.

The most common existing facilities are land disposal sites used for municipal wastes. Hazardous waste disposal in these landfills include the following problems:

1. Percolation of toxic liquids to ground waters
2. Dissolution of solids followed by leaching to ground water, as rain or ground water moves through the fill
3. Dissolution, with subsequent leaching of solid hazardous materials, such as heavy metals, by acidic leachates generated by decomposing municipal refuse.
4. Potential for undesirable chemical reactions within the fill, creating explosive situations or releasing toxic gases
5. Volatilization of wastes, releasing toxic or explosive gases or vapors to the atmosphere
6. Corrosion of hazardous materials containers, thus releasing their contents.

Much has been learned about landfills because of their long use in the disposal of various kinds of substances. Because industrial waste with hazardous properties has been improperly disposed of in sanitary landfills, they have sometimes been identified as "toxic dumps" as well. The improper use of sanitary landfills, like unregulated dumping areas has resulted in unidentified and uncontrolled hazardous waste disposal sites that must now be reclaimed by whatever methods are deemed appropriate in the individual circumstances.

A secure landfill, in contrast, permits a physical isolation of wastes from the environment. To protect the local land and water resources, the selection of a suitable site for hazardous waste disposal must be based on a comprehensive consideration of the hydrogeological elements of the site. The long-term entombment of wastes must be designed to prevent contamination of groundwater by leaching from the site. The new perspective directs that special technologies will have already been employed to detoxify difficult wastes and to reduce the total volume to be disposed of. Thus, ash from incinerators, sludge from waste treatment plants, concentrated metals and compounds from chemical treatment systems and inorganic residues from chemical processing are dealt with rather than the general volume of complex, untreated wastes that have been included in landfills in the past.

ECONOMIC CONSIDERATIONS

The main factors affecting the cost of hazardous waste management for a waste generator are:

- the amount of hazardous waste, and
- the ultimate disposal method

There are several factors which can have a major impact on the quantity of waste requiring disposal. As already mentioned there are examples where fundamental process changes and plant modifications migh well be justified by the raw material savings and the cost implied for waste disposal. Waste separation and concentration can also reduce waste. Even with the minimum amount of waste, it is possible to isolate the more hazardous or toxic waste streams form the mixture in which they occur. Waste separation early in process-stream flows, as well as simple isolation of similar wastes into separate disposal containers, can reduce waste handling and disposal costs. Concentration of wastes by dewatering will reduce the amount of wastes requiring treatment or disposal. This process not only reduces the cost of ultimate disposal but, more significantly, minimizes transportation costs, which are frequently the major variable in total waste-management costs.

The cheapest method for waste disposal is a sanitary landfill without predisposal treatment. The cost of physical, chemical and thermal pretreatment is sensitive to waste characteristics. The most expensive hazardous waste management option for a waste generator is pretreatment and ultimate disposal in a secure chemical landfill, however, it is essential to compare not only short-term but also long-term costs of different option. Specifically, cost comparisons of different tecnologies must be made on environmentally equivalent basis. The cost must be considered from the time of waste generation until the hazardous characteristics have been permanently harmless or can be assured of being immobilized over very long periods of time. As a result of landfill may, in fact, place a larger financial burden than other options that are not now considered to be cost-effective.

SITUACION ACTUAL DEL MANEJO DE DESECHOS SOLIDOS EN PAISES EN DESARROLLO

Julia Alicia A. de Zeissig

SUMMARY

Now it is taken for granted that industrialization countries have exerted larger pressures upon the environment and, in some cases, there evident signs of depletion of natural resources, degradation of soils, pollution of air and water and perturbation of the ecological cycles.

This paper offers some general guides to cope with these problems in Central America where the needed technologies for environmental protection are not fully applied or need adaptation to the effective in each country. The problems are complex and range from lack of legislation to a nonchalant attitude from the most of the population regarding the protection of the environment in all its aspects. These countries need more international cooperation to cope effectively with these increasing ecological problems.

INTRODUCCION

Todos los países han empezado a industrializarse en un intento de mejorar la calidad de la vida de su población. Este proceso de industrialización ha comenzado a ejercer mayores presiones sobre el medio

Lic. Julia Alicia A. de Zeissig, División de Análisis, Pruebas y Ensayos, ICAITI.

ambiente físico, ocasionando diversos problemas, como el agotamiento de los recursos naturales, la degradación de la tierra, la contaminación del aire y el agua y la perturbación de los ciclos ecológicos.

Entonces surge la necesidad de utilizar los recursos disponibles en grado óptimo, incluyendo los residuos derivados de la producción y elaboración agropecuaria e industrial.

Los problemas que se suelen plantear en relación con la utilización de tales desechos son la frecuencia con que se encuentran esparcidos por las dificultades de manejo y transporte, por falta de recursos económicos para su reutilización, la carencia de tecnolía y de la asistencia técnica adecuada los problemas para comercializar el producto final y muchas veces la insuficiencia de energía para elaborar los residuos en productos finales con utilidad potencial.

La experiencia ha demostrado, que es posible lograr utilización sostenida y ambientalmente racional de los recursos cuando:

a) Cuando se conocen las cantidades y las características de los residuos.

b) Cuando las tecnologías son compatibles con la economía y la cultura locales y es posible aplicarlas.

c) Cuando la elaboración de los residuos puede llevarse a cabo en la localidad donde se generan.

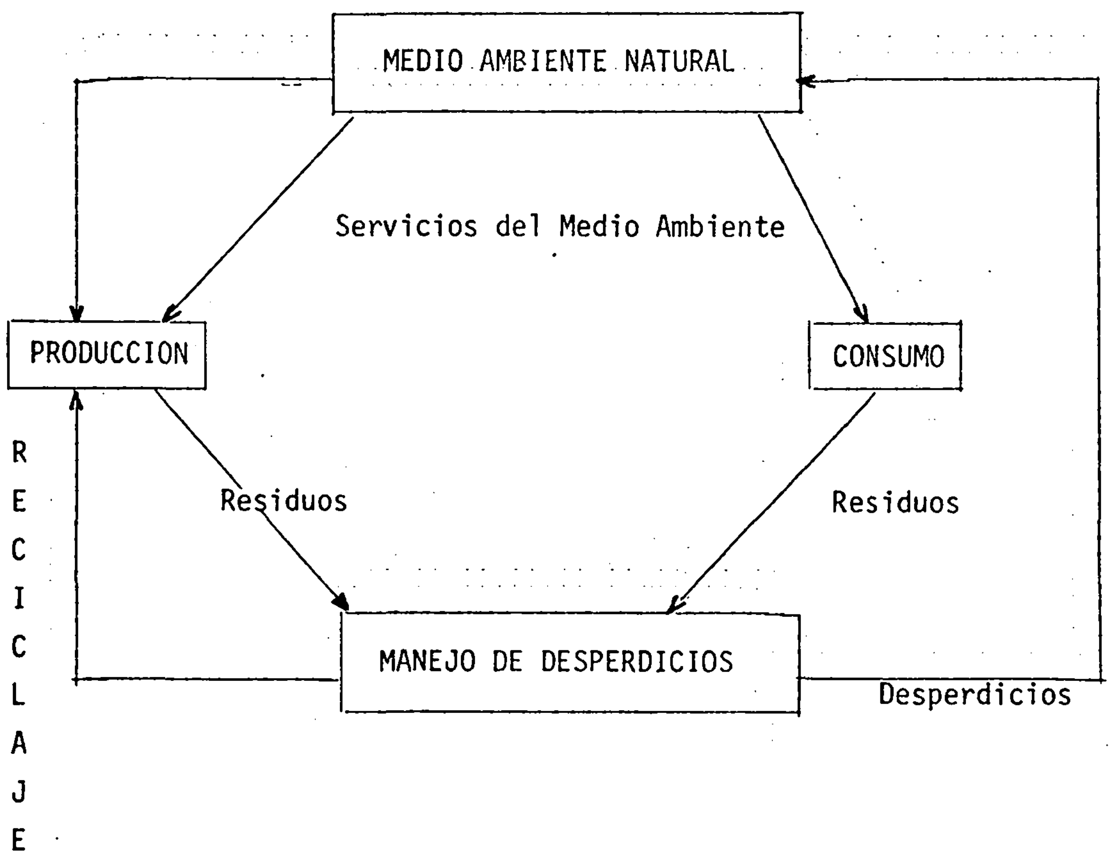
d) Cuando existe un mercado o uso para el producto final que se genera.

e) Cuando no se generen residuos secundarios que causen graves problemas ambientales o sociales.

f) Que exista un programa adecuado de asistencia técnica.

g) Y proporcione un beneficio económico a quienes llevan a cabo este reciclaje.

¿Cómo funciona el medio ambiente natural con interrelación con las actividades económicas?



En este simple diagrama de flujos, están representadas las tres funciones, fuentes de suplemento del sistema de soporte.

El ambiente natural y la interrelación con las actividades económicas del hombre.

El medio ambiente representa un flujo de producción y consumo, para propósitos de producción de materias crudas (agricultura) y junto a ello la extracción de materiales de consumo (energía). Amén que es usado para otras actividades como: el agua de consumo, transporte, edificaciones, agua para producir electricidad, etc.

Las acciones de producción y consumo son actividades que generan residuos: humo, ruido, calor, olor y materiales sólidos. Algunos de estos residuos quedan en el medio ambiente, otros pueden ser utilizados - para ser tratados o bien reutilizados (reciclaje) cuando esto es posible. El medio ambiente tiene facultades para asimilar despojos, pero - en la actualidad son tan grandes las cantidades de despojos que afectan la calidad del medio ambiente.

En los países centroamericanos, la cantidad de contaminación producida por la industria, en los centros urbanos oscila entre un 18 a 20% en - proporción por la causada por los desperdicios municipales, y con el - incremento de la población lógicamente se han incrementado los residuos sólidos en las ciudades. Este incremento ha sido tanto que los daños al medio ambiente son evidentes y muchas veces debido a operaciones - impropias que se efectúan en su manejo. Los problemas por el manejo de desechos sólidos son complejos y envuelven problemas de legislación, economía, actividades del público y tecnología, adicionalmente que no existe ninguna información comprensiva al público sobre las técnicas - de manejo de estos desechos que contaminan el medio ambiente donde se han localizado.

Como un inicio para lograr una coordinación en un programa de residuos sólidos deben tomarse en cuenta los siguientes objetivos:

a) Reunir información sobre las cantidades y características de los - residuos industriales, agrícolas y municipales de origen orgánico de la región y tecnología para su uso.

   Algunos datos al respecto se han mencionado y se darán a conocer por los expositores de este Seminario.

b) Facilitar el intercambio de experiencias entre los países e industrias interesadas, organismos gubernamentales u organismos no gubernamentales.

   En algunos países del área se han iniciado en forma directa algunas aplicaciones sobre la utilización de residuos, Costa Rica por ejemplo, ha efectuado trabajos sobre "Aprovechamiento de los residuos del café", en ICAITI se han efectuado proyectos sobre aprovechamiento de desechos e incluso el Ing. Carlos Rolz en su participación disertará respecto a ello.

c) Promover el intercambio de información que trate sobre la utilización de los residuos sólidos, con actividades de educación y capacitación tecnológica, así como de financiamiento.

Debido a las características de la región, los usos finales de los residuos agrícolas e industriales más importantes son los alimentos para animales, fertilizantes y energía. Sin embargo, el grado de aplicación varía de un país a otro y según la región del mismo país, y esto es debido a las necesidades de requerimiento, a condiciones económicas y sociales imperantes.

d) Apoyarse a través de un esfuerzo, en el establecimiento de mercados de productos básicos derivados de la utilización de residuos.

e) Promover entre los países el intercambio sobre las experiencias en la aplicación de reglamentos y leyes que traten de la utilización, manejo y comercialización de residuos.

f) Aunar esfuerzos para lograr:

   i) Métodos estándar para análisis de residuos.

   ii) Normas para el uso de la tecnología de utilización de residuos.

   iii) Terminología oficial, para definir un marco conceptual de cantidades, características y nombres de los residuos de mayor importancia en el ámbito centroamericano.

Como conclusión del tema a tratar conocemos que Costa Rica, ha llevado a cabo estudios sobre utilización de residuos agro-industriales, sobre aprovechamiento de los residuos del café, por mencionar alguno, y en ello lleva una experiencia teórica-práctica de unos 10 años, conocemos su experiencia con el relleno sanitario el cual fue descrito anteriormente.

Conocemos del potencial de residuos agroindustriales con que cuenta Nicaragua, El Salvador y Honduras.

Conocemos también de tecnologías llevadas a cabo en la región sobre residuos atroindustriales aprovechables en los biodigestores, en la producción de alcohol, pulpas, químicas, abono, energía, entonces, necesitamos:

a) La aplicación de la utilización de los residuos.

b) Difusión e información sobre lo mismo.

c) Comercialización de los productos.

Para lograr un incremento en la utilización de los residuos, debemos coordinar esfuerzos como una unidad.

1. Alentando a las industrias y las organizaciones gubernamentales específicas.

2. Lograr que se introduzcan reglamentos con disposiciones que fomenten la disminución de la contaminación con introducción en los mismos, de tecnologías para la utilización de residuos.

3. Crear incentivos, que estimulen a la industria.

4. Establecer cooperación industria-gobierno, por ejemplo: intercambios de desechos de industria-industria, transferencia de información técnica de las limitaciones actuales de la tecnología.

5. Otorgamiento de créditos o subsidios para aquellas industrias que no estén en condiciones de realizar un proyecto a la escala deseada.

Ahora bien, todos los factores mencionados son importantes para lograr éxito en la utilización de residuos, algunos de ellos son primordiales, pero tan importante como la organización es el estímulo necesario para mantener la continuidad, por que transcurrirá mucho tiempo para que el individuo perciba los beneficios de la utilización de residuos, gran parte de estos beneficios serán recibidos por la sociedad en su conjunto, más que por las personas y la industria.

REVISION DE LA LEGISLACION SOBRE MANEJO DE LOS DESECHOS SOLIDOS EN EL SALVADOR

Oscar Alejando Escobar

SUMMARY

This paper gives a review in order of all the law enacted relative to the handling of solid wastes in El Salvador.

No attempt to analise or assess the legislation is made. This work consists mainly of a listing of the most important laws related to solid waste disposal.

A reading of the laws and regulations suggest that they are well thought and seem to be more than adequate. This is true from the theoretical standpoint. However, implementation of these regulations is often difficult and, in some cases, impossible, owing to the lack of effective means or mechanism to secure compliance.

Esta revisión se realizará en el orden cronológico de emisión de las distintas leyes existentes.

Ing. Oscar Alejandro Escobar, Ministerio de Salud Pública y Asistencia Social, División de Saneamiento Ambiental, Departamento de Desechos Sólidos, El Salvador.

En el Anexo 1 se presentan los artículos de la Ley de Policía emitida el 6 de agosto de 1854, y que tienen relación con los desechos sólidos.

Con esta ley se ordena la limpieza de las poblaciones dando señalamiento sobre barrido, recolección y disposición de las basuras, también la escogitación de los sitios de disposición final.

Además trata de mantener el aseo, prohibiendo arrojar las basuras en cualquier lugar.

Así mismo se presentan en el anexo 2 los artículos del Código de Sanidad vigente desde el 13 de octubre de 1930 y que tienen relación con los desechos sólidos.

De este código los Artículos 50 y 56 permiten que despojos de fábricas y desagües de beneficios de café se viertan en los ríos. En cambio el artículo 116 proteje los ríos prohibiendo arrojar en ellos la pulpa y demás productos de elaboración del café, el cianuro y todo ingrediente venenoso, así como toda sustancia perjudicial a la salud pública y las aguas sucias sobrantes.

El código ordena la limpieza de las viviendas Art. 67.72 de los mercados Art. 223 y de todo establecimiento Art. 124 y 206, señala las acciones a realizar cuando hayan casas insalubre o que sean focos de epidemia de carácter grave o amenace la salud de los vecinos (Art. 73 al 77).

Prohibe la formación de los basureros con excepción de los designados para ese objeto (Art. 231).

Rige sobre los desechos que resulten del transporte de animales enfermos y muertos y la disposición final de éstos últimos (Art. 196,-200). Contiene lo relativo a las penas que se deben aplicar e indica las autoridades encargadas para su cumplimiento (Art. 234, 238, 240, 241).

Como anexo 3 se presentan los artículos del Reglamento General sobre seguridad e Higiene en los Centros de trabajo, relacionados con el manejo de los desechos sólidos.

Dicho reglamento fué dado como Decreto Ejecutivo No. 7, el 2 de febrero de 1971.

Su objetivo es el de prevenir los accidentes de trabajo y enfermedades profecionales.

Ordena el cumplimiento del aseo diario (Art. 48) y la correcta disposición de los desechos (Art. 49)

Sólidos

Como anexo 4 se presentan los artículos de la Constitución Política de la República de El Salvador dada el 15 de Diciembre de 1983 y que se relaciona con el manejo de los desechos sólidos.

Contiene el mandato que en todo centro docente se enseñe la conservación de los recursos naturales (Artículo 60 Inciso 2o.).

También establece que el Estado está obligado a controlar las condiciones ambientales que puedan afectar la salud y el bienestar (Art.-69 inciso 2o.).

Además declara de interés social la protección, restauración, desarrollo y aprovechamiento de los recursos naturales, lo cual se regirá por leyes especiales. (Artículo 117).

Da potestad a las Municipalidades para la elaboración de sus tarifas de impuestos las cuales deben ser aprobadas por la Asamblea Legislativa (Artículo 204 Inciso 6o.).

Permite a las Municipalidades a asociarse con el fín de realizar - obras y servicios que sean de interés común. (Artículo 207 Inciso 2o.).

Del análisis de las leyes en cuestión se concluye que por haberse - emitido para satisfacer las necesidades de su época algunas prácticamente son obsoletas, contienen artículos que se contradicen; además son leyes de débil y lenta aplicación.

Considerando los graves daños que se derivan de los desechos sólidos mal manejados, es de urgencia, promulgar nuevas leyes, que sean más ágiles, de efectiva aplicación, que señalen severas sanciones a los infractores, y a quien estando obligados a hacerlas efectivas, no - las apliquen.

ANEXO No. 1

La Ley de Policía

ARTICULOS QUE SE RELACIONAN CON LOS DESECHOS SOLIDOS

Artículo 2.

Inciso 5o. Corresponde a la Policía, cuidar de la comodidad y aseo público y del ornato de las poblaciones.

Artículo 172.

Todos los propietarios, arrendatarios, habitantes de casas, tiendas, almacenes, talleres, cuartos, cuarteles, edificios públicos y solares situados al lado de la calle, harán barrer toda la extensión de sus pertenencias hasta la mitad del ancho de la calle, en los días y horas que se dirán, cuidando de amontoner las basuras al borde - de la acequia que pasa por el centro.

Artículo 173.

El barrido estará concluído a las ocho de la mañana del sábado de cada semana. Se dispensa este servicio en los días de fuerte lluvia.

Artículo 174.

Los dueños de las casas o habitaciones que por cualquier motivo estén cerrados, quedan bajo la obligación a que se refieren los artículos - anteriores.

Artículo 175.

Por lo que toca a los edificios públicos, plazas, parques o alamedas los encargados de la policía harán el barrido correspondiente y la - extracción general de las basuras, de las ocho de la mañana en adelante.

Artículo 176.

Los encargados de recoger las basuras del barrido cuidarán de evitar el derrame de ellas al conducirlas al lugar designado para el depósito.

Artículo 177.

Toda infracción de lo mandado en los artículos procedentes, será penado con una multa de cuatro reales a un peso.

Artículo 179.

Inciso 3o.

Se prohibe arrojar a las calles, plazas, parques, lugares públicos y acequias interiores y exteriores, las basuras, escombros, residuos, desperdicios de cocina, animales muertos, y en general, respecto de las acequías, todo objeto que impidiendo el libre y fácil curso de las aguas pueda originar aniego.

El que contravenga esta disposición pagará una multa de uno a cinco pesos, sin perjuicio de responder conforme a las leyes por el daño inferido.

Artículo 181.

Es prohibido, bajo pena de cuatro reales a un peso, derramar o arrojar de los balcones, puertas, ventanas o de cualquier otra parte del edificio basuras o agua de cualquiera naturaleza que sean, que puedan mojar o ensuciar a los transeuntes o producir exhalaciones insalubres.

Artículo 182.

Es prohibido hacer depósitos de basuras en el interior de las casas o de los sitios en que haya caballerizas públicas, debiendo extraerse de éstas por lo menos dos veces por semana, bajo la multa de uno a cinco pesos.

Artículo 185.

Es prohibido depositar en las calles o lugares públicos basuras y otros materiales infectas, y sólo se permitirá amontonar el cieno de las acequias y basuras de las calles en los días designados para la limpieza de ellas. La infracción de esta disposición será penada con una multa de uno a cinco pesos.

Artículo 187.

Los vendedores de frutas u otras especies, situados en lugares públicos, mantendrán constantemente aseado todo el espacio que ocupan y sus alrededores. Tendrán al efecto, vasijas, canastos y otro cualquier receptáculo aparente para depositar las cortezas de la fruta o de las especies que vendan. La contravención a éste artículo será penado con una multa de dos a cuatro reales.

Artículo 188.

Es prohibido a los vendedores ambulates arrojar a la calles, plazas o plazuelas, hojas, cáscaras o desperdicios alguno de la fruta, hortalizas o cualquier otra especie que vendan, bajo la multa de dos a cuatro reales.

Artículo 189.

Es prohibido arrojar a las calles, plazas plazuelas o cualquier otro - lugar de tránsito, pedazos de hierro u otro metal, vasos o botellas rotas, huesos o cualquiera otra materia con que se pueda herir o maltratar a las personas o animales que transiten por dichos lugares. La Infracción de éste artículo será penada con una multa de uno a dos pesos.

Artículo 191.

Es prohibido sin expresa licencia del Alcalde, quemar basuras, ropa o cualquiera otras especies en las calles o lugares públicos de las poblaciones o sus suburbios. El que contravenga a lo prevenido en este artículo, pagará una multa de cuatro reales a un peso.

Artículo 194.

En todas las poblaciones de la República deberá designarse por los - Alcaldes respectivos uno a más lugares aparentes para depósito de inmundicias, los que deberán estar colocados por lo menos a doscientas varas de la población y de los caminos, plazas, paseos u otros lugares muy frecuentados.

ANEXO 2

Código de Sanidad

ARTICULOS QUE SE RELACIONAN CON LOS DESECHOS SOLIDOS

Artículo 50.

En ningún caso se permitirá que las casas o talleres industriales vier- tan aguas sucias a los acueductos, presas o depósitos destinados a us doméstico, y estos lugares serán especialmente vigilados de parte de autoridad. En lo sucesivo no se permitirá que las cloacas, despojos fábricas, etc., se viertan o arrojen en la parte alta de las poblacion sino en la parte más baja, designada por la Dirección General de San siguiendo la corriente de un río, o en lugares permeables indicados la misma autoridad. Se evitará asimismo que las corrientes producid por aguas lluvias ingresen a los depósitos de agua destinada al cons de las poblaciones.

Artículo 56.

Los beneficios de café y toda clase de fábricas o talleres instalado en propiedades o predios rústicos, deberán tener sus desagües hacia ríos que no sean de abastecimiento público, o en terrenos permeable en todo caso, dichos desperdicios se alejarán por medio de tuberías una distancia de 100 a 300 metros por lo menos del lugar en que est instalada la fábrica o taller. Dichos trabajos se harán previa auto- rización de la Dirección General de Sanidad, en vista del plano que al efecto deberán presentar los interesados.

Artículo 67.

Toda casa de vecindad tendrá un lugar conveniente para recibir las ba- suras, las que serán extraídas diariamente.

Artículo 72.

El buen estado de los excusados, el aseo de los patios, escaleras y otras dependencias de uso común en las casas de vecindad, mesones y otros establecimientos análogos, se hará por cuenta del propietario, quedando obligados los inquilinos, por su parte, a contribuir al mismo aseo en lo que toca a las partes que les corresponde.

Artículo 73.

Cuando la Dirección General de Sanidad o cualquiera autoridad sanitaria, por informes fehacientes que obren en su poder, considere que una casa o parte de ella es insalubre, lo notificará al propietario para que exponga lo conveniente dentro de tercero día y pasado ese término y previa inspección que se practicará con citación del mismo, le dará un plazo prudencial para corregir los defectos que se señalan. Terminando este plazo, si no hubiere dado cumplimiento a lo proveni do por la Dirección, ésta mandará fijar en la fechada de la casa, un aviso con caracteres bien legibles, que indique que aquella casa ofre ce peligro para los inquilinos de toda o parte de ella. El hecho de fijar ese aviso es causa de responsabilidad para el propietario, y por tal motivo, los que la habitan tienen derecho a exigir la rescisión del contrato y reclamar ante los tribunales respectivos los per juicios que hubieren sufrido; todo conforme a las leyes comunes. Las disposiciones del presente artículo, como todas las demás de éste Código a favor de los interesados, no son renunciables por ellos.

Artículo 74.

La Dirección General de Sanidad puede exigir del propietario la demolición de un edificio, cuando éste se encuentra en pésimo estado sani tario o que amenace ruina, y cuyas condiciones sean tales que no admi tan reparaciones, a juicio del Ingeniero de la Dirección General de Sanidad.

Recibido el informe del Ingeniero, se dará traslado de él al propieta rio, para que conteste dentro del tercero día y pasado ese término, el Director, acompañado del Secretario y del Ingeniero o la autoridad sanitaria respectiva, en unión del Secretario y del Ingeniero, y concitación del dueño, practicarán inspección del edificio y harán constar todas las circunstancias que justifiquen la necesidad de la demolición; y si ésta se ordenare, se dará al propietario un término prudencial para que proceda a élla. Si no cumpliere, se demolerá el edi ficio a costa del mismo propietario, a quien se le impondrá, además, una multa de veinte y cinco a quinientos colones.

Artículo 75.

Si una casa o parte de ella es un foco de epidemia de carácter grave o amenaza seriamente la salud de los vecinos, la Dirección General de Sanidad, mandará desocuparla.

Todos los gastos que ocasione la desinfección o reparaciones que se hubieren de hacer en la casa infectada, serán por cuenta de la nación.

La casa no podrá volver a habitarse hasta que se hayan remediado los defectos que tenía.

Artículo 76.

Las facultades concedidas en los artículos anteriores, especialmente las conocidas en los artículos 73, 74 y 75, serán ejercidas por la Dirección General de Sanidad, en la Capital, pudiendo apelarse de las resoluciones que al respecto dictara, ante el Ministerio de Sanidad. En las demás poblaciones, ejercerán dichas facultades los Representantes de la Dirección General de Sanidad, y en su defecto, los Alcaldes Municipales. De estas resoluciones podrá apelarse ante la Dirección General de Sanidad, dentro de los tres días de notificada la resolución pronunciada. La autoridad que conozca en grado, oirá, dentro del tercero día de recibidas las diligencias, al apelante, y oirá el dictamen de uno o dos facultativos o practicará nueva inspección, si lo solicitaren las partes, o de oficio, si lo creyere conveniente; y con el mérito de las pruebas resolverá lo que proceda. No obstnate la admisión del recurso de apelación, podrá llevarse adelante la providencia recurrida en el caso contemplado en el artículo 75.

Artículo 77.

Todos los establecimientos de enseñanza, públicos o privados, hospitales, cuarteles, hospicios, y en general todos los dedicados a la habitación común de varias personas, inclusive las casas y residencias particulares quedarán sujetos a la inspección higiénica y médica, conforme a las prescripciones de este Código y de los respectivos reglamentos.

Artículo 116.

Cuando un establecimiento no estuviere ubicado conforme a lo que previene este Código y se le haya conservado en el sitio en que esté, -

por respetar un derecho legalmente adquirido, si suspende sus trabajos durante seis meses, no podrá ser reinstalado en el mismo local, si no es sujetándose en todo a las prescripciones respectivas. Para los beneficios de café, el plazo será de un año. Se prohibe a los beneficios de despulpar y lavar café, a los minerales destinados a refinar brosas, y a todos aquellos que empleen substancias insalubres o venenosas, arrojar la pulpa y demás productos de elaboración de café, el cianuro y todo ingrediente venenoso, así como toda substancia perjudicial a la salud pública y las aguas sucias sobrantes, en la corriente de un río, sea de uso público o particular.

La Dirección General de Sanidad queda autorizada para reglamentar esta disposición de manera conveniente. Los establecimientos que tengan que verter aguas sucias en las corrientes de un río, deben instalarse, necesariamente, en la parte baja de la población, siguiendo el curso del río; de ninguna manera podrán hacerlo si el curso de dicho río en lo más riguroso de la estación seca no es, por lo menos, cincuenta veces mayor que el de tales aguas sucias. Los que produzcan emanaciones o humos incómodos al vecindario, se colocarán en la parte opuesta a la dirección de los vientos reinantes que soplen sobre la población.

Artículo 124.

Los residuos de las diferentes operaciones se recogerán todos los días para sacarlos del establecimiento y quemarlos o enterrarlos convenientemente.

Artículo 196.

Si es preciso hacer el transporte de animales enfermos o de sus cadáveres, se cuidará de que no se derramen en el trayecto productos que puedan ser nocivos, como sangre, excremento, etc.

Artículo 200.

Los cadáveres de los animales deberán ser conducidos sin dilación, a sitios apropiados que la autoridad señalará, donde serán enterrados o incinerados.

Artículo 206.

En los sitios en que se permitan ordeños, los dueños o encargados de éstos tendrán cuidado de que quede completamente limpio el lugar donde aquellos se sitúan, y que se recojan las inmundicias o basuras que se depositan allí y las que arrojan los animales en su tránsito.

Artículo 223.

Es absolutamente prohibido que los dueños de ventas en el mercado, boten en el pavimento las basuras que ocasiona su negocio, sino que deben depositarlas en un recipiente a propósito que, para el efecto, están obligados a tener.

Artículo 231.

No se permitirá que se formen basureros o muladares fuera de los sitios designados para ese objeto por la Dirección de Policía, con informe favorable de la Dirección General de Sanidad y habrá cuando menos, uno en cada población.

Artículo 232.

No se permitirá que se depositen materias fecales, ni animales muertos en los basureros.

Artículo 234.

Los delitos y faltas contra la Salud Pública, penados por la ley, que descubrieren las autoridades sanitarias, serán denunciados por éstos ante la autoridad correspondiente.

Artículo 238.

Las infracciones a lo prevenido en los capítulos Primero y Tercero, del Libro Segundo, se castigarán con multa de diez a doscientos colones.

Artículo 240.

Serán penados con multa de cinco a cien colones los que infrinjan las disposiciones contenidas en los capítulos IV, V, VI, IX, X, XI y XII del libro segundo; y a los que infrinjan lo dispuesto en los Capítulos VII y VIII, se impondrá la multa de cinco a trescientos colones. Estas penas, lo mismo que las anteriores, se establecen sin perjuicio de los delitos y faltas castigadas por el Código Penal en su caso.

Artículo 241.

Tanto la Dirección General de Sanidad como sus Delegados o Alcaldes Municipales, quedan facultados para clausurar las fábricas o establecimientos, o para suspender sus trabajos, si no llenan los requisitos que la presente ley exige como indispensables, pero solamente el tiempo necesario para que puedan llenarse esos requisitos hasta verificarlos.

La clausura o suspensión a que se refiere el inciso anterior, se llevará a cabo por el respectivo Alcalde Municipal, por el Director de la Policía Sanitaria o por los Delegados o Agentes, en la forma gubernativa, a requerimiento de la Dirección General de Sanidad.

ANEXO No. 3

REGLAMENTO GENERAL SOBRE SEGURIDAD E HIGIENE EN LOS CENTROS DE TRABAJO.

Artículos que se relacionan con los desechos sólidos.

Artículo 48.

El polvo, basuras y desperdicios deben removerse diariamente, efectuándose esta labor, de preferencia, fuera de las horas de trabajo y en tal forma que se evite cualquier incomodidad o molestia a los trabajadores y al vecindario.

Cuando no existan períodos de interrupción por sucesión de turnos, o sea necesario el aseo frecuente de talleres, éste se hará en las horas de trabajo, empleando equipos que impidan la dispersión de polvo en la atmósfera respirable de los locales.

Artículo 49.

Las basuras y desperdicios deberán ser colectados diariamente y en tanto no se hace el transporte fuera de la fábrica o establecimiento, deberán depositarse en recipientes impermeables de cierre hermético o en lugares aislados y cerrados.

En los lugares alejados, donde no existe servicio público de aseo, dichas basuras o desperdicios deben ser incinerados o enterrados convenientemente en la forma de rellenos sanitarios.

Cuando los centros de trabajo lo ameriten, la autoridad correspondiente podrá exigir la instalación de hornos incineradores de basura para la que ellos mismos produzcan. Estos hornos deben ser de los tipos y capacidad que apruebe el Departamento Nacional de Previsión Social, atendiendo a las necesidades y teniendo en cuenta muy especialmente, que la temperatura en el interior del horno sea la necesaria para incinerar la totalidad de la basura, según el tipo de que se trate.

AÑEXO 4

Constitución Política de la República de El Salvador.

ARTICULOS QUE SE RELACIONAN CON LOS DESECHOS SOLIDOS

Artículo 60 Inciso 2o.

En todos los centros docentes, públicos o privados, civiles o militares, será obligatoria la enseñanza de la historia nacional, el civismo, la moral, la Constitución de la República, los derechos humanos y la conservación de los recursos naturales.

Artículo 69 Inciso 2o.

Así mismo el Estado controlará la calidad de los productos alimenticios y las condiciones ambientales que pueden afectar la salud y el bienestar.

Artículo 117.

Se declara de interés social la protección, restauración, desarrollo y aprovechamiento de los recursos naturales. El Estado creará los incentivos económicos y proporcionará la asistencia técnica necesaria para el desarrollo de programas adecuados.

La protección, conservación y mejoramiento de los recursos naturales y del medio serán objeto de leyes especiales.

SITUACION Y SOLUCIONES PREVISTAS EN EL MANEJO Y DISPOSICION DE LOS DESECHOS SOLIDOS EN LA CIUDAD DE GUATEMALA

César Barrientos

SUMMARY

The present situation and solutions contemplated for handling and disposal of solid wastes in Guatemala City is reviewed. Since this responsibility is entrusted to the Municipality of Guatemala, a detailed description of the actual procedures and contemplated improvements is presented.

Measures proposed range from training of personnel to acquisiton of modern equipment. Treatment plants and sanitary landfills are under study. The finding needs for implementing these plans and improvements are important issue in the proper handling and disposal of solid wastes. In many cases lack of funds has been the main deterrent to establish a sound system for waste disposal and setting up treatment plants.

INTRODUCCION

El manejo de los desechos sólidos en esta ciudad corre a cargo de la Municipalidad de Guatemala. Interviene en estas actividades el Departamento de Limpieza de la Dirección de Servicios Públicos (recolección y limpieza de calles) la Dirección de Obras Municipales (disposición final por relleno sanitario) y el Programa del Medio Ambiente en calidad de cuerpo asesor y coordinador.

César Barrientos, Coordinador del Programa del Medio Ambiente de la Municipalidad de Guatemala. Ingeniero Civil con estudios de Posgrado en Ingeniería Ambiental (EPFL, Suiza y UNAM, México) e Ingeniería Sanitaria (ERIS-USAC, Guatemala).

De las 1,000 toneladas diarias de basura que aproximadamente se producen en la ciudad de 1,500,000 habitantes, se recolecta aproximadamente un 75% (25% por el servicio Municipal de Limpieza y 50% por sistema - privado de recolección), quedando un 25% sin recolectar.

El Programa del Medio Ambiente de la Municipalidad se ha dado a la tarea de actualizar los estudios existentes para plantear soluciones integrales al problema, caracterizado por falta de equipo y tecnificación, tomando como base las características propias del sistema establecido. Con el apoyo de la Organización Mundial de la Salud y la Oficina Sanitaria Panamericana se ha planteado el mejoramiento del servicio de limpieza pública de la Municipalidad de Guatemala. Consecuentemente se ha dispuesto atender el problema de las áreas marginales por separado, así como separando los aspectos de limpieza y recolección de la disposición final. El resultado de lso estudios plantea:

1. Capacitar al personal municipal encargado del manejo de las basuras.

2. Equipar debidamente al servicio municipal de limpieza.

3. Asesorar y tecnificar al servicio de recolectores privados.

4. Desarrollar plantas procesadoras por autogestión (cooperativas) en áreas marginales.

5. Implementar una planta procesadora municipal mediana.

6. Tecnificar y equipar el relleno sanitario.

Se destaca en el plan la necesidad de financiamiento para la compra de equipo indispensable y adecuado, además de la implementación de técnicas relacionadas con el reciclaje de los desechos sólidos.

Objeto y descripción:

El objeto del proyecto del manejo y disposición de desechos sólidos en la ciudad de Guatemala consiste en optimizar los servicios y demás actividades involucradas: limpieza, recolección, disposición final y reciclaje.

En la actualidad se tramita la obtención del equipo mínimo indispensable para realizar las tareas de barrido de calles y recolección de los desechos sólidos tanto de los planteles públicos como de las casas de habitación y las industrias, estos dos últimos atendidos por los recolectores privados. Estos constituyen un sistema especial, propio de la Ciudad de Guatemala que si bien tiene algunas deficiencias resulta siendo una forma adecuada para realizar la recolección principalmente de origen doméstico. 125 Microempresarios con 205 camiones convencionales y unas cuantas carretas de tracción animal y humana recolectan entre 500 y 600 toneladas diarias de basura sin costo alguno para la Municipalidad y más bien aportando cerca de Q.8,000.00 anuales por concepto de licencia para realizar la tarea. Su organización en cooperativa y el apoyo técnico de la Municipalidad, así como el eventual aval para la obtención de equipo más adecuado son algunos de los proyectos planteados por la Institución Municipal para el futuro próximo.

Respecto de la disposición final, esta se realiza principalmente con las técnicas de relleno sanitario o vertedero controlado. La falta de recursos y tecnificación no ha permitido realizar las tareas involucradas de una manera satisfactoria, fuera de que en el sitio donde se encuentra ubicado el relleno sanitario actual, practicamente en el centro geográfico de la ciudad se provocan serios problemas sanitarios que afectan un número considerable de vecinos así como la salud y el bienestar de un grupo de cerca de 300 "pepenadores" entre los que se encuentran hombres, mujeres y niños dedicados a la tarea de seleccionar residuos recuperables en condiciones infrahumanas.

En lo referente a las medidas correctivas y preventivas para lograr una disposición final de basuras adecuada, se tiene proyectado una serie de pasos:

1o. Terminar una etapa del relleno sanitario correspondiente a los últimos 12 años cubriendo cerca de 9 hectáreas y construyendo un área recreativa en dicha superficie, con un costo aproximado de 70,000 dólares.

2o. Estudio para la extracción de gas bioquímico del actual relleno sanitario y para la realización de un nuevo relleno sanitario con todas las técnicas adecuadas en barranco contiguo, cubriendo alrededor de 6 hectáreas y previsto para 15 años de vida útil, costo aproximado de 80,000 dólares.

3o. Construcción del nuevo relleno sanitario incluyendo drenajes, impermeabilización, caminos de acceso, edificaciones, con un costo aproximado de 350,000 dólares.

4o. Construcción de una planta procesadora de basuras semi convencional para 200 toneladas diarias (¼ a 1/5 de la basura producida) con un costo aproximado de un millón de dólares.

5o. Construcción y desarrollo de 26 plantas de tratamiento integral (basuras y aguas negras) manejadas por cooperativas plurifuncionales en áreas suburbanas marginadas de la ciudad absorbiendo alrededor de 100 toneladas diarias de basura no recolectadas actualmente (primera etapa), con un costo aproximado de 8 millones de dólares.

Deberá notarse que las actividades relacionadas con el reciclaje de los desechos sólidos han sido incluídas en los proyectos arriba mencionados. Así se prevee la recuperación del gas bioquímico del relleno sanitario, el reciclaje de vidrio, plástico, papel, metales, etc., tanto en el relleno sanitario como en la planta procesadora y las plantas de tratamiento integral, asímismo la producción de compost o acondicionador de suelo en dichas plantas, producto que será destinado a otro proyecto municipal de suma importancia desde el punto de vista ambiental como lo es la recuperación y protección del área verde que circunda la ciudad, constituída principalmente por barrancos.

En este particular, se piensa desarrollar áreas verdes productivas manejadas por autogestión comunitaria, o sea, por las mismas cooperativas plurifuncionales que atienden las plantas de tratamiento integral antes mencionadas.

La organización, la promoción y la educación ambiental, tanto de los pobladores de las áreas suburbanas marginadas, como de los "pepenadores o guajeros" se tiene concebida como un paso básico, indispensable, para desarrollar las actividades de reciclaje de desechos y preservación ambiental. Actividades éstas que deberán ser debidamente apoyadas por la capacitación y formación técnico organizativo.

LA PROBLEMATICA AMBIENTAL DE LOS DESECHOS SOLIDOS Y SUS EFECTOS EN LA SALUD DE LA POBLACION EN LA CIUDAD DE MANAGUA, CAPITAL DE LA REPUBLICA DE NICARAGUA

Eduardo Caldera N.

SUMMARY

In a very brief introduction the environmental and health problems caused by solid wastes in the city of Managua is given.

Then the following causes of these problems are listed, namely:

- the disorderly growth of the urban population.
- the proliferation of human settlements near the river basins.
- the lack of a systematic programme for flood control.
- the improper use of soils.
- the deterioration of the drainage network caused by deforestation.
- the state of the sheets.
- the lack of enough cleaning equipment in sound condition owing to scarcity of spare parts and lack of maintainance.
- the discharge of sewage water on Lake Xolotlán.

ANTECEDENTES

La basura, es sin duda alguna, el sub-producto físico más molesto de las grandes ciudades, y su eliminación y/o aprovechamiento ha sido - desde tiempo inmemorial objeto de estudios, discusiones, planteos -

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Ing. Eduardo Caldera N., DIRENA-MINSA, Nicaragua.

socio-económicos y legislaciones, que aún en nuestros días no han terminado de solucionar el problema, aunque se han hecho notables progresos.

En tal sentido, el hombre, productor y dispersor de los desechos sólidos, necesita liberarse de ellos por cuanto le crean situaciones cada vez más perjudiciales, de esta forma intenta contribuir a preservar su ambiente físico inmediato y consecuentemente su salud.

La liberación se hace en términos general, alejándolos y concentrándolos y de acuerdo a la tecnología actualmente practicada, se efectúa mediante operaciones de recolección de dichos desechos, su procesamiento o no y su disposición en el suelo o en grandes cursos o cuerpos de agua, generan en todas esas operaciones y muy especialmente en la disposición denominada final, situaciones de carácter sanitario que ameritan consideración, estudio y reglamentación. Por muy simple que parezca lo expresado, no se trata de considerar y estudiar un problema de escasez, sino de extrema abundancia y universal localización, aspectos muy diferentes a los examinados cuando se habla de recursos.

No se consideran los desechos sólidos como un problema sanitario en sí mismos, sino, que se tratan de las condiciones sanitarias adversas que su presencia crea y no constituyen parte de desarrollos económicos de cierta magnitud, sino, que son consecuencias de todas las actividades humanas en todos sus aspectos, valores y modalidades.

En general el problema causado por la acción de depositar los desechos sólidos en el suelo debe ser estudiado bajo los puntos de vista siguientes:

1. El aumento de la población es una causa del aumento de la cantidad de los desechos sólidos.

2. A medida que las poblaciones entran al proceso de desarrollo aumentan su producción per-cápita de los desechos sólidos.

3. La biodegradación de los desechos sólidos, tienen relación con el desarrollo de las poblaciones.

4. La población de los desechos sólidos per-cápita tiene relación con el tamaño de la ciudad

En el caso particular nuestro, abordaremos la ciudad de Managua, capital de la República de Nicaragua. La ciudad capital está localizada dentro de la cuenca sur del lago Xolotlán y en la periferia del mismo. La cuenca sur del lago de Managua tiene una superficie de 825 - kilómetros cuadrados y está formada a la vez por cuatro sub-cuencas, representando la ciudad capital el 25% del total de la cuenca, es decir 206 kilómetros cuadrados.

Managua, cuenta con una población de aproximadamente 850,000 habitantes, representando este alrededor de un tercio del total del país. A lo interno de esta ciudad se encuentran cinco (5) lagunas ubicadas en lechos cratéricos, de las seis (6) que comprende la cuenca sur - (Asosoca, Jiloa, Acahualinca, Tiscapa, Nejapa y Apoyeque).

Estas lagunas son cuerpos receptores de agua pluvial a través de la captación directa de la precipitación pluvial o por la descarga de - algunos cauces tal es el caso de las lagunas de Nejapa, Tiscapa y - Jiloa. El sistema de drenaje pluvial de la ciudad de Managua corresponde a una infraestructura conformada por varios kilómetros lineales de cauces revestidos, los cuales cubren y se desarrollan de forma poco estética en todo el territorio urbano de la ciudad capital. Cabe mencionar que a pesar de este importante sistema de drenaje pluvial, no se manejan y/o controlan las aguas superficiales que llegan a Managua, por lo que se producen severas pérdidas y/o destrucciones de la infraestructura económica existente.

En cada invierno, la ciudad es fuertemente golpeada por la escorrentía que en su recorrido trae consigo enormes cantidades de sedimentos destruyendo cauces, vías de comunicación, puentes, calles, habitaciones y en algunos casos barrios muy pobres han quedado completamente arrasados, como consecuencia, el lago de Managua, sigue recibiendo en forma acelerada grandes cantidades de sedimentos y basura.

Managua, por ser la zona industrial más importante del país, presenta como consecuencia una serie de alteraciones ecológicas, ya sea - por la contaminación de los desechos domiciliares y/o por la contaminación de los desechos de las industrias que se encuentran en la periferia del lago.

SITUACION ACTUAL

La problemática ambiental de los desechos sólidos en la ciudad capital, como en el resto del país, hay que enmarcarla dentro de la situación coyuntural de crisis económica mundial y de bloqueos y agresiones imperialista de la actual administración norteamericana hacia Nicaragua.

Indefectiblemente no podemos hablar del impacto ambiental negativo de los desechos sólidos, sino tenemos que saber de las causas y razones principales que explican el grado de contaminación, entre las que podemos mencionar la concentración poblacional carente de sistemas efectivos de las disposiciones de los desechos sólidos, del uso de la tierra y manejos de suelos sin las debidas medidas conservacionistas. Cabe mencionar que el deterioro ambiental actual, constituye el principal reflejo de la herencia del pasado, en lo que se refiere a las formas del uso y manejo de los recursos naturales, de la distribución de la infraestructura y centros poblados.

La problemática ambiental de los desechos sólidos tiene además mucho que ver con los niveles de educación higiénico sanitario de la población, así como de la capacidad de cobertura del actual sistema de limpieza pública.

Basicamente podemos identificar que los factores que contribuyen al deterioro ambiental y a los efectos sobre la salud de la población tienen una estrecha relación con:

1) El crecimiento desordenado de la población capitalina.

2) La formación de asentamientos humanos en los márgenes de los cauces.

3) La falta de un programa sistemático de control de torrentes.

4) El mal uso que se le ha dado a los suelos.

5) El deterioro de la red de drenaje provocada por deforestación.

6) La calidad de las calles.

7) La insuficiencia de equipos de recolección operando por la falta de mantenimiento, producto de la escasez de repuestos y aditamentos.

8) La descarga de las aguas negras e industriales en el lago Xolotlan.

La magnitud de los desechos sólidos que la ciudad capital genera diariamente se estima en 430 ton/día. De esto puede decirse que alrededor del 75% es atendido, el 250% restante que no es atendido da origen a la formación de basureros clandestinos, que se estiman alrededor de los 240 o más. Por disposición en cauces, tragantes, barrios de la periferia (inaccesibles) y terrenos baldios.

Esta situación de los basureros clandestinos nos genera problemas de salud y de deterioro a los recursos hídricos, además de afectar seriamente el sistema de alcantarillado sanitario. Como nuestra capital posee un sistema de alcantarrillado separado, cuando se inicia el invierno la basura que no pudo ser recolectada es arrastrada por la escorrentía hacia las cunetas, obstruyendo los tragantes y por ende provocando desbordamientos y anegación de los barrios ubicados en la parte baja de la ciudad. Posterior a esta lluvia resulta con más agravamiento la proliferación de moscas, por la dispersión de la basura orgánica y de animales muertos, lo que trae consigo una alza en las enfermedades de transmisión digestiva principalmente en la población infantil.

Si analizamos el medio natural de transporte de los desechos sólidos, como es el de las aguas pluviales, que conducidas en su mayor parte hacia el lago Xolotlan, por catorce (14) de los principales cauces que atraviezan la ciudad, podemos entonces darnos una idea de la cantidad de materia orgánica que recibe dicho lago, otra buena cantidad la recibe la laguna de Tiscapa. Por el hecho de que la población asentada en los márgenes de los cauces, depositan su basura en ellos.

El crecimiento de la población originado por la formación de nuevos asentamientos y reasentamientos que surgen de la busqueda de mejores niveles de vida en la capital, por el desplazamiento de habitantes originarios de la zona de guerra, así como por inundaciones, agudizan e incrementan aún más la problemática ambiental de los desechos sólidos en la ciudad capital.

Si nos ubicamos en el sitio de la disposición final de los desechos sólidos, podemos darnos cuenta del incremento aún mayor de los factores que favorecen la contaminación ambiental, ya que este sitio se encuentra ubicado en los márgenes del lago Xolotlan, y como resultado de la dinámica del proceso de Biodegradación de la materia orgánica, se obtiene un líquido percolado o de lixiviación, que al combinarse con las aguas del lago delimita áreas de restricción para la vida acuática. Esta sustancia polucionadora no la hemos estudiado y desconocemos la toxicidad de los elementos químicos que la misma conlleva.

Ante la sumatoria de toda esta problemática ambiental de los desechos sólidos en sus diferentes tópicos, el estado revolucionario ha orientado y está impulsando:

1. Programas de prevención y defensa, el cual contempla actividades de carácter preventivo en relación al uso y manejo de los recursos naturales (educación ambiental y permisotecnia) comprendidos dentro de la cuenca en la que esta la ciudad capital.

2. Programas de infraestructura conservacionista consistente en la formulación y ejecución de sub programas y/o proyectos que conduzcan a la restauración de los recursos naturales renovables, en aquellas áreas donde la acción natural y humana han ocacionado su deterioro, así como la conservación de áreas suceptibles a la degradación.

Este programa de infraestructura conservacionista contempla seis (6) sub programas:

Control de torrentes.

Este sub programa consiste en proyectar y ejecutar obras de ingeniería, con la finalidad de reducir la erosión torrencial y disminuir los efectos prejudiciales de las crecidas.

Controlándose este fenómeno, también se disminuye una fuente importante de contaminación con sedimientos cargados de agroquímicos y basuras que se botan en los cauces, lagunas y el lago Xolotlán y consecuentemente, se obtienen beneficios de tipo ambiental y económicos muy importantes.

Conservación de suelos y aguas.

Este sub programa se enmarca en la propuesta de uso agroforestal conducida bajo la orientación del manejo conservacionista, además asegura la mejor utilización de los suelos y mejora las posibilidades de aprovechamiento de las aguas.

Reforestación.

Este sub programa de reforestación se emprenderá preferentemente sobre superficies amplias que garanticen cambios favorables en el comportamiento hidrológico de la cuenca y otras incidencias medio ambientales que habrán de vincularse con el análisis económico respectivo sobre la base de los beneficios tangibles e intangibles que suministran.

Regeneración natural

El objetivo de este sub programa es inducir la regeneración natural de una cobertura vegetal, con fines mentalmente protectores y no para la obtención posterior de productos forestales.

Estabilización de carcavas.

Estabilización de táludes de los caminos-cauces.

3. Campañas de saneamiento ambiental en la ciudad capital y resto del país, donde el organismo rector de toda esta movilización nacional es el Ministerio de Salud, a través de las jornadas populares de salud y en estrecha coordinación con las municipalidades y organismos de masas, tales como los Comité de Defensa Sandinista (CDS), la Asociación de Niños Sandinista (ANS), la Asociación de Mujeres (AMPLAE), Asociación de Educadores (ANDEN), Asociación de Trabajadores del Campo (ATC), los sindicatos, el ejército popular Sandinista entre otros.

Esta movilización sobre la limpieza ambiental es también apoyada por los medios de comunicación (la radio, los diarios y la televisión). Basicamente esta campaña consiste en la limpieza de cauces, tragantes, eliminación de basureros clandestinos, charcas y demás criaderos de moscas, mosquitos, roedores, etc. causantes de la mayor parte de las enfermedades de transmisión digestivas como las diarreas, fiebre tifoidea, etc. Actualmente estas enfermedades gradualmente van siendo disminuidas en el número de casos.

Queremos señalar que a raíz del triunfo revolucionario estas campañas se han venido implementando año con año de manera que con la experiencia que nuestro pueblo ha ido adquiriendo, también ha venido educándose en los aspectos básicos sobre las prácticas de higiéne del medio, lo que va convirtiéndose en una actividad permanente de lucha. Para darles una idea en las campañas de vacunación contra la polio y el sarampión en la ciudad capital se movilizan de manera voluntaria de 8 mil a 10 mil brigadistas de salud.

Con los niveles de organización alcanzada por nuestro pueblo en las prácticas de higiéne y limpieza el sub-sistema de barrido de calles en cierta medida va adquiriendo una nueva modalidad ya que corresponde de manera voluntaria a cada habitante, en cada cuadra, en cada barrio, en cada ciudad y/o Municipio realizar este tipo de actividad.

Podemos decir entonces que los elementos o requerimientos legislativos para la formulación de una legislación ambiental en materia de desechos sólidos, nace y lo fabrica el mismo pueblo aunque en Nicaragua no se tenga una legislación o ley que este dirigida al control y prevención de la contaminación por desechos sólidos, y aunque en otros países exista este tipo de legislación o ley, no podrán ser efectivas sin la participación popular porque la factibilidad de su aplicación estarán determinadas por factores económicos y educacionales. Sin embargo existe un impuesto del 15% en el consumo de energía eléctrica sobre los servicios que la municipalidad presta a la población: alumbrados públicos, barrido de calles, recolección domiciliar y mantenimiento de calles.

La capacidad económica de la comunidad deberá siempre ser considerada y la educación hará posible que la comunidad acoja la ley y se logre su aplicación efectiva.

A pesar del innegable y obvio beneficio que se obtendría de las acciones de prevención y control, al ejecutarse éstas de manera efectiva, justa y permanentemente, con la firme e indispensable base de una legislación apropiada, la formulación y promulgación de ésta, es tarea dificil, por cuanto para ello es necesario motivar y motorizar a personas y grupos para profundos e intensos estudios y consideraciones.

Aún cuando pueda lograrse el inmenso éxito de la promulgación de la legislación, es necesario contar con una política sana y definida en ella apoyada y perfectamente concordante con la realidad y con la dinámica del avance socio-económico implicado, que permita alcanzar logros significativos en el aspecto sanitario, ahora bien, es necesario que se entienda el objeto y el espíritu de la legislación, es indispensable el complemento educacional, el perfecto conocimiento de las disposiciones legales sanitarias que rigen las relaciones entre el estado y los ciudadanos en esta materia, en razón de la importancia que, para la defensa y fomento de la salud, tienen este conocimiento.

EXPERIENCIA SOBRE DESECHOS SOLIDOS EN GUATEMALA

Enrique Hernández

SUMMARY

On the basis of the experience on solid wastes in Guatemala this paper emphasizes the lack of environmental education at all strata of the population.

The author insists that any environmental protection programme must be run parallel with an education compaign. Litter and garbage is thrown on streets, buses, public places, etc., with even insolent nonchalance.

The problem of industrial wastes disposal is another critical problem because there is no decission yet regarding the most adequate disposal system for each type of industrial waste.

Systems now used are the sanitary landfills and open dumping places.

The main problems are:

- There is no classification of industrial wastes.
- All wastes are dumped indiscriminately on the same landfill
- There are no statistical data on the industrial wastes production.

La dificultad que encaran los Gobiernos de los países industrializados o en vías de serlo al tratar sobre los urgentes problemas de conservación del ambiente y contaminación es: "Cómo persuadir o convencer a la gente a que cambie muchos de sus hábitos sociales y acepte los nuevos conceptos económicos". Esto se refiere a la importancia;

Lic. Enrique Hernández, ICAITI.

que no debemos de dejar de lado, que tiene la educación de la población a todo nivel. En Centroamérica enfrentamos este grave problema que debemos resolver. Educación: Es necesario que a la par que se desarrollen sistemas para disminuir la contaminación ambiental, se desarrollen también, programas educacionales bien deseñados, que no impliquen necesariamente grandes inversiones, ¿cómo hacerlo? voy a contarles algo que me sucedió, y que creo es muy ilustrativo y que demuestra hasta qué punto se desconoce la importancia de conservar el ambiente; subí a un bus extraurbano que hace el recorrido entre dos poblaciones y en la parte superior de la cabina del chofer se podía leer con letras esmeradamente pintadas la siguiente frase: "Señor pasajero si usted come golosinas por favor tire la basura por la ventana, firma la Gerencia". A partir de esa advertencia que origina serios problemas y considerando la penetración que este tipo de educación o nada educación puede alcanzar en la población podemos pensar que si en lugar de eso, en cada bus se coloca uno o varios depósitos de basura y se cambia el letrerito por otro que diga por ejemplo: "Señor pasajero si come golosinas deposite la basura en él o en los recipientes, se estará alcanzando un gran objetivo educacional, sólo pensemos cuantas personas suben a esos autobuses cada día"; el costo sería posiblemente emitir una regulación que indique a los propietarios de buses que deben cumplir con ese requisito así como advertir a las autoridades competentes que revisen si se está o no cumpliendo con la disposición.

Se ha escrito muchísimo sobre la contaminación, yo quisiera que tomáramos en consideración que contaminación por sólidos o líquidos equivale a decir DESECHOS. Pero si estos desechos pueden de alguna manera ser reciclados o depositados en un lugar adecuado la contaminación desaparecería o disminuiría debido a que en último término esta no es más que material situado en un lugar incorrecto en un tiempo determinado; según los economistas desecho es cualquier material el cual es más barato tirarlo que darle un uso posterior. Esto no significa que los desechos no tienen ningún valor; algunos de ellos ciertamente lo tienen. Por ejemplo hablando de materias primas, éstas en un momento pueden llegar a alcanzar precios que hacen posible pensar en el reciclaje de otros materiales considerados actualmente como desechos.

Más adelante podremos observar algunos datos recabados sobre las cantidades y tipo de desecho de origen industrial que existe o que actualmente se están produciendo en Centroamérica, estos datos provienen de industrias ubicadas en las capitales de cada país centroamericano, no están aquí contempladas industrias que aunque sabemos positivamente del alto grado de contaminación que producen, se encuentran éstas en áreas sub urbanas, es por eso que no se ha incluído la agroindustria a la que pueden estar beneficios de café, caña, algodón, etc., así tampoco la industria papelera que sabemos bien cuan contaminadora puede ser pues estas se encuentra fuera del área de influencia del proyecto, esto no quiere decir, desde luego, que no nos interese, claro que interesa y mucho pero de momento no podemos atender estos problemas.

Para entrar en el tema de desechos industriales podemos considerar que en países desarrollados se tiene estimado que los desechos industriales son 2 veces los desechos domésticos.

En una estimación general se puede decir que 1 t de desechos sólidos ocupa 1.15 M^3, para el caso de Guatemala por ejemplo: en que la disposición de desechos sólidos anda por las 1 000 t diarias debemos pensar en que diariamente se necesitan unos 1 150 m^3 de espacio para dar cabida a las mismas. Aunque ya es de todos ustedes sabido, no está de más nombrar las posibilidades que existen para disponer los desechos sólidos. Cada uno de los sistemas como casi todo, presenta ventajas e inconvenientes; en cada caso, antes de decidirse por uno u otro sistema es necesario sopesar previamente cuál es el más adecuado, o por lo menos cuál es el que presente menos desventajas. Entre los diferentes sistemas podemos mencionar: botaderos abiertos, rellenos sanitarios, compostaje, incineración, depositar los desechos en el mar; para algunos desechos peligrosos se usa como forma de depósito, colocar los desechos en recipientes herméticos y luego depositarlos en lugares completamente aislados y protegidos, como puede ser minas agotadas o lugares desérticos.

En nuestros países únicamente se utilizan los sistemas de rellenos sanitarios y los botaderos abiertos y la incineración, el otro sistema muy utilizado es botar la basura en donde a la gente se le pega la gana.

Para obtener datos sobre los desechos industriales ha sido necesario recabar éstos directamente de las industrias debido a que en Centroamérica no existe hasta la fecha actual, una separación entre los desechos domésticos o demiciliares y los desechos industriales, aunque si existen datos sobre cantidades de desechos provenientes de domicilios y del sector público, tal el caso de mercados, barridos de calles, etc., considerando que estos datos han sido ofrecidos por cada país en particular, no se volverán a indicar ahora.

Como el punto de nuestro mayor interés son los desechos de origen industrial, vamos a ver algunos datos obtenidos durante una encuensta realizada, "en el sector industrial".

1o. Para seguir un ordenamiento de acuerdo a sistemas internacionales se adoptó el sistema CIU de clasificación industrial universal habiéndose contemplado las siguientes ramas industriales # 1.

2o. Como ya les había indicado, se tomaron en cônsideración únicamente las industrias que se encuentran localizadas en el perímetro urbano de las capitales y dentro de éstas aquellas industrias que tienen cierta representatividad en cuanto a niveles de producción y de producción de desechos. Estas decisiones o exigencias se realizaron en base a tablas estereotipadas, si se quiere así llamarlas, por la contaminación producida por unidad de producto, en la tabla siguiente se puede observar un ejemplo de contaminación determinada en ciertas ramas industriales. #2

La encuesta industrial se realizó como una actividad del proyecto pero para ello se contó con la colaboración de las Municipalidades de entidades municipal y de ministerios, de los países. También ha sido de gran importancia la colaboración de Universidades principalmente ERIS y San José ALBA ALEXIS Rodrigo. Debido a que no existe una ley que obligue a las industrias a dar este tipo de información, los cuestionarios fueron llenados con la anuencia voluntaria de las empresas razón por la cual quiero agradecer aquí públicamente y de manera muy especial la colaboración ofrecida al proyecto tanto a las instituciones antes mencionadas así como a las industrias que tuvieron la buena voluntad de darnos los datos de los que tenia consentimiento.

Problema: 1. No hay clasificación de desechos industriales.

2. Todos los desechos se depositan en el mismo relleno sin separación.

3. No hay datos estadísticos de producción de desechos industriales.

PRETREATMENT OF INDUSTRIAL SOLID WASTES NON-THERMAL SYSTEMS

Ousman Sillah

RESUMEN

Principalmente describe sistemas no térmicos de pretratamiento para desechos sólidos de la industria:

. Cantidades de desechos industriales, peligrosos y especiales en diversos países.

. Recolección y transporte de desechos urbanos e industriales.

. Sistemas de pretratamiento de desechos: recuperación de recursos (reciclado), desmenuzado y compactación, pretratamiento biológicos y físico-químicos de desechos industriales (digestión anaeróbica, hidrólisis, tratamientos físico-químicos), rellenos, reciclado en la industria.

. Regulaciones y leyes.

INTRODUCTION

In the past, industrial waste in particular has generally been accepted as an unavoidable consequense of industrial production. Responsibility wal left with industry. The consequences of improper disposal of indi-

Dr. Ousman Sillah, GTZ, Germany.

vidual kinds of waste as well as their dangerous properties with regard to disposal were no matter of general concern, special disposal methods generally undeveloped. It was only within the period of concern about the state of the human environment, i. e. the early 60's that, even in highly developed and industrialized countries, the first steps were taken to investigate the scope of the problem or to develop means to solve it. In the last 15 years it was recognized, compared with the domestic waste, hazardous industrial wastes constitute relatively small quantities which can only be disposed of in special facilities in an orderly fashion, which means without detriment to the environment (air, water, soil) and without all effects through dust, odor and corrosive gas (1).

Although increasing energy and raw material prices have minimized spillage and stimulated innovative recycling procedures, there are still considerable quantities of solid wastes generated during industrial and commercial production. Examples of the quantities being generated in a number of OECD Member States are given in table 3. In general, industrial waste production figures will always be a direct function of the level of industrial productivity and the economic activities of a country in general. Reliable statistics on solid waste generation in developing countries are sparse and estimates have to be made rather by deduction and extrapolation (2).

Table 1 Industrial, hazardous and special wastes generated annually in selected countries, in thousands of tonnes

Country	Chemical Wastes	Non-Chemical Wastes	Total	Hazardous and Special Wastes
Canada	1,540	1,750	3,290	3,290 (1)
USA	22,509	15,726	38,235	38,235 (1)
Japan	15,863	87,413	203,276	15,683 (2)
Denmark	120	1,200	1,320	56,000 (3)
France	10,443	27,762	38,205	2,500,000 (4)
FRG	7,342	39,448	46,790	4,500,000
Netherlands	1,100	3,188	4,288	240,000
Sweden	500	3,500	4,000	520,000

(1) Hazardous wastes only
(2) All industrial chemical wastes
(3) Disposed harzardous wastes
(4) Estimated values

Note These data are provisional and still subject to revision for - accuracy and consistency.

COLLECTION AND TRANSPORT

In most of the cities in developing countries no special services are established for the collection and disposal of solid wastes from industrial estates. Most producers have, therefore, organized their own - disposal service which usually includes a private or public landfill site as the ultimate depository of the waste. Little governmental control over such industrial operations is exercised since productivity and economic considerations all too easily prevent the necessary expenses required for the safe handling and disposal of the wastes.

The adequate method of industrial (hazardous) waste transport must be by tanker truck and tractor trailer. Separate collection of hazardous househould waste (for example batteries) can prevent the contamination of domestic waste. Such collection stations should be placed nearby communal installations.

The flow chart of a collection centre for hazardous waste is shown on page 4 (1).

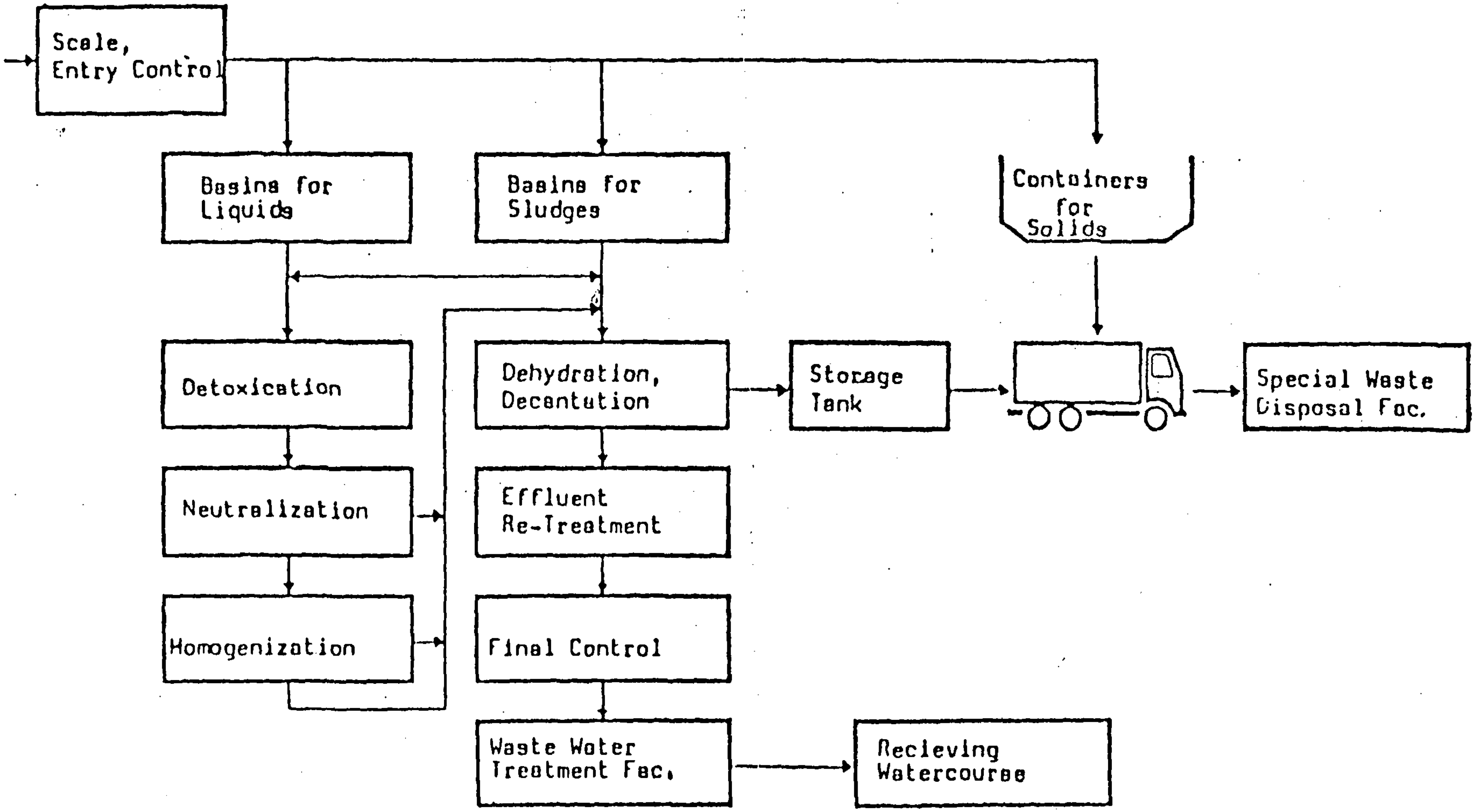
PRETREATMENT SYSTEMS

RESOURCE RECOVERY

The successful recycling of waste products will depend on a realistic appraisal of all economic and ecological relationships and on a careful examination of all organizational aspects.

The most favourable economic conditions for the recycling of industrial wastes are found when high disposal costs and raw material prices coin-

Flow Chart: Collection Centre



cide in time with low costs for the recycling and transportation of the waste products. Technological restrictions on the recycling of industrial waste materials are frequently imposed by the degree of purity of the waste which is insufficient for primary production purposes.

Which are the possibilities of reusing wastes anyway?

- A product can be reused in the same cycle, examples: multi-use bottles and containers.

- A product can be reused for other purposes; examples: old tires can be used to fortify embankments, to fill noise-suppression - embankments, or to stabilize a weak subsoil before road building.

- Wastes can be used as secondary raw materials by returning them to the original production cycle; examples: adding waste paper or broken glass to the paper and glass production processes.

- Wastes can be used as raw materials for other products; example: slag can be used in road building.

The majority of resource recovery activity for industrial waste have to be carried out by industry, rather than at a central treatment facility.

SHREDDING AND COMPACTION

Mechanical processing of the waste is required in almost all urban waste technologies. In most cases treatment in preceded by a sizing step - (shredding), in which wastes are uniformly sized for easier separation. The shredding is sometimes followed by a densification step, in which the waste materials are compressed. The consequence is the reduction of volume needed for landfilling

BIOLOGICAL, AND CHEMO-PHYSICAL PRETREATMENT OF INDUSTRIAL WASTE

Anaerobic Digestion - This process is used in many waste-water treatment plants to treat sewage sludge prior to disposal. It is a proven technology for sewage sludge applications. Its potential is being investigated for urban waste. Basically, the process employs organism in the absence of air to break down the waste and form methane gas. The methane recovered from this process has a varying Btu content. The use of the methane may be somewhat limited unless it is scrubbed of impurities and upgraded.

The decomposition of organics in the anaerobic digestion system is basically accomplished in a two-stage wet process. In the first stage, complex organics are broken down by organisms called acid formers into short chain organic acids. In the second stage, the short chain organic acids are acted upon by methane-forming anaerobic organisms and are converted to carbon dioxide and methane.

The major parameters affecting the yield of the process are the specific growth rate of the organisms, the saturation constant for the organisms, and the residence time in the fermentation tank. There are two general types of organisms used for the process, mesophilic and thermophilic. The mesophilic organisms operate in the middle range of temperature from 30° to 40°C; the thermophilic operate at a higher temperature, generally greater than 50°C.

The major advantages of anaerobic digestion are its operability on a small scale and the nitrogen and phosphate content of its waste products, which can be used as a fertilizer, thus avoiding the cost of waste disposal.

Hidrolysis - Conversion of cellulose, a major constitutent of urban solid waste, to glucose would provide a source of energy, food, and chemicals. Estimates are that, from one ton of waste paper, a half ton of glucose - can be fermented to yield 68 gallons of ethanol. The conversion process can be achieved either by acid hydrolysis or by enzymatic processes.

An evaluation of the two approaches suggests that acid hydrolysis is superior to enzymatic processes. Acid hydrolysis requires diluted 1.4 per cent sulfuric acid at elevated temperatures in order for the acid molecules to attach the cellulose molecule.

Chemo-physical tretament

Wastes with inorganic and organic contaminats can be treated through the following processes:

- oxidation of cyanides and nitrates
- reduction of hexavalent chromium
- neutralization of acids and alkalis
- heavy metal precipitation
- solids/liquid separation
- dewatering of precipitates
- treatment of oily water mixtures
- wastewater treatment
- treatment of flue-gas scrubber effluents
- treatment of leachate generated at the secure landfill site.

Mention should also be made of hospital waste, which must be given special attention because it is potentially infectious. Solutions to this problem are lacking especially in developing countries where such wastes are treated together with residential refuse.

Components of hospital wastes are hospital wards, wastes from chemical laboratory, operation room, biological laboratory, treatment rooms and hospital service units. The treatment required is:

- separate collection according to the type of waste.
- disinfection, sterilisation
- intermediate storage
- central container
- dumping in landfill for hazardous waste (or incineration).

LANDFILL (1)

Industrial and hazardous waste products with implications for the ecology should, after suitable preliminary treatment and subject to speical safety measures such as the comlete insulation of the deposited materials from the ground-water, be placed in secure landfill sites. In some cases also, solid and semi-solid special waste materials, mostly organic in character, which contain large amounts of halides and other injurious substances and which are therefore unsuitable for incineration either on land or at sea, can be dumped in a salt-mine for example.

The landfill must comprise the following installations:

- Operational building with amenity rooms of various types for the personnel.

- Laboratory for sampling of the substances delivered.

- Vehicle weight bridge

- Vehicle and instrument shop

- Control systems (drainage, retaining basins) for holding and treating the storm water and leachate.

RECYCLING IN INDUSTRIES (CLEAN TECHNOLOGIES)

The ideal case of industrial waste technology would be the zero-solution, i. e. wastes are processed/reused on the spot where they are generated.

For example:

The wide field of applications for non-ferrous metals, be it as metals, alloys or as chemical coumpounds, aggravates and to some extent even prevents any recycling into the production cycle.

The margin for recycling depends on several technical and economic factors, such as:

- quantity
- separate collection systems
- specific screening and separation processes

- energy requirements
- environmental impact
- quality to be achieved for the secondary material
- cost-efficiency

Metal recycling rates vary considerably, and the potential scope for recycling is far from being exhausted.

The paths and distribution of heavy metals are investigated by preparing material balances and systematically studying the material flows in raw material producing and processing industries, the subsequent manufacturing industries up to the finished product and waste disposal. By identifying the system's weak points and showing options for solutions, it should be possible to close the material cycle more definitely.

This is an important step for clean technologies.

REGULATIONS AND LEGISLATION

An adequate Waste Disposal Act may contain the following items:

- waste definitions
- facility siting
- collection and transportation; generators are responsible for their wastes
- management at facilities
- export and import of wastes
- licensing of waste management facilities
- registration of generators, hauler and disposer
- fine and/or imprisonment of offenders

The central task in an hazardous waste disposal system is, and will continue to be to ensure that a hazardous waste is directed along - the right disposal route from waste generator to waste transporter and to a disposal facility, where the waste may be properly treated.

The surveillance of this waste transfer is perhaps the most difficult element to manage in the overall waste disposal control system, as far as the manpower to do it efficiently and the great number of individual checks which have to be performed are concerned.

A system of accompanying documents (trip-ticket-system) shall enable - the responsible authority to trace the path of notifiable wastes from their source to ultimate disposal. Copies of the notification forms - enter the files of the authority as certificates on the orderly transport and disposal of the wastes.

LITERATURE

(1) UNEP-BMFT Congress, 1982,
Karlsruhe, Germany
(F. Deffreger)

(2) Dr. Bidlingmaier
TU Stuttgart, Germany
Waste management in developing countries

THERMAL TREATMENT OF SOLID WASTES

RESUMEN

Describe con detalle dos métodos térmicos para tratar desechos sólidos; también trata sobre la calidad del aire:

- Incineración: descripción, efecto sobre el ambiente, subproductos.

- Directrices técnicas para el control de la contaminación aérea.

- Pirólisis: descripción, diferentes equipos usados, efecto sobre el ambiente.

1. SUMARY

Thermal processes of solid waste management, mainly municipal wastes, had been developed in the time of cheap energy. At this time emphasis had been focussed on Quantity-Reduction because of a severe lack of - land space for waste disposal. First processes generated under this respect had been the varius types of INCINERATION. Other types of - thermal processes for solid waste management are PIROCYSIS and GASIFICATION. This processes, redeveloped within the last decade, became - interesting unden respect of recorevy of fuel.

A basic difference within a practical view is related to emission problems. As incineration plants cause severe air pollution, precipitators (particulates) and wet scrubbers of high efficiency have to be - treated Pyrolysis processes normally cause less pollution.

Dr. Peter Kolbusch, GTZ, Fed. Rep. of Germany

Related to proces varities, water emission are also to be expected in both of the processes.

Operating and capital costos of both of the processes are high if compared with deposition, but space for disposal is rare in West Germany and trasnsportation costs increase permanently. Total costs are to be calculated (1,981, FRG-Basis) with 65 - 70 DM/t for incineration and - 55 - 60 DM/t or more for pyrolysis.

Given costs for incineration are based on a plant size of 200 000 - tons/yr (e. g. 600 000 Inhabitants), those for pyrolysis are based on 42 000 tons/yr. This indicates an important difference if hole system will be discussed: Incineration starts with a size about 120 000 tons/yr which means high capital and transportation costs. Pyrolysis plants - are smaller and therefore able to meet the needs of a decentralized - waste-management conception if wanted.

2. INCINERATION

Direct incineration of solid municipal wastes originates from England (19th century) Germany has the following number of plants:

Table 1: Incineration plants in West Germany

	Plant Capacity (ton/h)			
	1 - 10	10 - 30	more than 30	Total
number of plants	17	21	8	46

Source: Unweltbundesamt, Germany 1,985

2.1. Process description (2)

Refuse can be fired as a supplemental fuel in a convetional power plant. The operation of the plant is little affected by the refuse if the refuse does not exceed 20%. Several arrangements are possible:

- refuse and fuel are fired separately (Munich, Stuttgart) or in a single combustion chamber,
- the economizer, evaporator, superheater, and flue gas cleaning - are common to both plants, or partially serparated.

Precise arrangements have a strong influece to corrosion.When refuse is fired, together with oil or coal, efficienciy decreases to about 70 %, due to a higher air factor and fouling rate.

For example, in Munich North, Block I refuse is burned (on a Martin grate) in a first combustion chamber. Pulverised coal is fired in a second chamber, separated from the first by a common tube wall. The flue gases from refuse combustion in a first flue are cooled to 800°C and, together, with the flue gases of the coal-fired chamber flow - through the second and third flue, which contain the superheater and the economizer. The plant can be operated in 3 modes:

1. in normal operation, with 40% of the heal load supplied by refuse, and 60 % by pulverised coal;

2. power generation with pulverised coal only;

3. boiler operation at lowered temperature and pressure with only refuse as a fuel. Power is no longer generated. Incinerator heat is uses for district heating, excess steam being condensed.

An other example is a pulverised coal-fired plant in Esse (Germany) with a Benson boiler, which was provided with travelling grates for refuse firing. Also in this region an existing plants was later transformed, to accomodate refuse firing. This solution requires a lower investment than the erection of a new plant'

The principle of operation can be studied by the following figures.

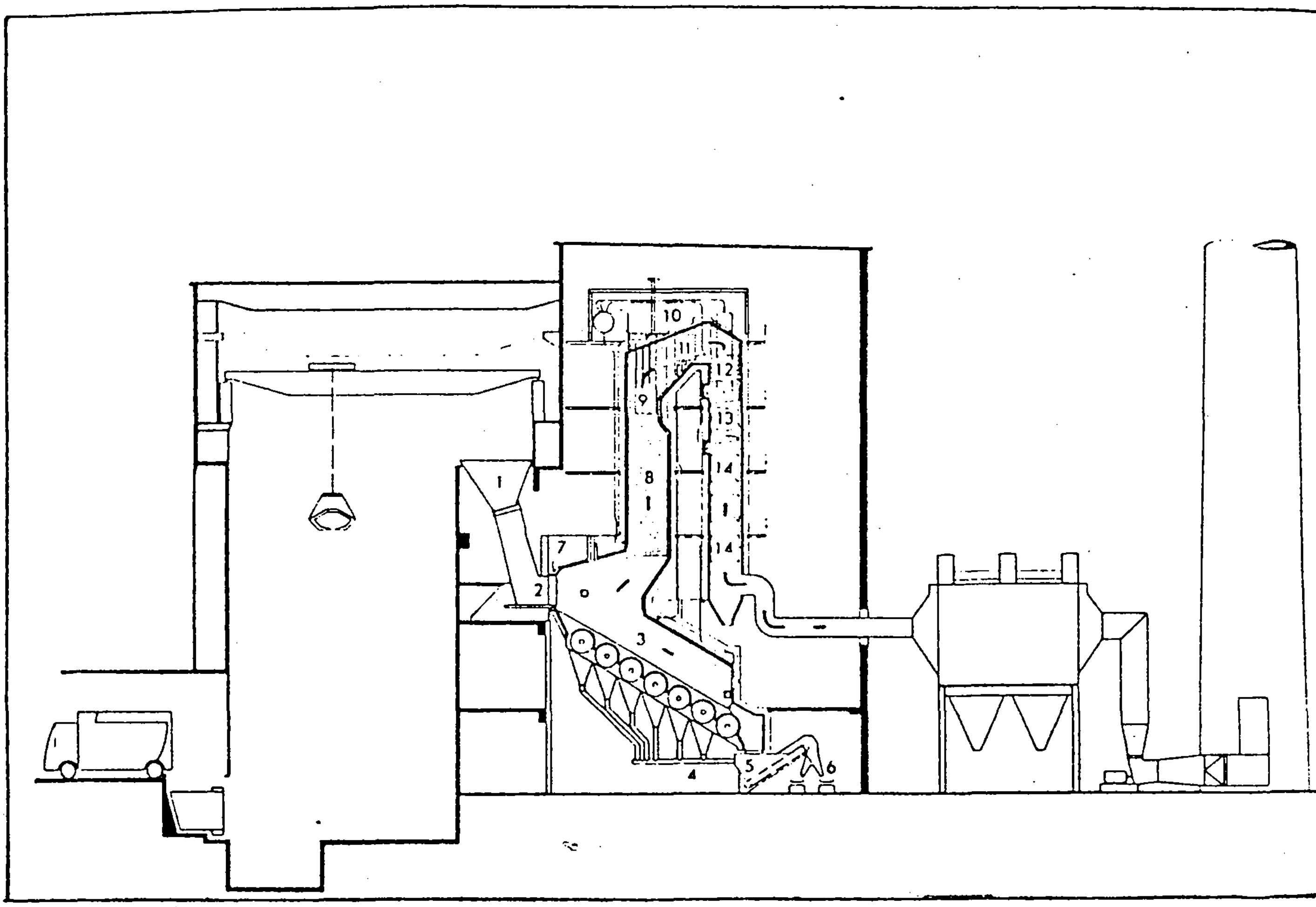


Fig. 1

Incineration plant Düsseldorf, 10 t/h Refuse, 16 t/h Steam saturated, 105 bar Steam pressure, 500° C, System VKW

Legend:

1.Refuse in, 2. slide-valve, 3. cylinder grate, 4.,5. ash-out
7.burner, 8. heat exchanger, 9. heat exchanger, 10. cooling,
11.,12. pre-heater 1+2, 13.evaporator, 14. process water preheater

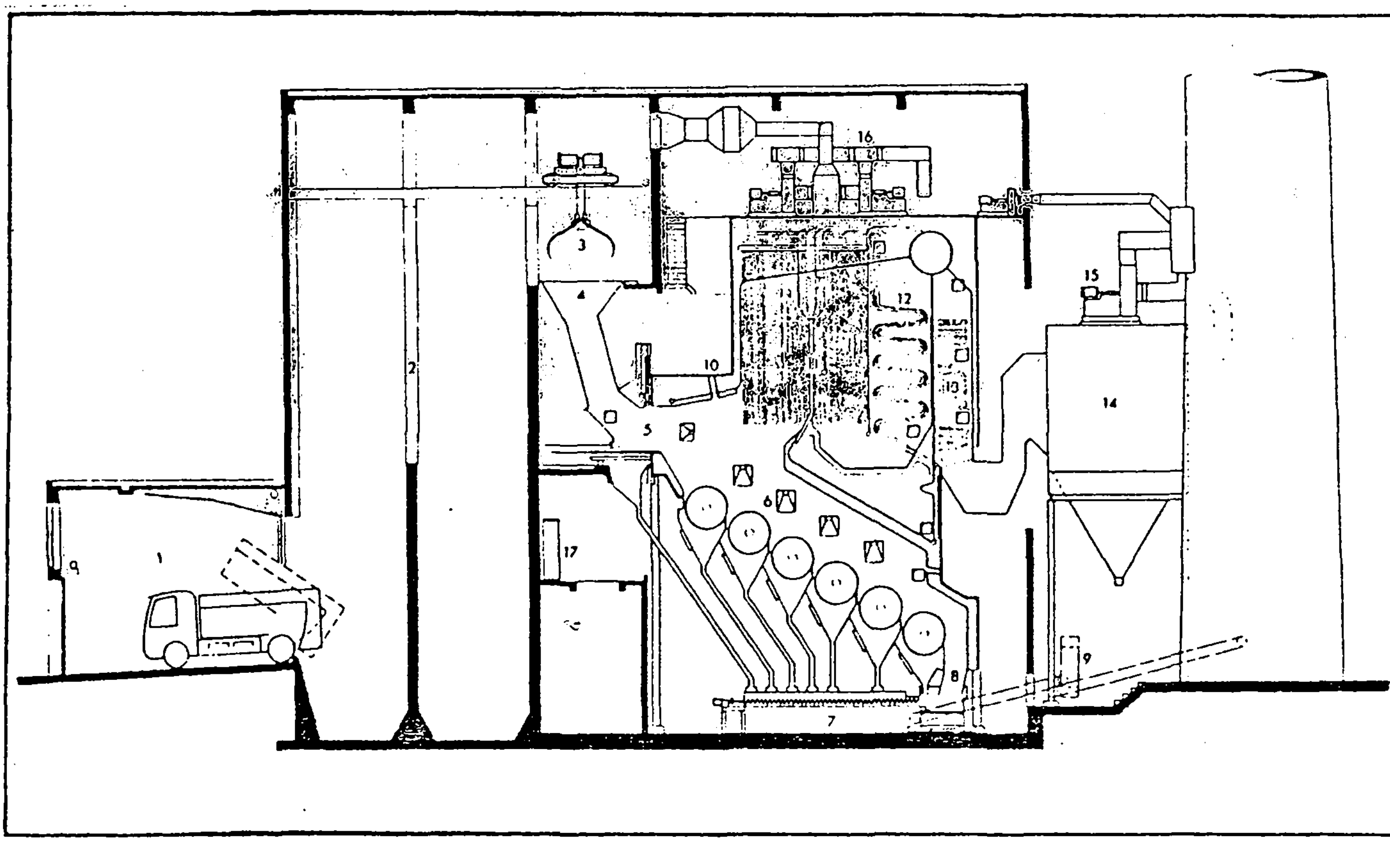
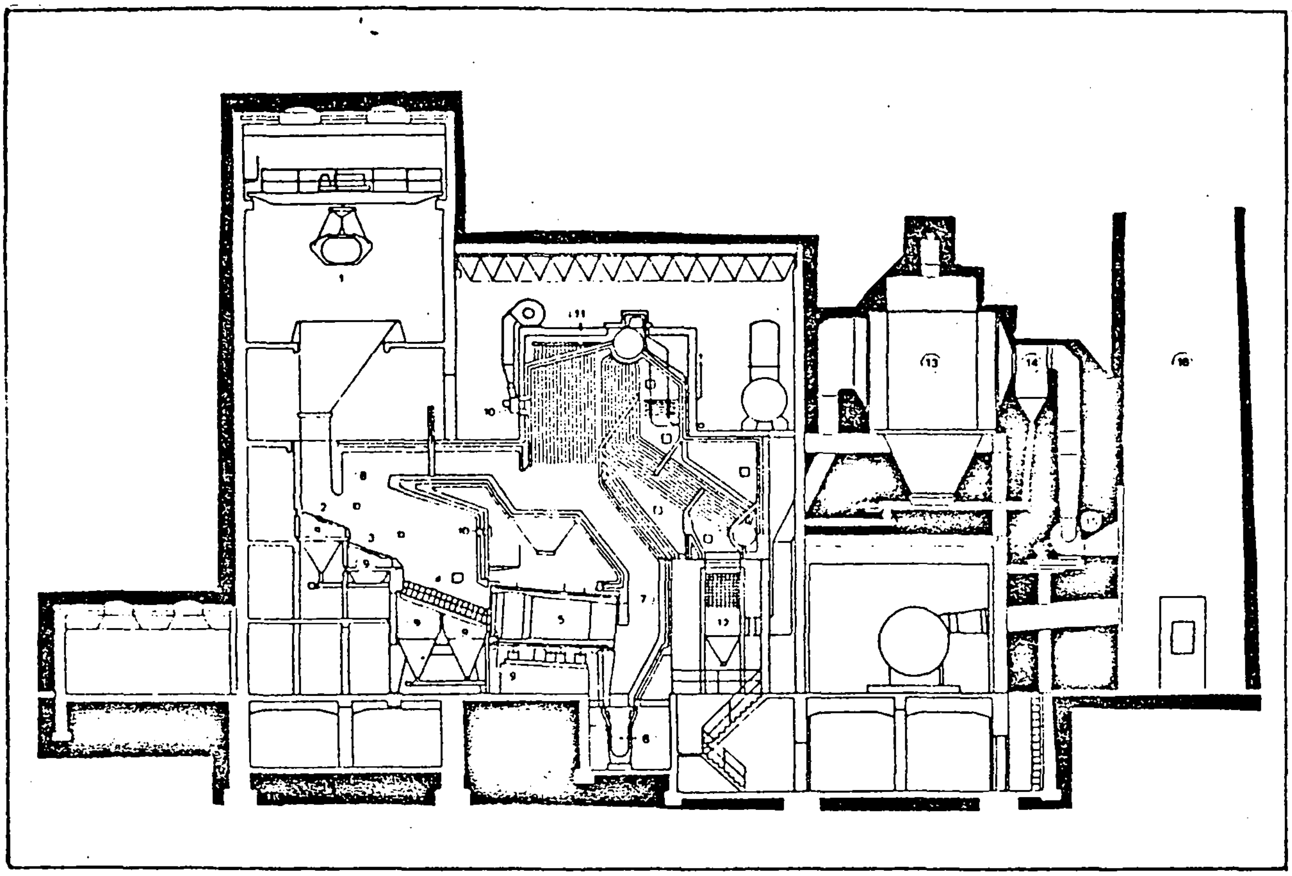


Fig. 2

Incineration plant Rosenheim, 4.5 t/h Refuse, 7.5 t/h Steam (saturated), 14 bar Steam pressure, System VKW

Legend:

1. - 5. Refuse in, 6. cylinder grate, 7.-9. ashes out, 10. ignition-burner, 11.+12. evaporator, 13. heat exchanger, 14. electro-filter, 15.+16. blast, 17. boiler



Legend:

1.Refuse in, 2.+3. grates, 4. ignition grate, 5. rotary kiln, 6. ashes out, 7. flue gas, 8.steam and air emissions, 9. air emissions, 10. burner, 11. boiler, 12. preheater, 13. electrostatic filter, 14. mechanical filter, 15.+16. chimney

Fig. 3

Incineration plant Bonn-Bod Godesberg, 4 t/h, 10 t/h Steam,

12 bar Steam pressure, 250^{o} C, System Koppers-Wistra

2.2. Availability of Incinerator Heat

The primary purpose of a municipal incnerator is disposal of refuse. The availability of a single incinerator furnace with heat recovery can be estimated at 75 to 85 %. But incinerator availability cannot be guaranteed, full standby capacity under the form of a convetional fuel-fired unit has to be provided. Moreover, cooling capacity should be available to dissipare all heat generated, since incineration is continued also at times when there is no heat demand. This inflates investment cost and often generates an inefficient use of incinerator heat.

Integration of the incinerator into a power plant, a large district heating or water desalination system, or another large heat sink, allows the invevitable variations and fluctuations in incinerator heat output to go by unnoticed. The incinerator is used to deliver part of the base-load, the rest of the demand beig delivered by a conventional unit with a suitable turn-down ratio.

2.3 Utilization of Heat

Incinerator heat can be used directly, i.e. under the form of hot flue gases, or indirectly as hot water, steam or electric power.

The direct use of hot flue gases as a drying medium is normally restricted to the drying of wastewater sludge and of wet refuse, because of their particulates. A rotary kiln, a multiple hearth furnace, a fluidised bed, a nd a ball mill drier have been used as contacting equipment. Odour problems are avoided by keeping the temperature of the flue gases above 700°C, or by recirculating them into the furnace.

Hot water is generated in small cooling circuits, e.g. in a water jacket surrouding the load shaft or the slag gasifier.

Steam is produced in a water-wall or a waste-heat boiler. The waterwall is fully integrated into the combustion chamber, but not the boiler. Operating pressure is mainly determined by the application of the generated steam. In large plants, with power generation, high pressure (30 - 120 bars) is required to obtain a reasonable efficiency of the thermodynamic cycle. Generally a pressure of 30 - 45 bar is selected. The higher pressure requires excessive super heater temperatures, which are conducive to high temperature corrosion.

A minor amount of steam is required for in-plant use, e.g. for operating the soot blowers, the deaerator, (possibly) turbinedriven fans, compressors, pumps or hammermills, and for plant heating. A hot water storage system can be used, in case of a district heating application.

2.4 Environmental Aspects of Incineration

Municipal and other wastes can be incinerated to a low-volume of sterized residue. The operation of well-designed, modern plants has generally been considered to be environmentally acceptable. Yet, it has to be recognized that incineration forms a real or potential source of - air (and soil) and water pollution.

Flue gases are loaden with particulates and obnoxious gases. The problem of particulates has been solved by using high-efficiency electrostatic precipitators. Recent concern has been expressed regarding the emissions of heavy metals. The emission of obnoxious efficiency wet - scrubbers.

Wastewaters from an incinerator plant are charged with suspended solids, soluble salts and organic materials. Wastewater treatment generally - consists of settling and neutralisation.

All in all environmental problems originating from incineration plants are severe but can be solved. It must be considered, that treatment - cost are very high, e.g. costs for flue gas-treatment can rise up to 25 DM/t (or refuse), depending to air standards.

2.4.1 Air Pollution generated by Incineration Plants

Air pollution from incinerators mainly depends on the chemical composition of the fuel, the kind of furnace, and its operating conditions. Several mechanisms are to be considered in an assessment of air pollution:

1. Mechanical entrainment of ash, dust charred paper, etc.
2. Occurence of incomplete combustion, with emission of carbon monoxide, thermally decomposed and incompletely oxidized organic compounds, and finely dispersed tar and soot particulates.
3. Formation of sbnoxious gases, from sulphur, chlorine, fluor and nitrogen compounds, which are present in fuel or wates.
4. Formation of nitrogen oxides at flame temperature, by combination of nitrogen and oxygen from air.
5. Evaporation of metals and saltas in the flame.

Emission depend on the kind and composition of the treated wastes, - the type and operating conditions of the furnace, and the nature and efficiency of the gas cleaning plant.

A typical composition of raw flue gases is geven by table 2.

Table 2: Typical composition of raw flue gases (wet basis)

			German standards
H_2O	10 - 18	Vol %	
CO_2	6 - 12	"	
O_2	7 - 14	"	
CO	0,1	"	1 g/m^3
Particulates	2 - 15	g/m^3	100 mg/m^3
Cl^-	400 - 2 000	mg/m^3 (as HCl)	100 mg/m^3
F^-	0,5 - 2	" (as HF)	5 mg/m3
$SI_2 + SO_3$	400 - 1 000	" (mainly SO_2)	
$NO + NO_2$	100 - 400	" (largely as NO)	

The comparision to German air pollution standards shows, that a removal efficiency of 99 - 99.5 % is required for particulates, and a 95 % efficiency for HCl-removal. Ther former condition can be met with an electrostatic precipitator, the latter with a hig efficiency met scrubber.

2.4.2 Water-emissions

Effluents vary within 0,5 and 8 m^3/ton of municipal wate:

- Normally bottom-ash is cooled and slaked with a water bath. If the water seal is open, the allowed temperature is limited to 60 ° C and less. Depending on the quantity and temperature of ash 3.5 to 6 m^3 of cooling water is required per ton of refuse. If the water seal is closed, ash is cooled by evaporation of water, and requires only 0.2 to 0.4 m^3 of cooling water per ton of refuse. The evaporated water per ton of refuse. The evaporated water generally rises into the combustion chamber. Quench water leaches salts and unburnt organic material from the residue. It contains particles in suspension, an reacts basic with a pH of 9.0 - 11.5. It contains besides - - - Ca^{2+}, Na^+, K^+ and some Al^{3+} and Mg^{2+} Heavy metal ions from Pb, Zn, Hg, Cd, etc.

- When fly-ash is collected in a wet scrubber, the resulting slurgy - has an acid-reaction, by absorption of acid gases, such as HCl, SO_2, SO_3, CO_2 an NO_x. Moreover, the collected particles contain adsorbed acid gases. Scrubbing liquor can be recirbulated after settling. It is highly corrosive and may cause abtructions and erosion. The required quantity of scrubbing water varies between 0.5 an 50m^3/ton of refuse, but is widely constituted by recirculated water.

- Incineration of 1 ton of refuse generates about 5 000 m^3 (s.t.p.) of flue gases, having a typical HCl-concentration of 1 g/m^3, which corresponds to a total amout of 5 Kg. HCl (per ton of refuse). This quantity will be absorbed to a 5 % solution which represents a volume of 0.1 m^3. Neutralization with lime requires a supplementary - 0.1 m^3, for preparation of the lime slurry.

- Purification of boilers creates wastewater too, e.g. spent brine, lime, sludge, mud, etc. depending on the origin of the feewater and kind of treatment.

2.4.3 Treatment of the flue gases from waste incineratore(11)

State-of-the-art technology for the treatment of exhaust gases from wate incineration comprises basically gravitational separators, dust filters, electrostatic filters and wet or dry scrubbers.

Gravitational separators are used relatively seldom, because particle size distribution does not facilitate adherence to prescripted emission limits. At the time electrostatic filters, with which the dust content of the treated gases can be reduced to and maintained at a level of - 10 to 50 mg/m^3, represent the method of choice. Whit dust filters, - e.g. textile filters, even lower levels (in extreme cases as low as - 2 mg/m^3) can be achieved.

Wet, quasi-dry and dry procedures are usde for the elimination of gaseous pollutants. The wet procedures involve the absorption of acid gases is an alkaline watery phase. In orden to keep the amount of - process water needed as well as the amount of wastewater as low as possible, the scrubbing water is recycled through the plant. The reaction products in the wastewater are transformed into sludges or into crystalline substances either by secondary treatment processes or thermal evaporization and after separation from the liquid phase are deposited in a landfill.

Quasi-dry procedures are based on reactors in which the exhaust gases are mixed with liquid reagents entering the system by means of jets - or spray nozzles. The chemical reactions that occur cause precipitation of the pollutants, simultaneously the water in the system is evaporated, so no wastewater accumulates. There after the dustlike reaction products are separated from the exhaust gases in an electrostatic or a woven filter.

The dry procedures utiliza dry reagents that bind the gaseous pollutants through sorptive mechanisms. Separation takes place in a subsequent filter. As a rule the separation efficiency is lower than that of the wet procedures; moreover chemicals ins excess of stoichiometric quantities are used.

Regulations and Guidelines for Air Purity

According to the Federal Law on Wate Disponsal (1972 and 1982 resp.) wate incinerators are also waste disposal plants. Refuse-fueled power plants must be approved as prescribed by the Federal Law on Inmissions. They must be equipped and operated with measures corresponding to state-of-the-art technology for limiting emissions; the relevant stipulations of the "TA-Luft" (Technical Directives for Limiting Air Pollution) as well as the German Engineers' Society Guidelines for the Limitation of Discharges are to be adhered to.

The law on Water Conservation is also relevant, especially in respect to the discharge of scrubber water from exhaust gas treatment processes into receiving waters.

Technical Directives for Limiting Air Pollution ("TA-Luft")

The amendment of the "TA-Luft" in February 1983 was intended to provide better immision controls for the protection of human health as well as of sensitive plant and animal species. The values of the emission limits laid down in the "TA-Luft" (TA-Luft, Section 3) were not revised at that time; however, they are now being up-dated.

At the time there are seventeen waste incineration plants equipped with scrubbers for cleaning the exhaust gases in the Federal Republic of Germany. The quantity of exhaust gas treated in the individual scrubbers varies between 13 000 and 130 000 m^3/h. All newly planned units provide not only for a decrease in dust discharges but also for the reduction of gaseous pollutants and the heavy metal contents in the gases finally discharges from the plant.

Presently, control authorities are also requiring that older plants also be equipped with units for the advanced treatment of exhaust gases.

The wate incineration plant in Hamburg-Stapelfeld has an installed capacity of about 225 000 t/a. The exhaust gases are de-dusted in electrostatic filters and cooled down to a temperature of about 110° C by means of a raw gas/clean gas heat exchanger. Thereafter they are passed through a wet scrubber based on a system of impingement baffle stanges connected in series. There they are purified by contact with an alkaline solution. In this plant, the following average values for emissions in the clean gas, as based on Vol.-% oxygen (moist), were determined during examinations on March 7 and 8, 1979, repectively:

Table 3:

Emissions from the incineration plant Hamburg-Stapelfeld

Dust content	mg/m^3	6
Carbon monoxide	mg/m^3	less than 100
NO_x	mg/m^3	120 - 121.9
Cl	mg/m^3	41,9 - 60.6
F^-	mg/m^3	0,4 - 0,5
SO_2	mg/m^3	18,6 - 25,0

Source: TÜV Norddeutschland

Another example is the hazardous waste incineration plant in Ebenhausen, Germany. In the year 1979 experiments wer carried out in a pilot plant to investigate the dry hot treatment of exhaust gases from the hazardous waste incinerator of the "Gesellschaft für die Beseitigung von Sondermüll in Bayern mbH" (Hazardous Waste Disponsal Company, Ltd.) in Ebenhausen. During these experiments slaked lime was used as a reagent and solids were separated from the gas by means of woven filters. The following concentrations of pollutants were found in the treated gas:

Table 4:

Emissions from (treated) flue gases from a Hazardous Waste Incineration Plant

Dust	mg/m^3			0,9	
HCl	mg/m^3	10	-	90	(Average values)
SO_2	mg/m^3	149	-	1 100	(350)
HF	mg/m^3	1		3	(1,6)
NO_x	mg/m^3	10	-	120	(131)
CO	mg/m^3				(70)
CxHy	mg/m^3	0,3		20	(2)

The complex problem of dioxin emissions arose in the year 1984. Dioxins are composed of carbon, hydrogen, chlorine and oxygen. The sum formula, for example, of 2,3,7,8-TCDD (2,3,7,8,-tetra-chloro-dibenzo-dioxin; know as the "Seveso-poinson") is $C_{12}H_4Cl_4O_2$.

Theoretically (chloro-) dioxins can be formed during the improper combustion (e.g. insufficient oxygen supply) of all comsutible substances containing chlorine. The are stabile up to temperatures of 700°C Proper combustion at high temperatures for a sufficient length of time leads to their complete decomposition. Dioxin can be oxidized in modern, refuse-fueled power power plants, so that end products such as carbon dioxide, water and hydrogen chloride, which can be removed from the exhaust gases by a simple srubbing procedure, are formed. The "Eidgenössische Materialprüfungs- und Versuchsanstalt" (Federal Institute of Materials Testing and Proving in Dübendorf, Switzerland, carried out analyses on the waste incineration plant on Josephstrasse in Zürich. On the basis of the results it was concluded in essence that for residents living with in a two-kilometer radius of the plant a safety facor of about 100 000 exists against the chance that the - uptake of dioxin through respiration would just reach the "still-non-harmful limit". characteristically dioxin is adsorbed very strongly on (solid) surfaces; thus modern exhaust gas treatment procedures provide additional safety factors, because the amount allowed in current relevant guidelines.

According to the UBA-Report (UBA= Federal Environmental Agency), "The Dioxin Situation", the safety factor for residents within a five-kilometer radius of a PCDD-burdened waste incineration plant is 80 000. - This safety factor, when compared with other normal risks of life, is so extraordinarily high that a corresponding hazard arising from the - incineration of wastes must be looked upon as being "equal to zero".

TCDD is an omnipresent compound, because it can be an unavoidable product fo all combustion processes, when the combustible material, e.g. coal or fuel oil, contains chlorine components. In this connection - the following data are presented, as taken from the lecture "Formation of Polychlorodibenzo-dioxins (PCDD) and - furanes (PCDF) during Waste Incineration and other Combustion Processes" held by Prof. K. Ballschmiter of the University of Ulm at the FGU Seminar in Berlin on May 10, 1984:

Table 5:

Dioxin contents of various gases

Exhaust gases from	2,3,7,8-TCDD-content (ppt)
Trucks, diesel	3
Otto-motors (cars)	1 - 4
Chimneys	1 - 100
Cigarettes	1

In the periodical "Umwelt, No. 102, April 30, 1984" the following was presented under the title "Dioxine and Altlasten" (Dioxins and Old - Burdens):

> "Because of the present, ubiquitous incidence of TCDD, its uptake in human beings can amount to 1,4 x 10^{-12} g of TCDD per day and kg. of body wight under unfavourable conditions (1,4 x 10^{-12} = 1,4 parts : 1 000 000 000 000). Thus the TCDD uptake of human beings is surely not acutely toxic. To our present Knowledge long-term effects arising from uptake can be ruled out".

All together it can be said that, as far as the incineration of wastes is concerned, the gestion of dioxin emissions can be solved by making the right choice of combustion temperature, combustion air ratio.

3. PYROLISIS PROCESSES

Refuse pyrolysis has only attracted attention during the last decade. The pyrolysis process itself however has been practiced for several centuries e.g. in the conversion of wood into charcoal and various - useful chemicals, such as methanol and acetic acid. Destillation of coal in coking furnaces is a major industrial operation for generation of coke to be used for steel production etc.

Besides the main product coke, tar and gas are also obtained. Coal tar is separated into useful products, such as crude benzene naphtalene, anthracene and phenantrene oils, pictch, etc., by means of destillation, solvent extraction and other follow up methods.

The recent increase of energy costs renewed the interest in gasification processes that produce a low or medium heating value gas. A recent number of gasification processes are under current development.

Worldwide about 30 - 40 plants for gasification and/or pysolysis are in operation. Most of them are pilot plants, but size varies widely from 1 ton/D to 900 t/D. Most activities will be observed in United States and West Germany.

3.1. Process Description

Pyrolysis or degasification of organic materials is a thermal degradation process conducted without or little (under-equivalent) addition of reactive gases (air, steam, hydrogen). Depending on the reaction conditions varying amounts of gaseous and liquid products and carbonaceous residue are produced.

Municipal refuse in Europe has a average composition $C_6F_{9,6}O_{3,8}N_{0,1}S_{0,01}$ not very unlike that of cellulose $C_6H_{10}O_5$. Therefore pyrolysis will normally be studied with cellulose as a good model for cinetics. As a function of temperature, pyrolysis of cellulose can be described as followes (5):

Table 6: Cellulose pyrolysis related to temperature of precess

Temperature	Process
25 - 150° C	Drying
150 - 240° C	loss of chemically bound water
240 - 400° C	Depolymerization formation of Levoglucosan, tars, oils CO, CO_2, H_2, CH_4 .
400 - 700° C	Dehydrogenation, formation of polycyclic aromatic compounds.

Pyrolysis of refuse generally yields

1. Gas
2. Oil and tar
3. Char

During pyrolysis the moisture content of the refuse is driven off, forming a water fraction (wastewater) when the volatile pyrolysis products are cooled below their dewpoint. Nature and relative quantities of the varius products are determined by thermodynamic and by kinetic factors. The most importantoperational parameters are: feedstock composition, - temperature, pressure, residence time of the solid and of the volatile material.

High temperature favours the formation of simple gaseous compounds, - such as H_2, CO, CO_2, H_2O and CH_4, at the expense of higher hydrocarbons, oil and tar. The carbonaceous residue looses weight by the evolution of volatile material. On the other hand supplementary carbon may be formed in the gas phase, by thermal cracking of oil and tar.

a Longer residence time favours the occurence of secondary reactions, i. e. the degasification of volatile products. For example, a high - yield of liquid product is obtained in the occidental Petroleum Flash Pyrolysis Process using very short reaction times at 500° C.

Nature of feedstock gives the following influence, as chown by tests - made by Kaiser and Friedman (6)'

Table: Influence of nature of feedstock on pyrolysis products (6)

Feedstock	Gas	Tar	Char	Water
Newspaper	25.8	10.2	28.7	33.9
Rubber	17.3	42.5	27.5	3.9
Vegetable feed waste	27.6	20.2	20.2	27.2

There is a strong influence of moisture content of feedstock on the oil yield. High moisture contents cause decreasing oil yields. With moisture of more than 50 %, no oil will be obtained, therefore refuse must be preheated if a oil fraction is wanted.

3.2 Reactor Systems

Three basic furnace types are considered:

1. Vertical shaft furnaces
2. Fluidised bed furnaces
3. Rotary kiln furnaces

3.2.1. Vertical Shaft Furnace

The properties are as followes:

Advantages

- Simple contruction, almost no moving part at high temperature.
- High thermal efficiency when operated in countercurrent.

Disadvantages

- Low heat transfer rates, especially with externally heated reactors.
- Bridging and channeling cause transfer problems.
- Process control is difficult.

The different reaction zones are the following.

Drying:	incoming refuse comes into contact with hot rising gases and loses its physically bound water.
Degasification zone:	Dried refuse is pyrolysed by not gases from the gasification zone. Tars and oils are produced in this zone.
Gasification zone:	Preheated and degasified refuse reacts with incoming gases (H_2O, O_2, air): formation of H_2, CO, CO_2.
Ash cooling zone:	Is not being used in any type of shaft furnace.

Unclassified refuse has a tendency of bridging and channeling. This results in a non-uniform bed and, hence, in a non-unifor flow of gases in the shaft. Dense parts of the refuse bed are impervious to the gas flow and remain wet, cold and unreactive. In gasifiers unconverted oxygen eventually mixes with pyrolysis gases, causing small explosions. In the Destruga and Kiener pyrolysis and the Purox gasification processes this problem is avoided by preliminary shredding. In the Motala process coal is added to increase bed uniformity.

3.2.2. Fluidized Bed Reactor

Fluidisation is a process in which a bed of finely divided solid particles is Kept in suspension by an upward stream of gas. The fluidised solidsbehave more or less like a liquid, very good heat transfer rates are obtained due to the rapid movement and the high surface area of the solids available for heat exchange, hence an almost uniform bed temperature is obtained, The bed can be formed either by the pyrolysis resue or by a foreign material (e.g. sand).

The properties are as followes:

Advantages

- High rates of heat transfer,
- high reaction rates,
- uniform bed temper,
- stability of precess even if sudden changes in refuse composition occur.

Disadvantages

- Reprocessing in terms of homogenisation of refuse is necessary (shredding, separation of dense materials etc.)
- gases bear a high load of particulates,
- loss of fluidisation when clinkering of ash and bed materials,
- difficulties in valve gearing.

3.2.3 Rotary Kiln Reactors

As rotary kilns are well known, a description does not seem to be necessary.

Properties are:

Advantages

- Simple construction,
- good mixing.

Disadvantages

- Preliminary shredding is required,
- jealing of kiln is difficult,
- control of reaction conditions is difficult.

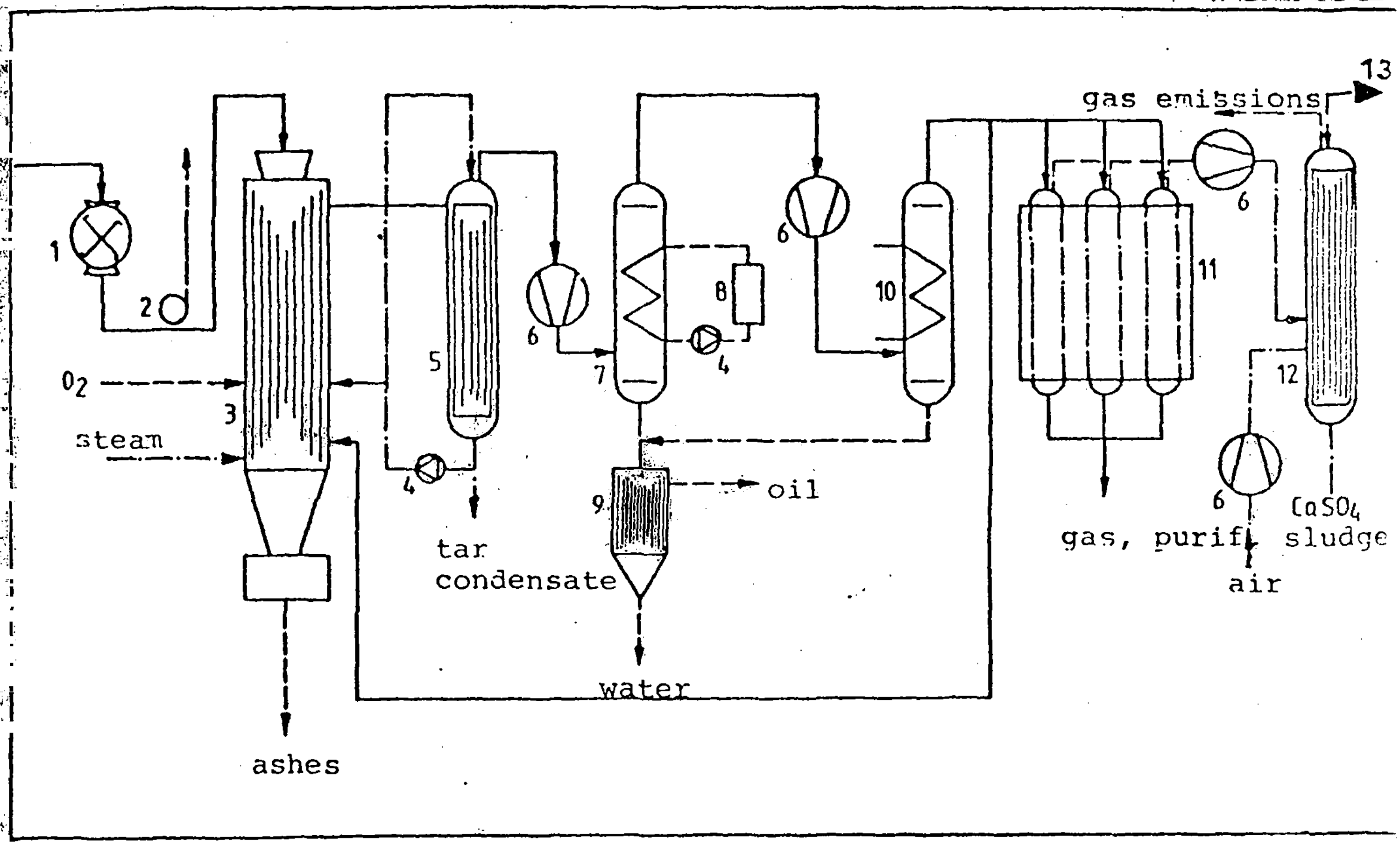


Fig. 4

Pilot plant for gasification of refuse, Saarberg Fernwärme GmbH, Germany, 1 ton/h (7)

Legend:

1. shredder, 2. metal separation, 3. gasifier, 4. pump, 5. heat-exchanger, 6. blast, 7. heat exchanger, 8. cooler, 9. decanter, 11. regeneration, 12. neutralization, 13. lime storage

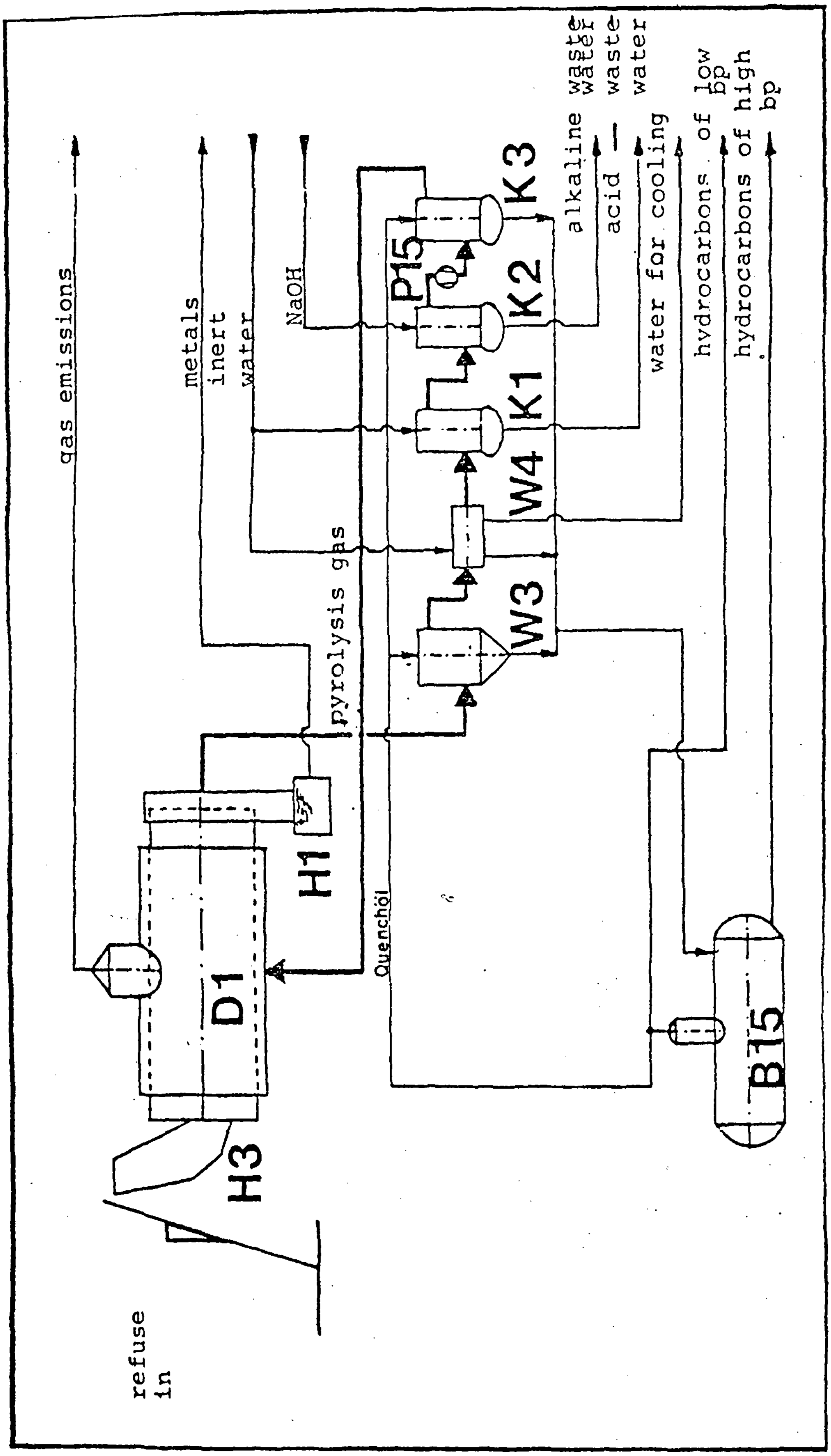


Fig. 5
pyrolysis pilot
plant for pyro
of refuse,
Veba-Oel Umwel
technik, German
200 kg/h (7)

Legend:

H3 material in
D1 rotary kiln reactor
H1 output soli
W3, W4 cooler, condens
K1, K2 gas was
K3 absorber for hydrocarbon
P15 vac. pump
W3 cooler
F1 separator f water/oil
B15 tank

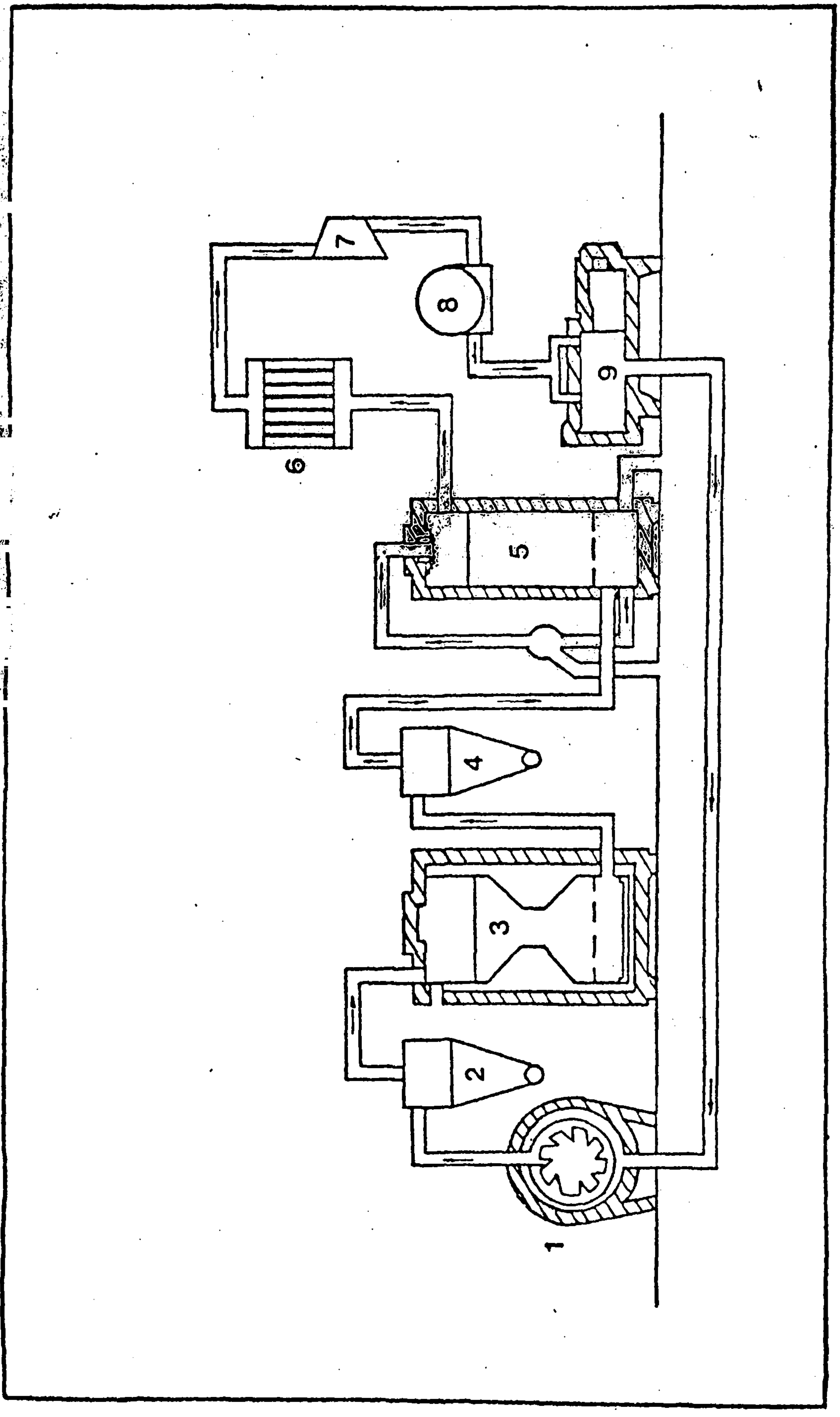
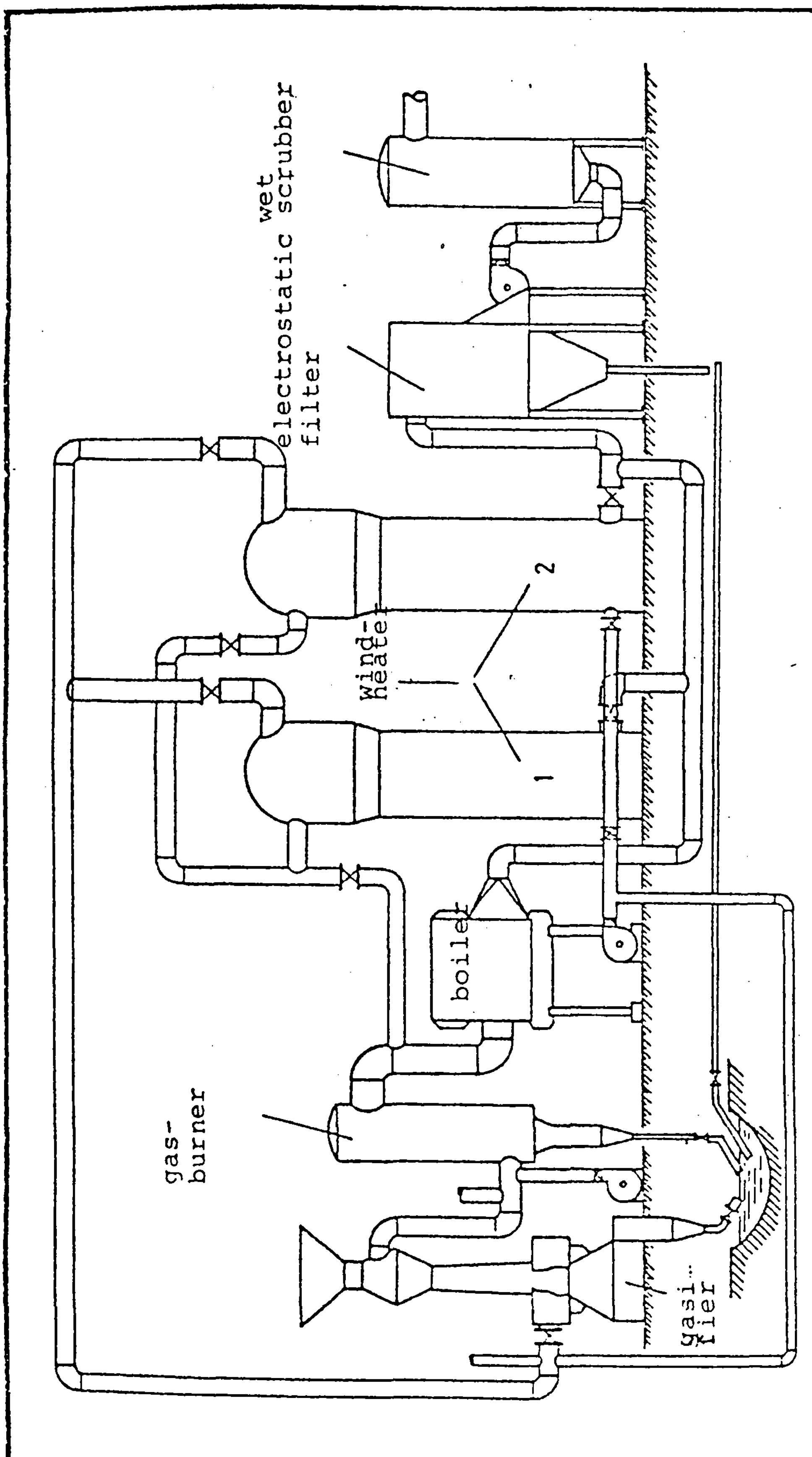


Fig. 6
Pyrolysis pilot
System Kiener
Pyrolyse Gesell-
schaft für ther-
mische Abfallver-
wertung GmbH,
Germany
300 kg/h (7)

Legend:

1. cylinder for mouldering of refuse, 2. cyclone, 3. cracker,
4. cyclone, 5. gas washer, 6. gas cooling, 7. exhauster,
8. gas tank, 9. gas engine



Quelle: Reirner H, Neue Verfahren der therm. Abfallbehandlung, Der Städte-tag, 2/76

Fig. 7
Pyrolysis plant
System Andco-To
Municipality of
Frankfurt, Germ
8 t/h (9)

3.3. Environmental Aspects

3.3.1 Air Pollution

Selection and design of gas treatment plants are normally based upon:

- volumetric flow of gas to be treated,
- actual composition of the gas
- emission standards to be met.

Anny pyrolysis or gasification process finally produces flue gases, as gases are normally used as a fuel. Some processes directly burn the evolving pyrolysis or gasification gases, where as others first purify by means of a wet scrubber.

- Processes in whichi the gases are directly burned (ANDCO-TORRAX, LANDGARD) generate flue gases that are essentially free from organic contaminants if the secondary combustion chamber will be - properly designed.
  The main advantage when compared to conventional incineration is the use of a much smaller excess of combustion air, so that the volume of flue gases to be cleaned is reduced.

- Processes in which produced gas is cooled and cleaned generate a condensate and/or scrubber effluent, which is highly polluted and contains toxic components, such as cyanides, hydrogen sulphide - and ammonia (e. g. PUROX, DESTRUGAS, OXY, ...).
  In these processes the quality of the product gas is improved as the cost of a severe wastewater problem.

Some pyrolysis and gasification processes feature low gas velocities (e. g. Purox, Destrugas). The entrainment of particulates in these processes is low.

Fluidised bed processes, on the other hand, require elaborate particulate-arresting equipment (cyclones etc.).

A major difference with incineration is the presence of a reducing atmosphere in all or in part of the furnace. This may cause various problems:

- Formation of toxic gases, such as CO, NH_3, H_2S, HCN, Dioxine, PCDF (see chapter 2.4.3.)

- Formation of explosive mixtures with air, e.g. in the event of mechanical damage (rupture of a vessel or of transfer lines) or of an outward or inward leak.

- Formation of hard tar which condenses in colder part of the reactor and eventually forms obstructions.

3.3.2 Water Pollution

The main soucer of waste water in pyrolysis or gasification systems are:

- Scrubber effluents including condesarion water,
- Quench tank effluent.

Moisture content of municipal solid waste in Central Europe generally amounts to 250 - 400 kg/ton of raw refuse. In some processes this water is contained to the flue gases, formed by direct combustion of the pyrolysis/gasification products. In other processes this water will be condensed together with volatile organic compounds, oils and tar and soluble gases and liquids.

Aditionally, scrubber effluent contains any particulates, gases and vapours, which may be washed from producer gas. The quench tank effluent may leach soluble materials from carbonized residue. On the other hand, carbonized residue may adsorb impurities from the waste water and contribute to their purification.

This water has vey high COD content (some 50 000 mg/l) and contains various organic compounds such as alcohols, ketones, aldehyds and organic acids as well as phenols.

The high BOD and COD-values, as well as the presence of toxic phenols and heavy metals, prohibits biological treatment and possibly chemical pretreatment. Following talbe indicates expensive water treatment.

Table 8: Characteristics of Destruga's wate water (4)

Component	Concentration in mg/l
ph	8.2
BOD_5	$12,7 \times 10^3$
COD	$21,3 \times 10^3$
phenols	840
cyanides	25
NH_3	2 250
Chloride	1 100
Sulfates	1,780
Sulfide	42

3.3.3 Immissions

Hashegawa et.al (8) studied the distribution of heavy metals in different fractions obtained in Tsidashiwa Kikai dual fluidized bed process. Their results show, that most of the heavy metals are concentrated in the solids (cyclone ash, coarse residue, sand). An exception is mercury which is largely been found in the tar. Ananalysis from Hitachi process generates similar results:

	Zn (ppm)	Cd (ppm)	Cr (pmm)	Pb (ppm)
Raw Refuse	32,81	8.33	31,25	37,50
Fluidised sand	8,04	1,08	6,66	10,00
Charcoal	93,75	32,50	125,00	312,50
Particualtes	312.50	99,37	187,50	450.00

The above analysis as well as numbers given in table 8 indicates, that pyrolysis and gasification may cause as severe environmental problems, as incineration does. Therefore it had been absolutely necessary to develop these processes under this specific respect.

REFERENCES

(1) Barniske, L. and Schenkel, W.:
Entwicklugsstand der Müllverbrennungsanlagen mit Wärmeverwertung in der Bundesrepublik Deutschland.
CRE, 1975, p. 91

(2) Kolbusch, P. and Schäferm W.:
Biokonversion - Biologisch Technische Systeme zur Energiegewinnung,
BMFT (Hrsg.) 1979, p. 155 ff.

(3) Conversion of Refuse to Energy (CRE)
Conference Papers,
First International Conference and Technical Exhibition,
Montreux, Switzerland 1975

(4) Unpublished papers and materials selected for setting up loc. cit. 2 such as:
Informations from industry, unpublished official papers etc.

(5) Phillipp, B. et. al.:
Zum Einflub einiger chemischer Faktoren auf den thermischen Abbau der Cellulose.
Cell. Chem. Technol., 6 (4), 1972

(6) Kaiser, E.R. Et. al.:
The pysolysis of Refuse Components,
Combustion, 5, 1968

(7) Neue Verfahren der Thermischen Abfallbehandlung
- Dokumentation - stand 1980
Combustion, 5, 1968

(8) Hashegawa, M. et. al.:
Research and Development of circulation systems between fluidized beds for application of gas-solid reactions.
Pachec 1977

(9) Reimer, H.:
Neue Verfahren der thermischen Abfallbehandlung
Der Stadtetag 2 (1976)

(10) Lenz, S.; Heil, J.; Silberberger, F. and Pruckner, E.:
Bericht über stand und Entwicklung der Niedertemperaturpyrolyse System Kiener,
Stuttgart 1981

(11) Tabsaran, O.:
Emissions from the Incineration of Solid Waste
Recycling International, Berlin 1984

DEWATERING OF PRIMARY SLUDGE FROM INDUSTRY

Dr.-Ing. Klaus G.H. Pöppinghaus

RESUMEN

Uno de los múltiples problemas que se afrontan con el tratamiento de lodos provenientes del tratamiento de desechos lo constituye el proceso de deshidratación.

El presente trabajo hace una descripción de los métodos más utilizados, tales como el filtrado al vacío, centrifugación, prensado, en sus diferentes formas al igual que el sistema de utilización de lechos de secamiento y el uso de lagunas.

En cada caso se hace una descripción de los fundamentos de la operación y las características de los equipos que se usan.

Igualmente contiene datos de rendimiento de las operaciones y el grado de secado a que se puede llegar al usar dichos procesos.

SUMMARY OF WASTEWATER ENGINEERING FOR SLUDGE DEWATERING

Dewatering is a physical (mechanical) unit operation used to reduce the moisture content of sludge for one or more of the following reasons:

Dr.-Ing. Klaus G.H. Pöppinghaus, GTZ, Germany

1. The costs for trucking sludge to the ultimate disposal site become substantially lower when sludge volume is reduced by dewatering.
2. Dewatered sludge is generally easier to handle than thickened or liquid sludge.
3. Dewatering is normally required prior to the incineration of the sludge to increase the calorific value by removal of excess moisture.
4. In some cases, removal of the excess moisture may be required to render the sludge totally odorless and nonputrescible.
5. Sludge dewatering is commonly required prior to landfilling to reduce leachate production at the landfill site.

Dewatering devices use a number of techniques for removing moisture by filtration, squeezing, capillary action, vacuum withdrawal, and centrifugal settling and compaction.

The selection of the dewatering device is determined by the type of sludge to be dewatered and the space available. For smaller plants where land availability is not a problem, drying beds or lagoons are most frequently selected.

Aerobically digested sludges can be dewatered on sand beds with good results.

The available dewatering processes include vacuum filters, centrifuges, filter presses, horizontal belt filters, drying beds, and lagoons.

Vacuum Filtration

The function of the unit operation of vacuum filtration is to reduce the water content of sludge, whether it is untreated, digested, or elutriated, so that the proportion of solids increases from the range of 5 to 10 percent to the range of 20 to 30 percent. At this higher percentage, waste water sludge is a moist, easily handled cake. To visualize the amount of water to be removed, consider 1000 kg of sludge with 5 percent solids, or 50 kg of dry solids and 950 kg of water. After filtration to 30 percent solids, the 50 kg of solids would be associated with 117 kg of water in 167 kg of sludge. Thus, 833 kg of water would have been extracted by the vacuum filter. This represents an 83 percent reduction in the weight of sludge to be disposed of from the treatment process.

Table: Typical specific resistance values for various sludges

Sludge	Specific resistance r, m/kg
Primary	1.5 - 5.0 x 10^{14}
Activated	1 - 10 x 10^{13}
Digested	1 - 6 x 10^{14}
Digested and coagulate	3 - 40 x 10^{11}

The yield of the filter in kilograms of dry solids per unit time may be changed by varying the suction, the speed of rotation, the portion of the cycle time during which suction takes place, and the permeability of the filter cake. The latter is controlled by the addition of sludge-conditioning chemicals.

Operation description

In wastewater-treatment plants, vacuum filtration is a continuos operation that is generally accomplished on cylindrical drum filters. These drums have a filter medium which may be a cloth of natural or synthetic fibers, coil springs, or a wire-mesh fabric.

The performance of vacuum filters is affected by the type and age of the sludge, prior sludge processing, filter medium selected, and sludge feed temperature. Although some generalities regarding vacuum-filter performance can be made, the results obtainable in practice are extremly variable. In general, conditioning of wet sludges is necessary to achieve satisfactory yields from vacuum filters. Conditioning coagulates the sludge particles and allows the water to drain freely. As a result, a thicker filter cake is produced, and the drum can be rotated at a higher speed.

The number and size of filters are based on the type of sludge to be filtered and the number of hours of operation.

The optimum solids content for filtration is about 8 to 10 percent. Higher solids content makes the sludge difficult to distribute and to condition for dewatering; lower solids content requires the use of larger-than-necessary vacuum filters. Chemicals that are commonly used for conditioning sludge are lime, ferric chloride, and polyelectrolytes. Sludge from primary settling tanks, in general, requires lesser amounts of conditioning chemical than sludge from biological-waste-treatment processes. Elutriation of digested sludge, as previously discussed, reduces the chemical requirements.

The performance of a vacuum filter is measured in terms of the yield of solids on a dry weight basis expressed as kilograms per square meter per hour. The quality of the filter cake is measured by its moisture content on a wet-weight basis expressed as a percent. Where the cake is to be heat-dried or incinerated, the moisture content is a critical parameter, since all the water remaining in the cake must be evaporated to steam. If the cake is conveyed into a truck an hauled to a disposal site, moisture content is not as important, although it does affect the mass that must be hauled. In such cases, the drum can be operated at the highest speed that will produce a cake that will separate easily from the filter. Moisture content normally varies from 70 to 80 percent, but after heat treatment of the sludge, filters may be operated to produce a cake of 60 to 70 percent moisture where the cake is to be heat dried or incinerated. A design rate of 17.0 kg/m^2 h (3.5 lb/ft^3.h) is frequently used.

Centrifugation

The centrifugation process is widely used in industry for separating liquids of different density, thickening slurries, or removing solids. The process is applicable to the dewatering of wastewater sludges and has been used with varying degrees of success.

Table: Expected performance of vacuum filters handling properly conditioned sludge

Type of sludge	Yield, kg/m^2 h	Cake solids, %
Fresh solids		
Primary	20-60	20-40
Primary and trickling filter	20-40	20-30
Primary and air-activated	20-25	16-25
Primary and oxygen-activated	25-30	20-30
Air-activated (alone)	12,5-17,5	15-25
Pure-oxygen-activated (alone)	15-20	15-25
Digested solids (with or without elutriation)		
Primary	20-40	20-30
Primary and trickling filter	20-25	15-28
Primary and air-activated	20-25	12-25
Primary and oxygen-activated	25-30	15-25

Equipment description

Sludge dewatering may be accomplished by solid-bowl and basket centrifuges. In the solid-bowl machine, sludge is fed at a constant flowrate into the rotating bowl where is separate into a dense cake containing the solids and a dilute stream called centrate. The centrate contains fine, low-density solids and is returned to primary clarifier. The sludge cake, contains approximately 75 to 80 percent moisture. Depending on the type of sludge, solids concentration in the cake varies from 10 to 40 percent, but reductions below 25 percent are not usually feasible economically. The cake can then be disposed of by incineration or bt hauling to a sanitary landfill.

Solid-bowl centrifuges are generally suitable in the same applications as vacuum filters. Their performance ist governed by the same factors that affect vacuum filters. The units can be used to dewater sludges with no prior chemical conditioning. Chemicals for conditioning are added to the sludge within the bowl of the centrifuge. Dosage rates for conditioning with poly-electrolytes vary from 1.0 to 7.5 kg/10^3 kg of sludge.

Basket centrifuges have been used for partial dewatering at small plants. They can be used to concentrate and dewater waste activated sludge, with no chemical conditioning, at solids capture rates up to 90 percent.

Table: Expected performance data for solid-bowl centrifuges

Type of sludge	Cake solids,%	Solids Capture, % Without chemical	With chemical
Untreated			
Primary	25-35	75-90	90+
Primary and trickling filter	20-25	60-80	90+
Primary and air activated	12-20	55-65	90+
Waste sludge			
Trickling filter	10-20	60-80	90+
Air activated	5-15	60-80	90+
Pure-oxygen activated	10-20	60-80	90+
Digested			
Primary	25-35	75-90	90+
Primary and trickling filter	18-25	60-75	90+
Primary and air activated	15-20	50-65	90+

Design considerations

The operation of centrifuges is simple, clean, relatively inexpensive. Special consideration must be given to providing sturdy foundations and soundproofing because of the vibration and noise that result from centrifuge operation. Adequate electric power must also be provided because large motors are required.

The major difficulty encountered in the operation of centrifuges has been the disposal of the centrate, which ist relatively high in suspended, nonsettling solids. The return of these solids to the wastewater treatment units could result in a large recirculating load of these fine solids through the sludge and primary settling system and in reduced effluent quality. Two methods can be used to control the fine-solids discharge and to increase the capture. Longer residence of the liquid stream is accomplished by reducing the feed rate or by using a centrifuge with a larger bowl volume. Particle size can be increased by coagulating the sludge prior to centrifugation with ferric chloride and lime or organic polymers. Solids capture may be increased from a range of 50 to 80 percent to a range of 80 to 95 percent of influent solids.

The addition of lime will also aid in the control of odors that may develop when centrifuging untreated sludge. Untreated primary sludge can usually be dewatered to a lower moisture content than digested sludge, because it has not been subjected to the liquefying action of the digestion process, which reduces particle size.

The area required for a centrifuge installation ist less than that required for a vacuum filter of equal capacity, and the initial cost is lower. Higher power costs will partially offset the lower initial cost.

Pilot plant tests should be run whenever possible before final design decisions are made.

Filter Presses

In a filter press, dewatering is achieved by forcing the water from the sludge under high pressure. Advantages cited for the filter press include

- high concentrations of cake solids,
- filtrate clarity,
- solids capture, and
- chemical consumption

Disadvantages include high labor costs and limitations on filter cloth life. Various types of filter presses have been used to dewater sludge.

In operation, chemically conditioned sludge is pumped into the space between the plates, and pressure of 40 to 150 N/cm^2 is applied and maintained for 1 to 3 h, forcing the liquid through the filter cloth and plate outlet ports. The plates are then separated and the sludge is removed. The moisture content varies from 55 to 70 percent.

The most significant costs associated with this method of dewatering are those for chemical conditioning and maintenance and replacement of filter cloths.

Horizontal Belt Filters

Several new mechanical dewatering systems have been introduced in the past few years. They are the

- belt pressure filter,
- capillary dewatering system, and
- rotating-gravity concentration.

All four systems use horizontally mounted continuous belts on which the sludge is conveyed and dewatered, and all four systems appear to be designed to compete with vacuum filters. Operating complexity and energy requirements are similar. Solids capture and cake moisture content are very close to those achieved by vacuum filters.

Belt pressure filter

The belt pressure filter consists of two continuous belts set one above the other. Conditioned sludge is fed in between the two belts. Three process zones exist. First, the sludge passes through the drainage zone where dewatering is effected by the force of gravity. Then, the sludge passes into the pressure zone where pressure is applied to the sludge by means of rollers in contact with the top belt. Finally, the sludge is passed to the shear zone where shear forces are used to bring about the final dewatering.

Capillary dewatering system

In the capillary dewatering scheme, chemically conditioned sludge is distributed evenly over the screen where free water is released and the solids concentration is increased by 25 percent.

Rotating-gravity concentration

The rotating-gravity-concentration process consists of two independent cells formed by a fine-mesh nylon filter cloth.

Sludge-Drying Beds

Sludge-drying beds are used to dewater digested sludge. Sludge is placed on the beds in a 200- to 300-mm layer and allowd to dry. After drying, the sludge is removed and either disposed of in a landfill or ground for use as a fertilizer. The economical use of sludge-drying beds is generally limited to small- and medium-sized communities. For cities with populations over 20.000, consideration should be given to alternative means of sludge dewatering. In large municipalities, the initial cost, the cost of removing the sludge and replacing sand, and the large area requirements preclude the use of sludge-drying beds.

Open beds are used where adequate area is avialble and sufficiently isolated to avoid complaints caused by occasional odors. Covered beds with greenhouse types of enclosures are used where it is necessary to dewater sludge continuously throughout the year regardless of the weather, and where sufficient isolation does not exist for the installation of open beds.

Sludge-bed loadings are computed on a per capita basis or on a unit loading of kilograms of dry solids per square meter per year. With covered drying beds, more sludge drawings per year can be accommodated because of the protection from rain and snow.

Sludge dewaters by drainage through the sludge mass and supporting sand and by evaporation from the surface exposed to the air. Most of the water leaves the sludge by drainage; thus the provision of an adequate underdrainage system is essential. The sand layer should be from 230 to 300 mm deep with an allowance for some loss from cleaning operations. Deep sand layers retard the draining process. Sand should have a uniformity coefficient of not over 4.0 and an effective size of 0.3 to 0.75 mm.

Table: Typical area requirements for open sludge-drying beds

Type of sludge	Area $m^2/10^3$ persons	Sludge loading rate, kg dry solids/m^2 yr
Primary digested	90-140	120-200
Primary and humus digested	110-160	100-160
Primary and activated digested	160-275	60-100
Primary and chemically precipitated digested	185-230	100-160

Sludge can be removed from the drying bed after ist has drained and dried sufficiently to be spadable. Dried sludge has a coarse, cracked surface and is black or dark brown. The moisture content is approximately 60 percent after 10 to 15 d under favorable conditions.

Logoons

Drying lagoons may be used as a substitute for drying beds for the dewatering of digested sludge. Lagoons are not suitable for dewatering untreated sludges, limed sludges, or sludges with a high-strength supernatant because of their odor and nuisance potential. The performance of lagoons, like that of drying beds, ist affected by climate; precipitation and low temperatures inhibit dewatering. Lagoons are most applicable in areas with high evaporation rates.

Unconditioned digested sludge is discharged to the lagoon in a manner suitable to accomplish an even distribution of sludge. Sludge depths usually range from 0.75 to 1.25 m. Evaporation is the prime mechanism for dewatering. Facilities for decanting of supernatant are usually provided, and the liquid is recycled to the treatment facility. Sludge is removed mechanically, usually at a moisture content of about 70 percent. The cycle time for lagoons varies from several months to several years. Typically, sludge is pumped to the lagoon for 18 months, and then the lagoon is rested for 6 months.

TREATMENT OF RESIDUES FROM ECOLOGICALLY SENSITIVE INDUSTRIES

Dr. Hans Sutter

RESUMEN

Describe el manejo de los desechos producidos por la industria de acabado de metales, la industria metalúrgica, la industria de maquinado de metales, la industria química y la industria tenera.

Indica que las industrias que tienen mayor potencial de producción de desechos peligrosos tóxicos son: la industria de químicos orgánicos e inorgánicos, refinerías de petróleo, industria de acero y metales no ferrosos, tenerías, pinturas y recubrimientos finales, galvánica y acabado de metales.

Los productos tóxicos más comúnes en estas industrias son grasas y aceites, solventes, ácidos, sales tóxicas.

También hace referencia a que los métodos de tratamiento son fundamentalmente: reducción del volumen o concentración, neutralización, precipitación y adecuada disposición final.

INTRODUCTION

Wastes are generated by almost all branches of modern industry, but a few major groups are most likely to produce hazardous toxic wastes which require special treatment. Industries with a high potential for generating hazardous wastes are mainly: Inorganic and organic chemicals, petroleum refining, iron and stell, nonferrous metals (smelting and refining), leather tanning and finishing paint and coatings, electroplating and metal finishing.

Dr. Hans Sutter, Germany

In this paper hazardous waste management in the metal finishing industry, the chemical industry and the tanning industry will be described.

METAL FINISHING INDUSTRY

The metal finishing industry uses a large number of individual processes designed for machining and the surface treatment of metals and other materials (e.g. metalplated plastics) to protect them against corrosion, to modify their properties, or for decoration.

Some of the more important metal finishing processes are cleaning and degreasing, chemical and mechanical surface treatments, electroplating, chemical and electrolytic stripping, anodizong, galvanizing, chemical or electrochemical machining, and chemical, mechanical or electric polishing. These processes involve the use of a wide range of chemicals which may subsequently appear in liquid, sludge or solid waste arising from these operations. The industry undertakes work for a wide range of customers, typically in a large number of widely dispersed installation. It includes those "job shop" operations where materials, owned by someone else, are subjected to a wide variety of chemical, electrochemical, and mechanical processes. Similar functions are performed by "captive shops" as part of a service to a larger, parent operation. A simplified shop operation, which includes mechanical, cleaning, pickling and plating processes is shown together with the most important hazardous waste streams in Figure 1. Without pollution control regulation these liquid waste streams are normally discharged directly to waterways or disposed of on site.

Machine shops, specifically the machining, stamping, cutting, and forming shops, produce metal dust of the type of the material being worked. Oils are utilized for both cooling and lubricating. The resulting mixture of waste oils and metal dust is a hazardous waste. The waste may be essentially aqueous, contaminated with small quantities of oil, emulsified oils, nonemulsified oil mixtures or spent lubricating oils. The degree and nature of the contaminants present will depend on the use from which the oil was derived. For example, water-soluble cutting oils will contain less than 10% of mineral oils finely dispersed in water, plus such substances as emulsifiers, biocides, metal swarf, and specialist lubricating oil additives. The in-house recovery of used cutting oils, producing a clean metal swarf and oil for reuse, is possible.

Metal components are degreased using mainly halogenated solvents, either by cold or hot dipping in a solvent bath or by contact with solvent vapour. Whichever method is employed a sump residue, containing cutting oils, lubricants, fine metal particles, general dust, etc., accumulates with use. This

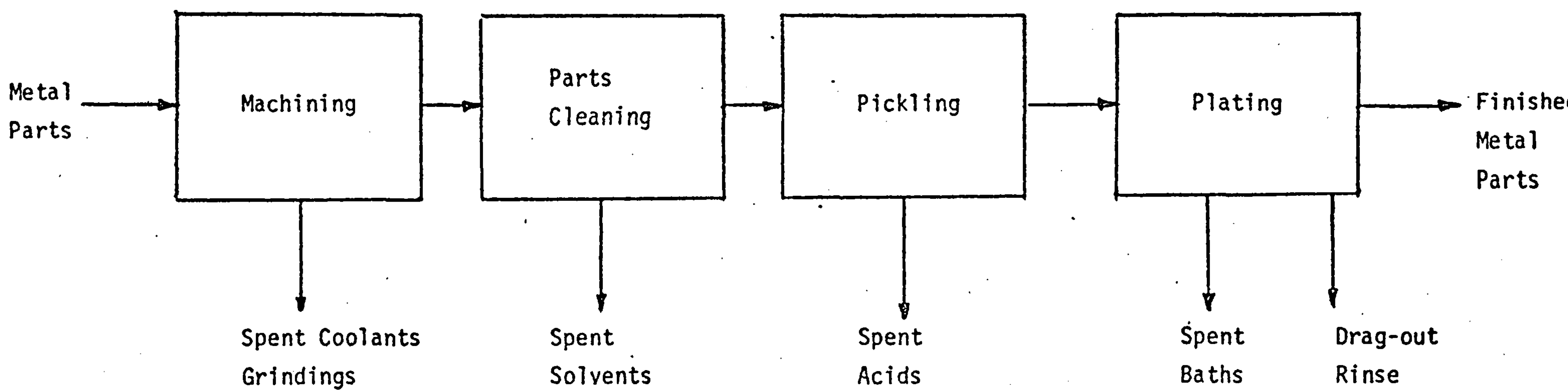


Figure 1: Simplified typical metal finishing operations and hazardous waste streams

resid e is allowed to build up until an unacceptable level of contamination is reached, and the dirty solvent then removed for disposal or recovery, or residue is continously removed by recycling through an on-line purification plant. The waste for disposal is an oily sludge containing solvent at a concentration of less than 1% in residues from the most sophisticated solvent recovery units to more than 80% where no recovery is practised. Figure 2 shows a typical solvent recovery system and the treatment of the resulting distillation sludge. The sludge is potentially hazardous because it may contain halogenated solventes, heavy metals and oils.

In metallurgical operations various acids and mixtures of acids are used for pickling, etching, anodizing, electroplating and other surface treatments of ferrous and non-ferrous metals. Typical compositions of mineral acid wastes arising from the metal treatment sector are: 8% HCl, 5% Fe, 1 to 2% dissolved Zn; or 13% nitric acid, 5% hydrofluoric acid plus dissolved nickel, chromium and iron salts. For large waste streams many processes are available for the recovery of hydrochloric acid from pickle liquors and, to a lesser extent, for sulfuric acid. Smaller waste streams are neutralized. The precipitates contain all the heavy metals of the pickling acid, and the sludges are therefore considered as hazardous and should be disposed of in a chemical landfill.

Electroplating is a series of process steps that involves the preparation of the part in addition to the plating operation. Figure 3 is a flow chart of a chromium plating operation of zinc die casting. The sequence and/or the process steps may vary from plant to plant because of the many variables involved with electroplating. The operations produce two types of waste: rinse water wastes and spent processing solutions. When an object is removed from a cleaning, treating or plating bath, it carries over a volume of plating solution into the rinse system. This dragged-out plating solution contained in the rinse water is usually one major source of pollutants in an electroplaters waste stream. The second waste stream is made up of spent procoessing solutions containing high concentration of chemicals. Both waste streams are considered potentially hazardous and need special treatment, because the contain electroplating chemicals such as cyanide, chromium, nickel, cadmium and zinc which are classified as toxic substances.

Treatment of metal finishing wastes by neutralization followed by gravity settling for separation of suspended solids - with additional treatment steps for hexavalent chromium and cyanide - has become so widely used in the metal finishing industry that it is usually reffered to as "conventional" treatment. Figure 4 is a schematic of a conventional treatment facility to electroplating wastes containing chromium and cyanides in addition to other heavy metals, acids and alkalis:

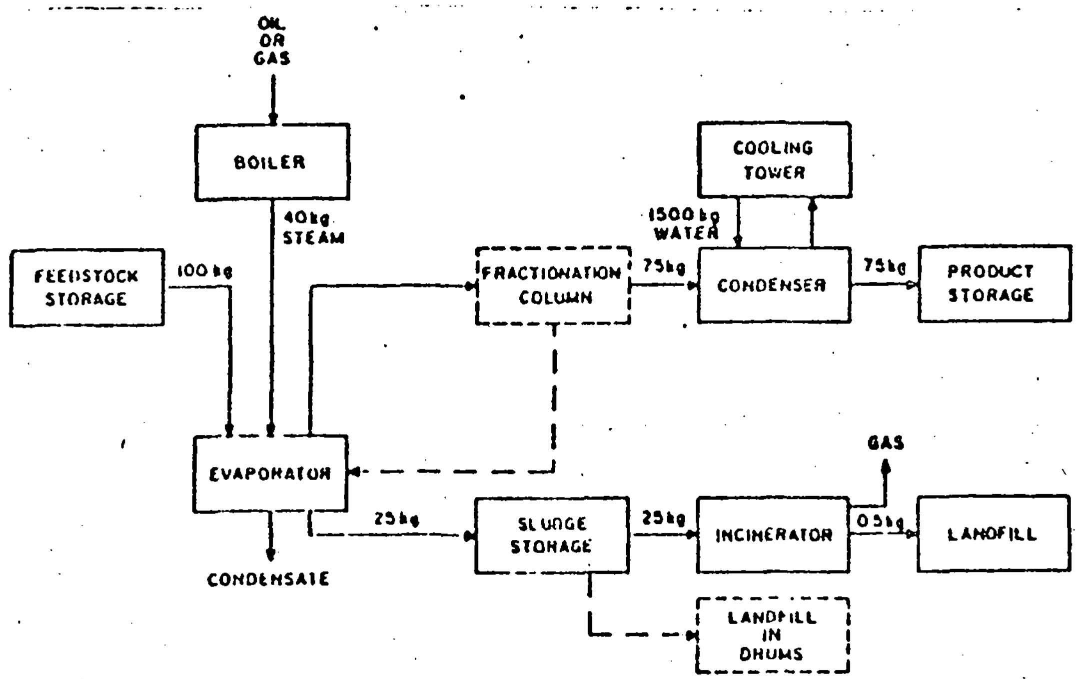


Fig. 2: Solvent Recovery System

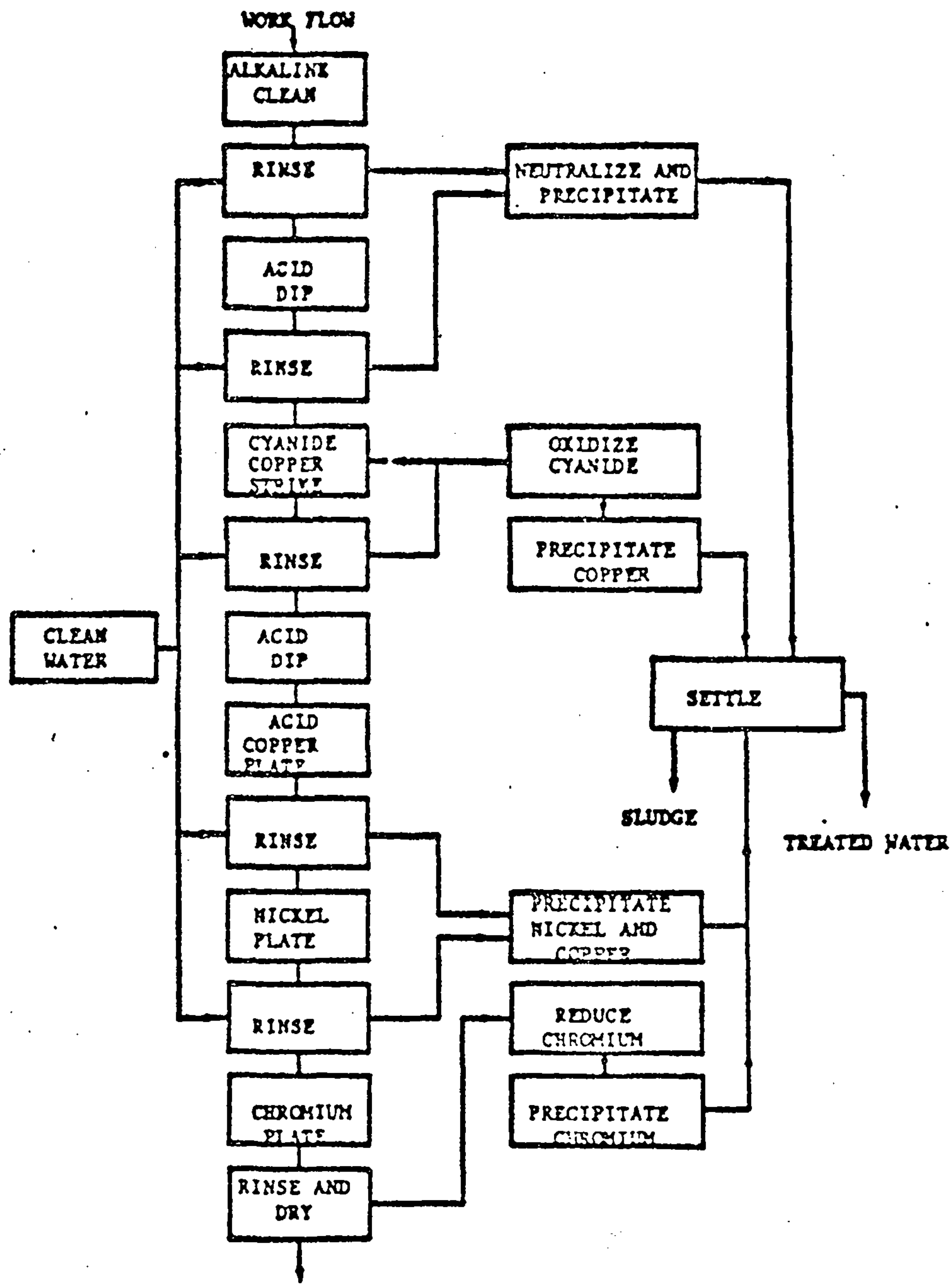


Fig. 3: Flow Chart Chromium Plating

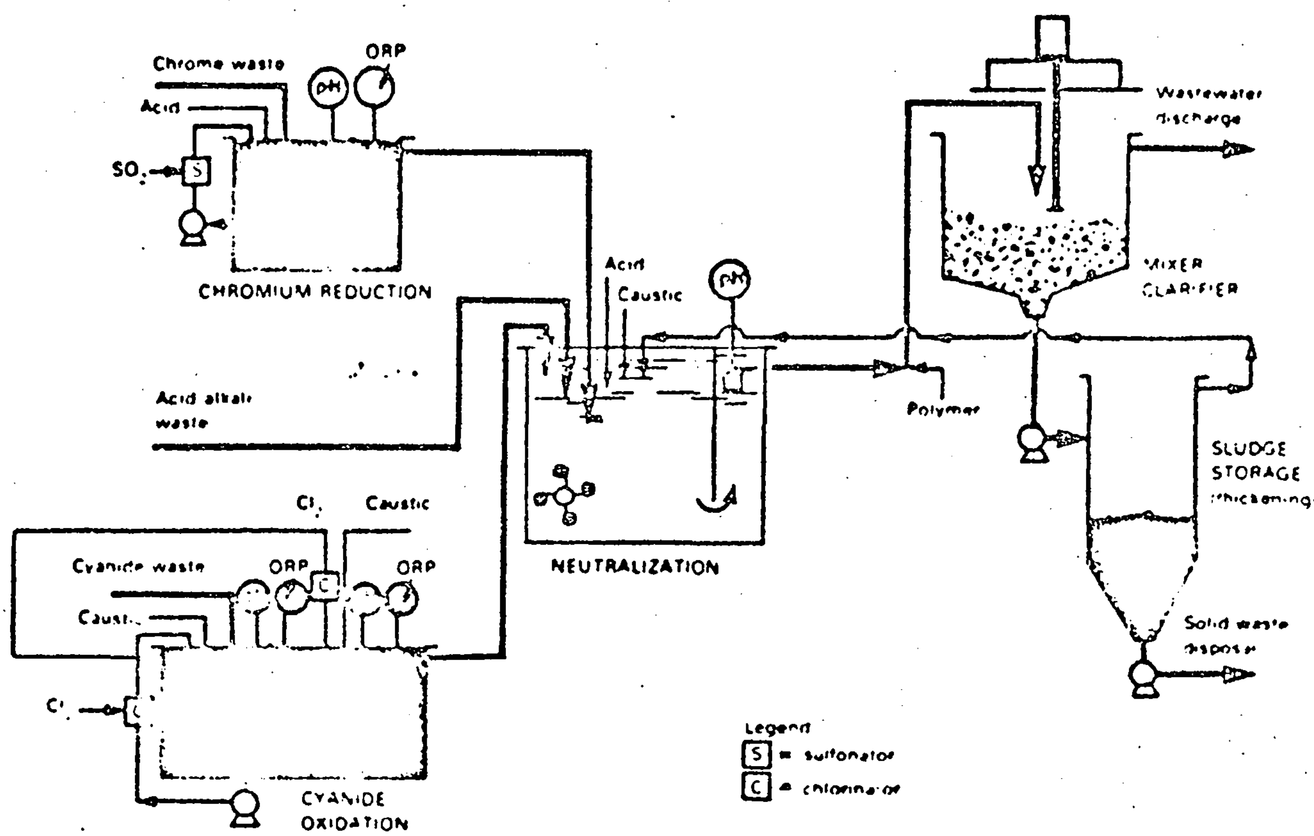


Fig. 4: Electroplating Industry (conventional Treatment)

Chromium complexes are usually present in electroplating wastewater as trivalent chromium (Cr^{+3}) or as hexavalent chromium (Cr^{+6}). Although most heavy metals are precipitated readily as insoluble hydroxides by pH adjustment in the neutralizer, hexavalent chromium first must be reduced to trivalent chromium. Reduction usually is done by reaction with gaseous sulfur dioxide (SO_2) or a solution of sodium bisulfite ($NaHSO_3$). The net reaction using sulfur dioxide is

$$3SO_2 + 2H_2CrO_4 + 3H_2O \longrightarrow$$

$$Cr_2(SO_4)_3 + 5\ H_2O$$

Because the reaction proceeds rapidly at low pH and acid is added to control the chromic acid wastewater pH between 2 and 3. Gaseous sulfur dioxide is metered continuously into the reaction tank to satisfy the reduction demand based on the concentration of hexavalent chromium.

Dilute cyanide rinse streams resulting from plating operations and cyanide dips also must be treated separately to oxidize the highly toxic cyanide first to less toxic cyanate then to harmless bicarbonates and nitrogen. The oxidation reagent is usually chlorine, which can be introduced into the system by adding chlorine gas (Cl_2) or sodium hypochlorite (NaOCl). Using chlorine, the typical reaction in the first stage is:

$$NaCN + 2\ NaOH + Cl_2 \longrightarrow$$

$$NaCNO + 2\ NaCl + H_2O$$

and in the second stage

$$2\ NaCNO + 5\ NaOH + 3\ Cl_2 \longrightarrow$$

$$6NaCl + CO_2 + N_2$$

$$+ NaHCO_3 + 2\ H_2O$$

When sodium hypochlorite is used, the typical reaction in the first stage is:

$$NaCN + NaOCl \longrightarrow NaCNO + NaCl$$

and in the second stage

$$2NaCNO + 3NaOCl + H_2O \longrightarrow 3NaCl + N_2 + 2NaHCO_3$$

The mixed acid/alkali waste streams from the various metal cleaning and plating operations are combined in the neutralizer with the effluent from the chromium reduction and cyanide oxidation steps. Because the heavy metals are soluble at low pH (acidic) conditions in the wastewater, the pH is adjusted to a range of 7,5 to 9,5. In this pH range the minimum solubility of a mixture of metals is reached and the metals precipitate as hydroxides.

Metal hydroxides and other insoluble pollutants are removed from the wastestream by gravity settling. The solid removal efficiency depends on the settling rate of suspended solids in the wastewater feed. Typically, some of these solids settle very slowly because of their small size and their slight density difference compared with the water. Because economical design of the clarifier limits the retention time in the settling chamber, some level of suspended solids will appear in the overflow.

To enhance the settling characteristics of the suspended solids, flocculating agents - such as polymers, alum, or ferrous sulfate - are added in a mixing chamber before the flocculator, in the flocculator the wastewater is agitated gently to allow the solids to coagulate. The wastewater then enters the clarifier, where the solids settle out. The solids in the underflow can be discharged to a holding tank to thickening, or they can be discharged directly to sludge disposal.

The solids from clarifier are typically discharged to sludge holding tanks at solids concentrations of 0,5 to 3 percent; overflow from the tanks is recycled to the clarifier. Usually metal hydroxide solids will concentrate to approximately 3 to 5 percent solids in these tanks if given adequate retention time. The tanks also provide adequate storage time and volume for the sludge before shipment to a disposal site.

Further concentration of the thickened sludge requires the use of mechanical dewatering equipment. Centrifuges, rotary vacuum filters, belt filters, and filter presses have been used to dewater metal hydroxide sludge.

Installation of waste treatment systems will result in the discharge of two streams: overflow from the clarifier and sludge from the clarifier or thickener/holding tank. The costs associated with these discharges will be site specific for each plant, and will depend on the availability of local disposal sites to receive the sludge and on municipal sewer costs.

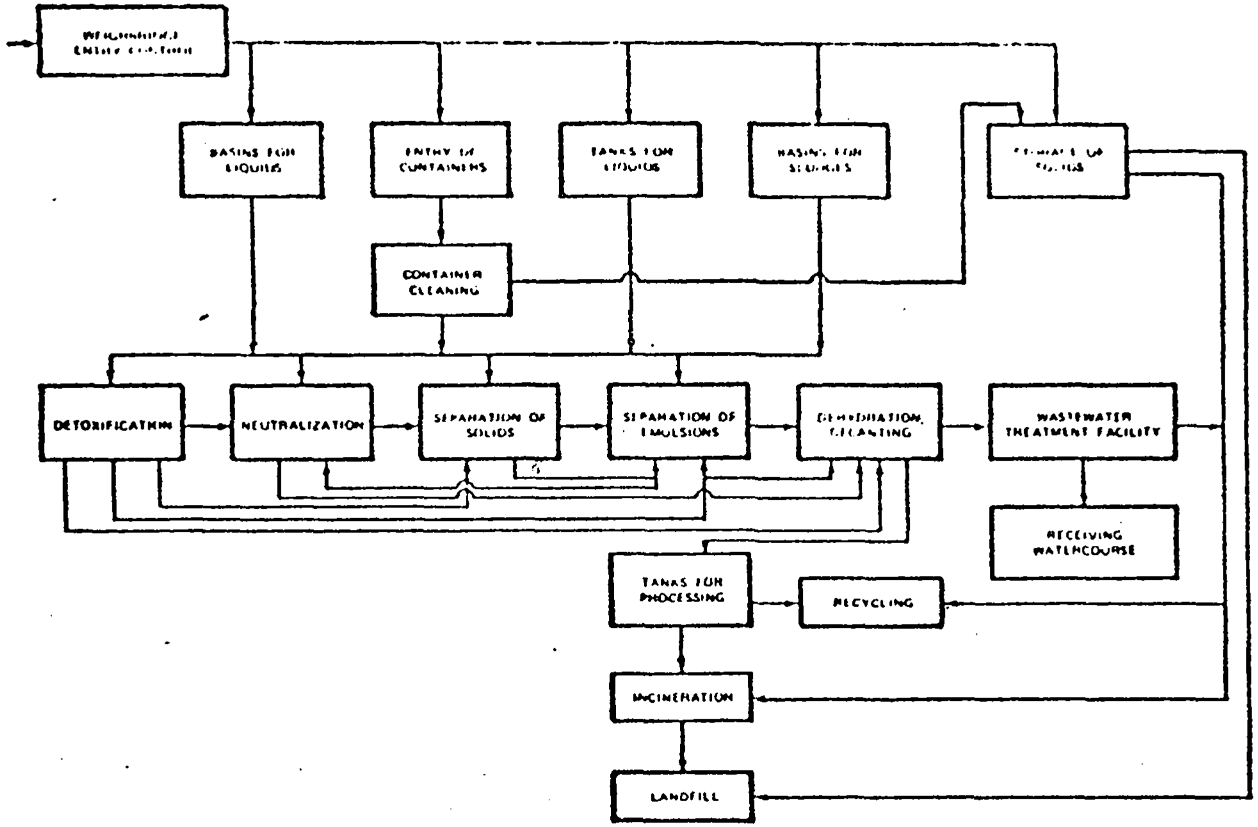


Fig. 5: Centralized Treatment Plant

The operating and investment costs for waste treatment systems in the electroplating industry depend directly on the quantity of pollutants and on the volumetric flow rate of the wastestreams. In-plant modifications to the plating baths and rinse systems can reduce wastestreams flow rates and pollutant loading and thereby can improve raw material yields and reduce pollution control costs. These methods are usually cost-effective alternatives to end-of-pipe wastestreams treatment.

The high cost of replacing and treating plating chemicals lost to the waste streams has resulted in the application of various separation processes to recalim these materials for reuse. These processes all operate on the same basic principle: they concentrate the dragged-out plating solution contained in the rinse water to the degree that the solution can be returned to the plating bath.

Recovery processes include evaporation, reverse osmosis, ion exchange, and, most recently, electrodialysis. Their use can result in an essentially closed system around a plating bath, no plating chemicals are consumed other than those plated on the ware, and no rinse water is sent to waste treatment. Except in the case of purge streams from the recovery unit, under very favorable conditions a recovery system can achieve zero effluent discharge.

Smaller firms usually do not have sufficient resources of their own to properly dispose of their wastes at reasonable cost. For the small and medium-sized firms, therefore, solution must be found at a level above that of the individual firms. The major advantage of centralized waste treatment is that the investment required and the operating cost for a single large facility is much less than that associated with installing a treatment plant at each company. In the Federal Republic of Germany, for example, all the above mentioned wastestreams from small firms are treated off-site in centralized plants (Fig. 5).

TANNING INDUSTRY

Hides may be tanned by the use of chromium salt or vegetable tannin, respectively, or by both. In the present paper, reference is made to the chrome tanning process. The process is illustrated in Fig. 6 The cycle produces a great variety of liquid and solid wastes, including the semi-solid wastes (sludges) which are generated in the wastewater treatment processes.

The hides (which arrive at the tannery salted so as to avoid any rotting phenomena which would inevitably start due to long periods of stocking and transport) first undergo soaking treatment. Any organic residues

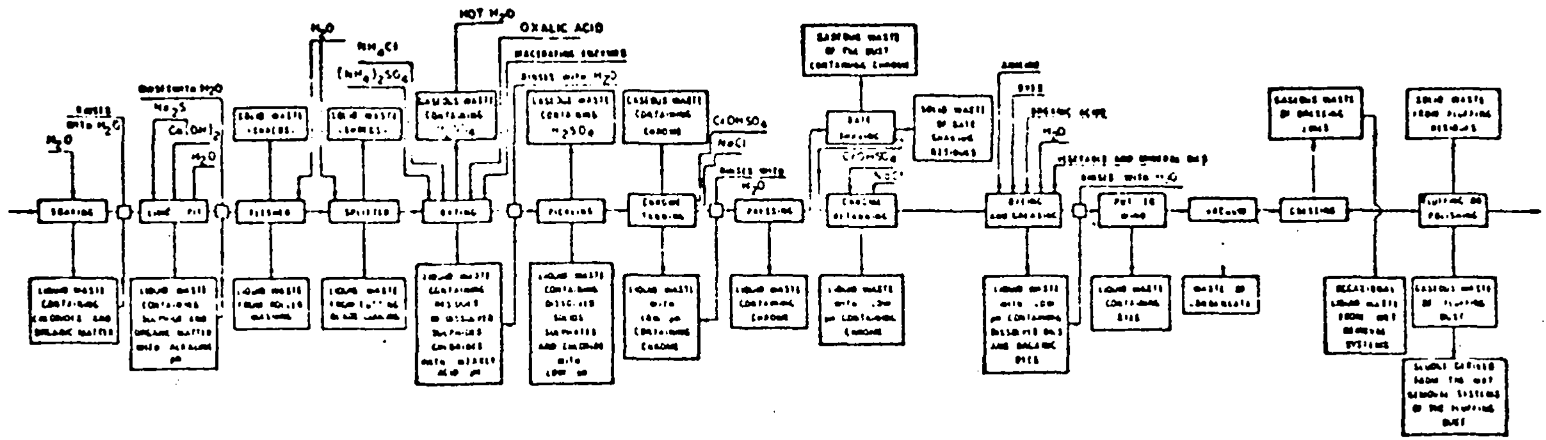


Fig. 6: Tanning Process and Wastes Produced

(faeces) which were still on them are also dissolved in the water, which is then discharged at the end of the operation from the opening of the drum.

Liming, which is the process following soaking, is then carried out to separate the upper layer of the hide and the hairs sticking to it from the lower layer. To this end mainly clacium hydroxide ($Ca(OH)_2$) (from which the process takes its name) and sodium sulphide (Na_2S) are used.

After liming, the hides are washed repeatedly to eliminate excess reagents. After depilation the mechanical operations of fleshing and splitting are usually carried out. During the fleshing process the pieces of flesh still sticking to the hides (shreds) are removed and separated as solid waste. Splitting consists in separating the highest quality part of the hide (grain) from its lower layer (split). Together with the grain and split, a fleshy pulp is also separated, similar to the shreds.

After splitting (which is not carried out on all hides), the bating operation takes place. The hides are put in drums and lactic acid is added to remove the lime residue together with enzymes to remove albumin and fatty residues. Then the hides are rinsed.

After bating, pickling usually takes place. The hides are put in drums and salt, sodium formate (HCOONa) and sulphuric acid (H_2SO_4) are added. In this way the action of the enzymes is interrupted and the hide is prepared for penetration of the tanning agent.

During the tanning operation trivalent chromium is added, and reacting with the protein chains of the hide it confers the softness necessary for products used to make clothing. Basic chromic sulphate containing 25-30% of chromic oxide (Cr_2O_3) equal to 8-10% of the weight of the hide is added. The hides are then rinsed so as to get rid of the excess residues of the tanning substances.

After drying, the hides undergo mechanical shaving which brings the hide to the required thinness. Shaving produces a solid waste made of small pieces containing the tanning agent from the previous phases which can amount the one-third of the weight of the dry hides at the beginning of the process.

After shaving, the hides undergo dyeing and stuffing. Dyeing is usually done with dyes containing aniline and organic acids. Stuffing is done with mineral or vegetable oils.

TABLE 1

Characteristics of soaking, bating, pickling and dyeing effluents

Characteristics	Soaking	Bating	Pickling	Dyeing
pH	7	7	4	4
Sedimentable solids (ml l^{-1})	10	12	2	—
Suspended solids (mg l^{-1})	4000	1200	500	100
Chlorides (mg l^{-1})	15,000	—	1000	—
Sulphides (mg l^{-1})	–	50-100	—	—
COD (mg l^{-1})	6000	5000	1000	700

* Barducci *et al.* (1982).

TABLE 2

Characteristics of exhausted lime pit baths

pH	12.6	12
BOD (ppm)	4991	—
COD (ppm)	—	12,000
Total solids (ppm)	52,430	—
Organic substances (ppm)	9460	—
Mineral substances (ppm)	42,970	—
Suspended solids (ppm)	17,270	6500
Dissolved solids (ppm)	35,160	—
Lime (such as Ca) (ppm)	6860	—
Sulphides, S^{2-} (ppm)	1875	1640
Total nitrogen (ppm)	2182	—

TABLE 3

Characteristis of chrome tanning wastes

	1	2	3	4	5	6
Total solids (ppm)	—	93,000	95,900	76,800	100,889	70,446
Mineral substances (ppm)	—	80,000	77,180	—	81,838	54,073
Organic substances (ppm)	—	13,000	18,720	—	19,051	16,373
Suspended solids (ppm)	7000	—	460	1990	1503	1610
Dissolved solids (ppm)	—	—	95,440	74,810	99,386	68,836
Total nitrogen (ppm)	—	—	—	—	—	1628
pH	3.7–4	—	—	3.2	3.7	3.5
BOD (ppm)	—	—	280	618	1330	—
COD (ppm)	10,000	—	—	—	—	—
Chrome (Cr_2O_3)	15,000	—	—	—	—	—

The hides then undergo dressing which generally includes a first hot air drying, spraying with reagents containing aniline and formalin, and a second hot air drying. Lastly, the hides undergo fluffing or, alternatively, polishing.

As regards the importance of the effluents, the lime pit and tanning effluents are predominant, both for the degree of pollution (organic or non-organic) and for the potential recovery. Tables 1-3 show the qualitative characteristics of the different effluents. By far the most important solid by-products are the shreds derived from the fleshing and splitting operations which consist of fatty material. The residues of shaving and fluffing are also important, although quantitatively not so great as the shreds. As already mentioned, the wastewater treatment sludges must also de included among the semi-solid residues. They can generally be found in three different forms.

(1) Primary sludge due to the decantation of the effluent when there is a chemical physical biological centralized treatment plant.

(2) Chemical sludge from clariflocculation of the effluent with lime and ferrous sulphate.

(3) Biological sludge, derived from the classical activated sludge treatment which is usually carried out after the primary and/or chemical-physical stage.

In the field of tanning treatments, the possibility of recovering raw materials and energy from by-products of the processes is considered with interest. Together with recovery operations which for some years now have been carried out in various industries, recently many experimental initiatives have developed which announce new industrial applications of recovery. The present and potential recovery possibilities are summarized below.

(a) Sodium sulphide recovery from exhausted lime pit baths: this is carried out by means of decantation, centrifugation or ultrafiltration; the latter seems to be the most interesting and allows recovery percentages higher than 80% of Na_2S.

(b) Chromium recovery from exhausted tanning baths: this is carried out by precipitating the chromium as its hydroxide at a high pH, dehydrating the slime obtained and then re-acidifying the solid cake with H_2SO_4. At the experimental level the method of dry tanning (which allows saving of 20-30% on the chromium consumption with respect to the traditional tanning) is worth mentioning.

(c) Energy recovery from sludge digestion: in this case a very traditional technology is applied to the sludges, both primary (free from chromium) and biological, with production of biogas which can be compared to that obtained with domestic sludges. Digestion of the above-mentioned sludges mixed with previously ground shreds is also of interest.

(d) Recovery of valuable products starting from the solid wastes of the processes: in particular it is possible to produce from the shreds edible and technical gelatines, products which find a very profitable market.

(e) Solid wastes and sludges which contain chromium should be deposited at a chemical landfill.

CHEMICAL INDUSTRY

Approximately 20 000 - 30 000 chemicals are currently manufactured worldwide in quantities exceeding one ton per year. A few examples of manufacturing processess will illustrate the large volume and variety of hazardous wastes that result.

Primary organic chemicals are produced from oil, natural gas, and coal in large-scale continuous-process plants. They are in turn converted into secondary or intermediate materials either for in-house processing, sale to chemical processors, or for various industrial applications. Intermediate materials are processed into a wide variety of final products, e.g. fine chemicals, pharmaceuticals, pesticides, plastics, resins, dyestuffs, synthetic detergents, synthetic fibers, elastomers, and many others. The production processes are based on specified feedstock and standard plant condition, thus generating residues of fairly constant composition and properties. Residues also may be extremely complex materials, however with the detailed composition not always known. Residues may be liquids, sludges, or solid tarry wastes.

Processing of organic chemicals into end-products involves both batch and continuous processes. In batch processing, residues often are complex mixtures which may contain unreacted feedstock, filtercakes, precipitated materials, tars, solvents, acids, or alkalies used in the washing process, as well as off-specification products, spent catalysts, contaminated filter aids, and contaminated containers. Residues may be liquids, sludges, and solids of varying physical or chemical complexity. The substances present may be soluble or insoluble, inert, corrosive, flamable, chemically reactive, or toxic, and may contain human carcinogens.

Inorganic chemical products, including sulfuric, phosphoric and butric acids, chlorine, sodium hydroxide, lime, ammonia, and many others, account for 9 out of 10 major products of the chemical industry worldwide. Manufacture of many of these inorganic products generate large volumes of hazardous waste. For example, more than 100 million tons of phosphate rock are mined worldwide annually for production of phosphorus, phosphoric acid, and phosphates. Up to 13 tons of by-products result from each ton of phosphorus produced; these include calcium silicate slag, which may be used as a concrete aggregate or hard core; ferrophosphorus, which may be used as an additive to steel; phosphorus mud, which may be recycled; precipitator dust; and condenser gas.

TECHNICAL, ECONOMICAL AND LEGISLATIVE PROSPECTS AND LIMITATIONS OF SOLID WASTE MANAGEMENT

Bernd Wolbeck and Jürgen Orlich

RESUMEN

Enumera los objetivos de una política de manejo de desechos orientada a la conservación de los recursos y a la protección del ambiente:

- Reducir la producción de desechos comunes y de desechos peligrosos.
- Necesidad de instalar plantas de disposición de desechos en los países en desarrollo.
- Uso de materiales sustitutos.
- Reciclado de materiales y recuperación de energía incorporada en los productos.

Indica medidas que deben adoptar las autoridades para una política de manejo de desechos. Explica cuatro factores dignos de atención en el reciclado. Señala algunos problemas: la información entre sectores interesados; uso de materiales secundarios; diseño de los productos para facilitar su reciclado; problemas políticos.

INTRODUCTION

The problem of waste management in principle affects nearly all fields of economic activity. Waste materials accur as residuals, by-products, or end products in the production, distribution, or consumption of commodities. To the extent that appropriate materials are being fed back into the production-consumption cycle for economic reasons - which is being done today to a high degree - they do not represent a central problem of public concern either in view of the protection of the environment or under economic aspects. Increased attention in technical and policy discussions is, rather, focused on that part of materials to which no economic value is attributed for the time being and which, therefore, has to be disposed of as "waste".

Dr. Bernd Wolbeck and Dr. Jürgen Orlich, Germany

A waste management policy will not meet the actual problem requirements if it confines itself solely to the aspects of recycling or final disposal. Indeed, the relevant consideration should include all those processes that have a bearing on the generation, utilization, and disposal of primary and secondary materials. Only if this comprehensive approach to the problem is made it will be possible to avoid inadequate coordination of individual measures, the occurrence of undesirable problem shifting, as well as economic misallocations of public and private initiatives (e.g. investments).

AIMS

With regard to the twin objectives "resources conservation" and "protection of the environment", the policy for waste managements is directed at the following aims:

(1) reduction of no longer utilizable materials (wastes) at the production and consumer levels by reducing wastes generated in the production process, applying environmentally sound production techniques (reduction of air and water pollution), extending the life of products, and increasing the re-use of products;

(2) substitution of scarce for less scarce raw materials in the production process (while retaining the purpose for which the product is to be used);

(3) increased utilization of wastes by recycling during the production process (recovery of materials), recovery of the energy content of wastes and feedback into biological cycles; and

(4) environmentally sound disposal of wastes.

These objectives are not to be regarded as separate and isolated tasks. Rather they should be tackled in a joint approach, taking into account the materials concerned. Thus, for example, increased recycling of wastes does not replace efforts made in the direction of a direct saving of raw material but only complements such efforts for reasons of raw material management and environmental policy.

The direct reduction of consumption of materials by producers and consumers must be considered as the most urgent challenge both on a medium and long-term basis. The following conclusion is valid: curtailment of absolute consumption and appropriate application of raw-material-saving technologies have a much more positive effect on the conservation of raw material resources than recycling.

Disposal, in turn, often provides an economically and ecologically reasonable solution of the problem in those cases where appropriate materials, being "dispersed" in terms of time and location or having been put to multiple uses, occur as a mixture of most varied substances and materials.

WASTE REDUCTION AND AVOIDING OF WASTE GENERATION

In all solid waste management programms avoiding of waste generation has got first priority. But on the consumer level in developing countries this challange is just an empty political phrase with no conection to the reality. By analysing the composition of domestic waste one easily can find out that nearly no component can be avoided by the consumer. The only way to reduce the amount of domestic waste is the reduction of the consumption itself, which already is on a very low level. Even the waste from residential areas is uninteresting because of its small amount.

The same is true for recycling of household waste. In most cases a further waste reduction by recycling is impossible. Nearly all valuable materials are already separated at the site and go to recycling processes.

The situation is different with industrial wastes and here specially with hazardous wastes.

A particular threat to the environment is caused by hazardous industrial wastes, with their high concentrations of pollutants. Methods needed for a proper treatment and monitoring are either insufficiently available or inadequatly applied. Moreover, this situation is influenced by more stringent laws on air and water pollution control, which inevitably result in new accumulations of pollutants.

Taking these effects into account it must be emphasized that the hazardous waste disposal problem will be a continuous and, probably in the future, even more challenging problem from the environmental point of view. This holds in particular true for developing countries on their way to an industrialized society.

This challenge requires that the environmentally necessary treatment and disposal plants for the hazardous residues/wastes have to be established on priority basis. Moreover, intensive efforts have to be made that the quantities of hazardous residues and wastes no longer utilized should be reduced or at least should not be allowed to increase without effective control.

In parallel, the necessary regulatory framework for disposal has to be developed. This means above all that the flow of wastes from the generator to final disposal has to be controlled and that disposal facilities have to be licensed before they accept wastes.

ASPECTS RELATING TO RAW MATERIALS

Thr recycling of wastes or sencodary materials is gaining importance with a view to the supply of raw materials. For the time being, this development is due to an increase in the prices of raw materials largely contingent upon political factors and increasing costs for exploitation rather than to an elementary scarcity of raw materials.

Already the use of secondary raw materials is of very great importance. In the Federal Republic of Germany, for example, statistics show that production residuals at a rate of up to 80 percent are being partly utilized by the plastics industry, while paper mills are using waste paper at an average rate of about 43 percent. In the case of lead and copper, approximately 45 percent of the demand is covered by scrap.

Not only because of the worldwide interdependence in the economic field, a policy relating to the utilization of secondary materials should be carefully oriented toward the initial situation in regard to supply with primary raw materials. According to the rules of supply and demand, international conditions of the primary raw materials secotr also influence the markets for secondary raw materials. Despite this influence, however, it is to be noted that the policty concerning waste materials is much more nationally oriented than is the case for primary raw materials. An important political element should be seen in the high degree of national independence regarding the secondary raw materials policy - that is, self-sufficiency.

ENERGY ASPECTS

The "recycling of wastes" is nearly always linked to the question of energy balance. This effect, which is directly apparent for energy recovery from wastes, likewise applies to the recovery of materials.

Comparison between energy use for the extraction and processing of primary raw materials, and energy use connected with appropriate processing of wastes, provides an important criterion in assessing the value of recycling. Considering that energy use and its adverse effects on the environment (e.g., air pollution) are correlated factors, it is also possible simultaneously to make an ecologic assessment in addition to the economic evaluation.

Energy consuption and residue generation in processing materials is dependent on the "state of dispersion" of the system under consideration.

For instance, it decreases to the extent to which the purity and concentration of raw material resources or the homogeneity of the waste increase. Studies undertaken in the field of recycling often reveal a trend in the direction of energy conservation as compared with the use of virgin raw materials, including exploitation. Reference may here be made, by way of example, of corresponding comparison in respect to aluminium, copper, scrap steel, glass, or paper. In some cases the differences are considerable, up to factor 10. On the other hand, energy consumption may also constitute a limiting factor for recycling. For example, if one considers the processing of highly mixed wastes with low concentration of valuable materials.

BASIC PRINCIPLES

In the framework of the private market economy system, economic processes such as those taking place in the field of secondary materials management are in first place subject to decision of producers, distributors, and consumers. In the light of this principle, governments and public authorities have to concentrate on supporting measures and the provision of guiding principles and information in order to direct the efforts of these groups toward the politically desired objectives. It must not be forgotten: Waste management is to constitute an integrated partial domain of the economic system as a whole.

As far as support by the State is concerned, the following-priority measures will be necessary:

(1) improvement of statistics as well as development of forecasting models;

(2) education of producers and consumers;

(3) promotion of the basic and further training of specialized manpower;

(4) promotion of research and development project as well as demonstration plants;

(5) improvement of conditions for the marketing of secondary materials by eliminating discriminatory policies with regard to recycling products and by establishing quality criteria;

(6) financial aid in particular cases (i.e., tax rëleases);

(7) improvement of the organization of waste management;

(8) further development of legislation on waste management (e.g., separate collection of materials, prohibition of certain production techniques, control of waste streams, lecensing and surveillance of disposal facilities).

SOME FACTS

At least four basic "facts of life" must be considered in the economic analysis of recycling - all of which merit explicit mention. First, the value of any raw material, primary or secondary, is a function of a number of factors. The important characteristics which affect the value of a raw material are location, quantity, and quality. Large mass of high quality (i.e., high concentration) close to the locus of production and/or market are desired characteristics. This is as true for a secondary material as it is for a virgin raw material. A high-grade iron ore in comparison to a low-grade iron ore is similar to the comparison of high-grade used newspapers with low-grade used newspapers. The quantity and quality affect the cost of processing and the quantity of residuals generated in that processing and hence the residuals management costs associated therewith. There is likely to be a wider variety of contaminants or nonusable materials in secondary materials than in many virgin materials. In some cases these contaminants, while small in quantity may be difficult to remove and thus increase the cost of processing for use.

From the first fact of life follows the second, and obvious fact. The extent of use waste materials (and the extent of recycling) in both national and international contexts, is a function of the relative prices of the alternative materials as factor inputs into economic activities. Relative prices are affected by a number of factors and, in addition, by such governmental policies as depletion allowances, expensing provisions, severance taxes, and capital gains tax provisions on virgin materials, tax credits for using secondary materials.

Third, there are economics of scale in materials/energy recovery and by-product production, just as in basic production processes.

Fourth, because all of the factors affecting relative prices of secondary and primary materials are dynamic the extent of recycling changes with time, in both the short run and in the long run. In the short run, there is some flexibility, both in individual plants in an industry and for the given installed technological mix in an industry as a whole, to use different proportions of secondary and virgin materials. In the longer run this flexibility can shift, as old capacity is retired and new capacity is added - with the mix of new capacity based on estimated relative prices of secondary and virgin materials.

PROBLEMS

Information and Distribution

The collection, and provision of relevant information on wastes are essential prerequisits for any systematic planning of recycling and disposal.

As regards the establishment and further development of relations between producers, users and disposers of such materials, adequate knowledge of the type, quantity, and place of production of the materials and the factors influencing their generation is of utmost importance, together with possibilities for their use and marketing. Information of this kinds can be made available, for example, in the form of periodic publications such as "waste exchange", through the medium of circulars and meetings of specialized associations, by advanced training courses or by the establishment of information systems with inquiry facilities.

Practical solutions regarding the use of secondary materials require much more detailed information than those relating to disposal. Apart from technical data, organizational and economic issues are of equal interest, the latter frequently being sensitive to regional and even local needs. With rising demands on the substance of the information, the difficulties in making the information available increase. Often adequate knowledge in the composition of wastes, for example, does not exist even at the factory level, where these wastes are generated.

Moreover, available information is often retained for reasons of economic competition or for fear of public reaction - for example, in the case of waste with harmful effects on the environment. Among other efforts, improved training and advice will be needed, as well as more open-mindedness and closer cooperation within the sectors of economy concerned.

The distribution of waste materials in terms of location and time is a decisive factor in determining the economic efficiency of recycling outside the plant. As a consequence of this distribution, the transport routes in particular have repercussions on cost and sufficient utilization of capacity of recycling and disposal plants. Where the sources of secondary materials are scattered, as in the case of metal surface tretament or consumer wastes, new possibilities of recycling often can only be put into practice if the multiplex interests of individual plants are coordinated so as to achieve what may be called "recycling in a combined system". Increased recycling more and more for giving up a philosophy based on the concerns of individual plants.

Collection of secondary materials - the rate of secondary materials in the production process

Even in discussions among experts, the impression is often given that increased recycling of secondary materials primarily depends on the raising of collection and reprocessing rates - that is, the degree to which such materials are separately collected or sorted for onward processing. Not neglecting the importance of this factor, it must be emphasized that this view does not meet the real problems. The most important factor for recycling is the rate of utilization of secondary materials in the production of appropriate products. Recycling is predominantly a problem of materials related to the amount of raw materials used - is determined by the manufacturing technology, product design, and price situation. This dependence shows little variability, at least in the short-term range. Recycling of secondary materials is closely linked to the total production. Consequently, for example, changes in the demand for steel mostly entail an analogous response on the scrap market; a decline in the consumption of paper generally results in a corresponding decrease in the demand for waste paper.

Tanking into account that product design and product requirements are connected, expanded utilization of secondary materials will decisively depend on the following three conditions:

(1) development of new production techniques;

(2) development of new products and marketing potentials; and

(3) change of requirements on products, frequently in the sense of reducing certain quality requirements.

This dependence makes evident that research and development have to be considered as focal tasks in the field of waste management.

Whereas the development of new production techniques or products in many casesis a long-term objective, the reduction of certain quality requirements can be achieved at relatively short notice. Products with and without waste content are frequently offered together on the market and are often designed to be for same purpose.

Recycling design

Recycling design is concentrating on the following tasks:

(1) designing of products with a view to facilitating their recycling after use, and

(2) designing and developing new products with the aim of increasing the portion of secondary materials (prior to use) in the products.

Both tasks tend to raise - as the determining factor for recycling - the rate of utilization of secondary materials in the production process which is depending on technical and economic requirements.

"Recycling design" is subject to a very different set of factors and questions. For example, new developments in the field of research are playing an important role, as do consumer attitudes. On the basis of a considerable know-how already available, it will be necessary, not only to promote new means of recycling by adequate product design, but also to recall former patterns that are no longer used. In this connection, there is no need to emphasize that there exists a high degree of dependence on the type of material under consideration.

In view of the readjustments which are aimed at in the field of secondary raw materials management, the systematic treatment of the set of questions connected with "recycling design" must be regarded as an important task. Only in this way will it be possible to render things transparent for decision makers, not least in the political sphere. Of particular importance is the demand for binding or recognized assessment and quality criteria for the economic and environmental "usefulness" of recycling. Their quantification is of special necessity if the instrument of cost-benefit analysis is to be usefully applied in this field. Recycling is not an end in itself but must be economically and ecologically defensible.

Political aspects

Developments and needs in the field of waste management are not only subject to purely technical aspects. On the contrary, a strong influence on the part of political parameters is making itself felt to a decisive extent.

Economic growth, with the ensuing increase in production and consumption, will remain an indispensable political element in the near future. Recent experience with economic recession has made this quite obvious. The demand for conservation of resources must be and related to this fact. Employment policies, international trade relations agreements, as well as technical and economic adjustment process - to mention only a few factors - make it politically difficult to enforce any radical short - term changes in production and consumption structures. The compromise between short-term economic policy and long-term safeguarding of resources is not yet defined as clearly as is frequently supposed and implied in statements on public policy. In this context more efforts are needed on a worldwide basis. One should keep in mind: What we fail to do today can cost us dearly tomorrow.

Concluding comment

Waste Management and in particular recycling cannot be analyzed adequately, nor rational policies with respect to it developed without a clear understanding of the multiplicity of factors that affect the issue as they relate to different materials/energy and to different economic activities. It is particularly important to recognize that:

(1) policies not specifically directed toward recycling can have important effects on recycling such as tax and "pollution control" policies; and that

(2) changes in input prices, such as energy and services can have major impacts on waste management.

The impacts can induce more or less recycling, or can make recycling more or less physically and economically feasible. In turn, the necessity for disposal may increase or decrease.

For example, the increase in price of crude petroleum, and the concomitant increase in price of lubricating oil, has stimulated a substantial increase in recovery and re-use of used lubricating oil from industrial sources. The increased price of lubricating oil for vehicles, coupled with the increased price of lubrication in service stations and garages, has stimulated increased "do-it-yourself" oil changes by vehicle owners in many countries.

That practice disperses the generation of used oil and makes recycling more difficult.

LA PROTECCION AMBIENTAL Y EL MANEJO DE LOS DESECHOS SOLIDOS

Tomás Prieto Pérez

SUMMARY

This paper gives a brief account of the increasing deterioration by the irrational exploitation of nature by man. The advances of the technological age have been obtained at a great cost in terms of environmental contamination and ecological damage. Now most countries are aware of these problems.

The developing countries are still less prone to environmental contamination by huge industrial complexes. But, on the other hand, their lack of adequate systems for solid waste problems is an ever-increasing cause of concern and poses considerable health hazards.

This paper describes also the means available in Central America for disposal of solid wastes. Some recommendations for improving the situation are given and presents quantitative data on contamination by metals.

The author suggest that a coherent and well coordinated programme for environmental protection could produce excellent results with a minimum of effort.

La influiencia del hombre sobre el equilibrio ecológico de su aparición sobre la tierra ha supuesto una regresión de los sistemas naturales, en relación con el estado que se podría suponer más probable si la especie humana no hubiera existido.

Lic. Tomás Prieto Pérez, ICAITI.

En menos de 200 años las naciones colonizadoras europeas practicaron en muchos puntos una verdadera política de "tierra quemada" sin valorar lo más mínimo las consecuencias ecológicas y sociales de sus actos; lo que interesaba eran los primeros resultados, los más palpables.

Más tarde, con la revolución industrial, se introduce el uso de máquinas herramientas accionadas por combustibles sólidos o líquidos. Los efectos de la combustión de dichos productos empezaron a ejercer sus efectos sobre la biosfera. Asímismo , al aumentar la producción humana de materiales, las consecuencias del no reciclaje se harían cada vez más patentes en la naturaleza; a todo ésto hay que añadir los efectos del fenómeno urbano.

Con lo anterior tenemos reunidas las condiciones del medio históricas y que determinarán la creciente contaminación del medio ambiente, derivada de las diferentes formas de consumo de energía, de multiplicación del volumen materiales y de una organización del espacio que no respetan las leyes ecológicas a las que la sociedad humana está sujeta.

El mejoramiento en las condiciones de la vida y las mayores demandas concernientes a la higiene han colocado el problema de los desechos entre los íntimamente relacionados con los del medio ambiente.

La acumulación de desperdicios domésticos e industriales constituye hoy día un problema agobiante. El aumento de la población al ritmo actual, con la consiguiente demanda de bienes de consumo duplicará los desechos sólidos en los 20 años que siguen. Por tal razón debe promoverse una remoción adecuada de estos desechos implementando los ya existentes sistemas de recolección y transporte. Deben encontrarse nuevos lugares céntricos para depositar o se deben establecer plantas de tratamiento incluyendo en este programa a los pueblos más grandes de las áreas rurales.

Si consideramos la situación real de nuestra región, la recolección de los desechos se hace únicamente en las grandes o medianas ciudades. En las ciudades pequeñas y en los pueblos no existe una recolección regular de los desechos domésticos; el manejo de los mismos es simplicísimo: Se arrojan a la calle. La consecuencia inmediata es una mala situación higiénica.

Como puede apreciarse, la eliminación de los residuos domésticos e industriales en los países del Area Centroamericana plantea graves problemas. El método generalmente más empleado para eliminar los re siduos sólidos es su amontonamiento al aire libre. Además de sus características antiestéticas ello puede plantear graves problemas de orden higiénico. Amén de las molestias que ocasionan y de la destrucción del paisaje, atraen ratas, insectos y otros vectores de enfermedades; los vertederos de basuras, además, cuando llueve, contribuyen a contaminar las aguas superficiales y subterráneas, en particular si se hallan situados en terrenos permeables.

Sabemos que en nuestros países tenemos otros problemas quizás más urgentes, pero con la prosperidad y los progresos que tarde o temprano vendrán estos países deben encarar los inevitables problemas ambientales como lo hacen actualmente los países industrializados y no deben cometer los mismos errores que éstos cometieron; se debe aprender de las equivocaciones de los demás.

Sólo cuando los graves perjuicios ambientales conmovieron la opinión pública mundial (catástrofe de Smog en Londres 1952; la enfermedad de Itai-Itai en Japón; la contaminación petrolera de las aguas del mar y de las costas a raiz de accidentes de buques-tanques, la muerte de peces en ríos contaminados por los desagües de la Industria Química, etc.), sólo entonces la opinión pública tuvo cada vez más conciencia de lo valioso y cuán facilmente destrozable es el don de un medio ambiente natural, múltiple y sano.

A través de accidentes ambientales, que a causa de su magnitud despertaron el interés mundial, las personas vieron claramente que el equilibrio que domina en la naturaleza corría el riesgo de desaparecer y que el medio ambiente antropógeno se había transformado en un sistema sumamente inestable que muy facilmente podría entrar en colapso.

Para mejorar la mala situación en que se encuentra la disposición y manejo de los desechos sólidos en nuestros países y así contribuir a mejorar el medio se pueden tomar en consideración algunos hechos fundamentales:

- La implementación del sistema de recolección y transporte. Hacerlo en forma barata ya que la mayoría de los habitantes de la ciudad o pueblo no son capaces de financiar por sí mismos el manejo y disposición de los desechos.

- No se necesita para estos países una alta tecnología para recolección y transporte que quizás sería deficiente por falta de repuestos mecánicos. Además existe un gran número de personas que ofrecen sus servicios baratos y a los que se les puede dar suficiente dinero para que cubran sus necesidades mínimas vitales.

- Deben darse facilidades para recuperar lo máximo que se pueda de los materiales desechados.

- Debe encontrarse facilidades baratas para reciclar la materia orgánica, haciendo compost, del que hablaré más adelante, que en muchos países en desarrollo puede ser un excelente acondicionador de suelos.

- Cuanto más suba el precio del transporte (alza en la gasolina) se debe minimizar su costo usando estaciones de almacenamiento y transferencia.

- La recolección debe implementarse colocándose apropiadamente recipientes colectores de los desechos, pensando en las características principales de los desechos como: densidad, grado de humedad, contenido de materia orgánica u otras. Estos recipientes deben removerse cada dos días y ser reemplazados por otros vacíos.

Usando métodos simples de recolección, transporte y tratamiento de los desechos acompañado por información intensiva a la población se puede alcanzar un implemento en la situación general del medio y por lo tanto de la salud. Para los países en desarrollo, con sus crecientes cantidades de desechos, ésto puede ser una importante contribución a los esfuerzos para proteger el medio ambiente.

Las medidas técnicas para la protección de medio ambiente representan en la actualidad un elemento esencial de una sociedad industrial que no quiere eludir los problemas ecológicos y desea mantener la calidad de vida. En los últimos años se han adoptado una serie de medidas para la protección de las aguas y del suelo, para el mantenimiento de la limpieza del aire y para la eliminación no perjudicial de los residuos. Entre estas medidas se encuentran:

- La construcción de plantas para la purificación de desagües.

- El establecimiento de depósitos de basuras ordenadas y de plantas para el tratamiento mecánico de las mismas o para su reciclaje.

Tocando el punto de reciclaje podemos decir que éste comienza en la calle o en el camión, donde los guajeros comienzan a seleccionar ciertos materiales. Sin embargo, la mayor purga de los desechos se hace en el mismo relleno sanitario, que suelen ser lugares abiertos - en la mayoría de los países en desarrollo.

Otro incluso mejor sistema de reciclaje será la instalación de plantas de composta de la que hablaré después de hacer ligeras alusiones a los rellenos sanitarios e incineración, todas ellas alternativas para contribuir a mejorar o al menos no degradar tanto nuestro medio ambiente reduciendo a un mínimo los desechos que se puedan.

La idea de reciclaje no es nueva; basta recordar el viejo sistema de - campo-granja donde prácticamente no se producía basura; los desechos se arrojaban a los animales o se usaban para calentamiento o eran tiradas al basurero-estercolero.

Sin embargo, el reciclaje no es el remedio universal para la escasez en las materias primas; al presente, aún domina el mercado la ley de la oferta y la demanda.

El éxito en el reciclaje de los desechos dependerá de la conjugación de factores económicos y ecológicos.

Considerando el contenido de desechos reutilizables se puede concluir que sumas considerables de materias primas de segunda clase pueden sacarse de tales desechos. En 1,980, aproximadamente 1500 T de desechos sólidos municipales fueron producidos en las 5 capitales de Centro América, de los cuales aproximadamente el 60% es materia orgánica; del 12-15 de materia inerte, del 15-22% de papel, del 3 al 6% y del 6 al 8% de vidrio y otros. Como puede apreciarse, al menos teóricamente, los desechos tienen una buena base como materias primas para nuevos productos o tomado bajo otro enfoque, disminuyen grandemente la carga ambiental tratados en forma apropiada.

Rellenos Sanitarios

Un vertedero abierto no se puede permitir; implica contaminación de las aguas superficiales y subterráneas. Además de su impresión visual desagradable emana nocivos y molestos gases y esparce por doquier papeles - sucios y otras partículas.

Por contra, un relleno sanitario bien llevado protege al medio ambiente de casi todo tipo de emisiones: los rellenos sanitarios son el método más barato pero también el más peligroso en la disposición de los desechos sólidos.

Incineración

Se recomienda como buena para la disposición de las basuras de las ciudades, particularmente de aquellas situadas en aglomeraciones densamente pobladas, (unas 400 T de desechos sólidos/día, 100 a 150 000 habitantes, dan unos 15 00 kw.

La incineración debe combinarse con la producción de energía: calor, vapor, electricidad. Naturalmente la incineración es sólo posible para las grandes ciudades de los países en desarrollo.

El método de incineración de los desechos con la recuperación de energía no siempre es óptimo en todos los países en desarrollo por razones del mismo desecho.

Además hay que tener presente que la mayoría de plantas que queman las basuras producen venenos tipo dioxina; ese veneno se origina principalmente en la mala combustión de los plásticos.

Compostaje

Para hacer más énfasis en la protección ambiental y en una eficiente disposición de los desechos debemos considerar que el volumen de éstos aumenta en la misma manera en que aumenta el problema de la disposición de los mismos con todas las consecuencias para con el medio ambiente. Por qué no pensar entonces en atacar el problema en forma diferente que por calcinación o como materia de relleno de áreas perdidas?.

La obtención de composta es una transformación relativamente barata y provechosa con la mayor armonía con la naturaleza. La transformación de los desperdicios orgánicos por los microorganismos del suelo en material nutritivo para las plantas es un verdadero proceso de reciclaje, dinámico y confiable, que cierra el ciclo biológico.

El compostaje es una tecnología previa a la preindustrialización y que actualmente se está promocionando con el nombre de Biotecnología, de la cual el compostaje es una parte. La tecnología del compostaje es una solución atractiva por sí sola, especialmente para aplicarse en los países en desarrollo y en las áreas semi-rurales donde viven pequeñas poblaciones y donde existe alto potencial de ventas.

Los problemas que pueden ocurrir cuando se considere el compostaje como alternativa de tratamiento y recuperación de los desechos serían:

- Impacto en el medio ambiente
- Problemas de comercialización
- Problemas financieros, de planificación y operación
- Su apropiada aplicación en los países en desarrollo

Problemas relacionados con el medio ambiente

A. Organismos Patógenos:

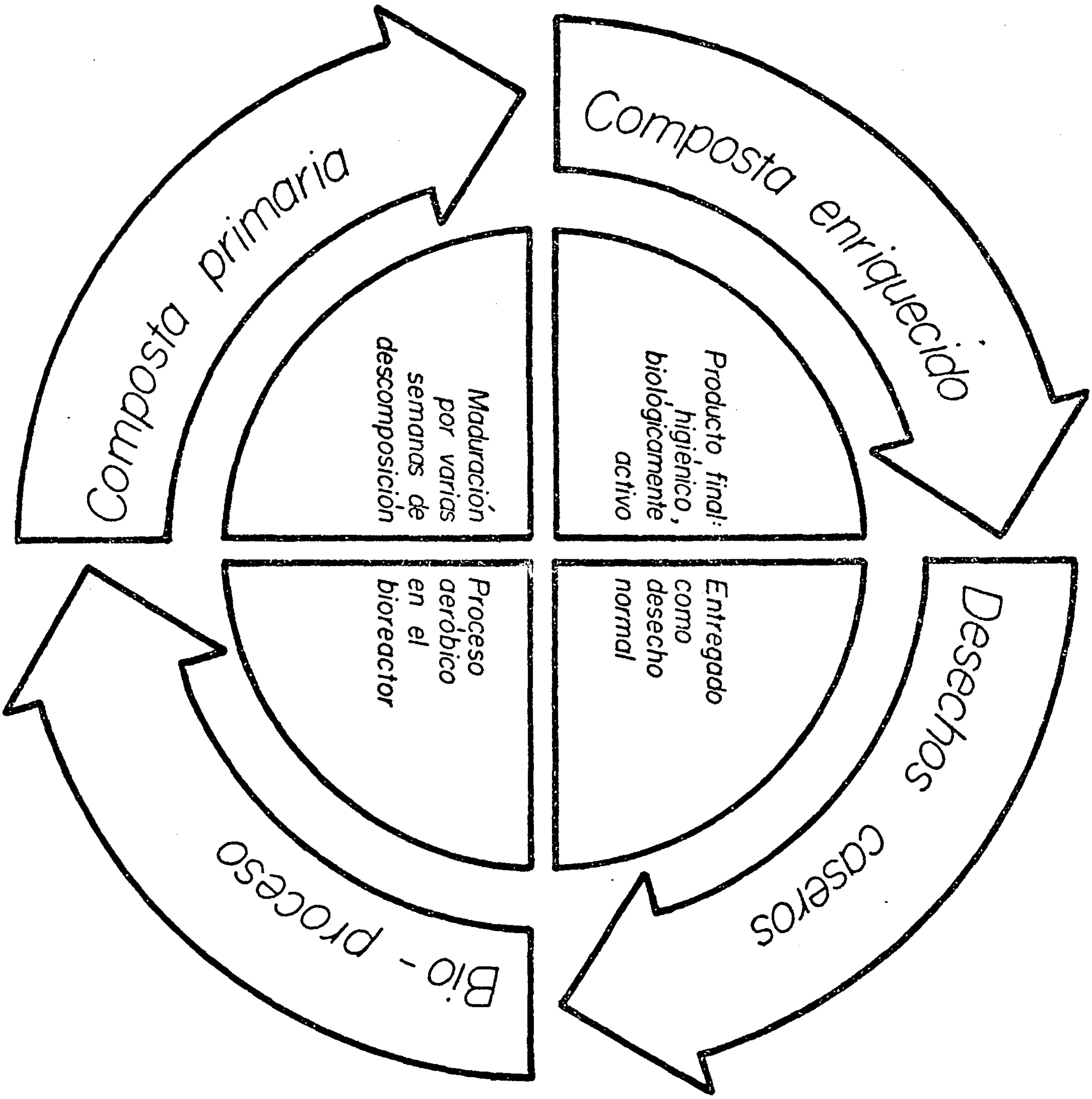
Es posible la sobrevivencia de organismos patógenos en el composta. - Virus, bacterias, protozoos, hongos y otros organismos capaces de causar enfermedades a humanos, plantas y animales pueden persistir en el compost debido a un tratamiento impropio. El mismo peligro involucrado durante el producción o uso del composta no ha sido aún bien establecido. Se necesita hacer más investigación; en adición a la persistencia de organismos patógenos pueden existir otros problemas producidos por los vectores de enfermedades como insectos, roedores, cucarachas, etc. que son atraídos por los desperdicios y pueden multiplicarse en ellos.

B. Presencia de Metales Pesados

El mayor problema para el compostaje es la remoción de los metales - pesados que pueden causar serios peligros para el ambiente y la salud.

La presencia de metales pesados en el compost o en los lodos pueden - acumularse en lso suelos y ser tomados por las plantas o ser lavados y llevados a los mantos de agua subterránea. Por eso es necesario conocer su composición química antes de emplearse en grandes cantidades para enriquecimiento de los suelos.

Posibles contaminantes en ppm de material seco:


Composta primaria
Composta enriquecido
Desechos caseros
Bio - proceso
Producto final: higiénico, biológicamente activo
Entregado como desecho normal
Proceso aeróbico en el bioreactor
Maduración por varias semanas de descomposición

a) En compost de desechos sólidos

b) En compost de desechos y lodos

c) En compost de lodos

	A	B	C
Arsénico	100		1 100
Boro	5	6.4	6.4
Cadmio	3	0.4 a 6	6.2 a 64
Cobalto	4.2 a 20	5 a 11	33
Cromo	60 a 65	60	1335
Cobre	180 a 380	150 a 337	227 a 1153
Hierro	1250 a 8000	11000	10880
Mercurio	2 a 5	----	0.1 a 4
Manganeso	363 a 615	54 a 410	475 a 565
Molibdeno	10	7.5 a 8.4	10 a 13
Níquel	10	44	----
Plomo	147 a 985	42 a 340	285 a 334
Zinc	173 a 933	487 a 820	1045 a 2410

Problemas de Mercadeo

Antes de comenzar a planear una planta de composta, debe estudiarse cuidadosamente el potencial del mercado local. Si no se prevé este aspecto puede suceder que ya elaborado el composta vaya a depositarse a un relleno sanitario. Por lo tanto, es necesario chequear desde un principio:

- Si existe demanda para la aplicación del composta

- Si existe corta distancia entre productores y consumidores

- Si el consumidor es de mente abierta para usar composta

- No hay que olvidar el impacto de una antipropaganda en contra del composta por parte de los vendedores de fertilizantes químicos, - por la aparición de plásticos, vidrios, metales, mal olor, etc. - que pueden exbirse como reciclaje de materiales sucios.

Problemas Financieros

Un composta bien hecho no puede ser barato, se necesita de maquinaria y hombres; el costo mínimo para el tratamiento del desecho (desde la entrega del desecho hasta el composta terminado) no será menos de $ - 10-15/tonelada. También se necesita de espacios que deben ser comprados o arrendados a precios tanto más elevados cuanto más cercanos estén de las grandes urbes.

Aplicación del compostaje en los países en desarrollo

Muchos grupos e iniciativas privadas han estudiado la mejor utilización de los materiales orgánicos para mejorar la calidad del suelo y detener la erosión.

Se recomienda que en las grandes ciudades los desechos domésticos e industriales apropiados se recojan y procesen (si posible con lodos) en plantas de compostaje. Las pequeñas comunidades deben organizarse en grupos. Los desechos de 40 a 100 000 habitantes deben colectarse y tratarse en una sola planta de composta. Los requisitos indispensables deben reducirse a un mínimo.

Los desechos municipales junto con efluentes y lodos proporcionan un compostaje apropiado para usarse en la mejora de cosechas.

Conclusión

Que todas las ideas anteriormente expuestas nos hagan pensar que con un poco de esfuerzo y buena voluntad por parte de todos es relativamente fácil mantener un medio ambiente sano y dinámico para conveniencia y placer de todos los que estamos inmiscuidos en el mismo.

REQUIREMENTS TO A SUITABLE WASTE MANAGEMENT LEGISLATION FOR CENTRAL AMERICA

Dr. Peter Kolbusch

RESUMEN

Contiene y explica los requisitos o requerimientos que deberían contener las solicitudes para considerar la tratamitación de autorización para el establecimiento de botaderos de desechos sólidos.

Explica con detalle las condiciones de cómo construirlos y las especificaciones necesarias para operarlos. Describe igualmente el uso que se le debe dar a los botaderos de acuerdo al tipo de desecho sólido que vaya a depositarse en el mismo. Hace recomendaciones igualmente sobre los aspectos ambientales que deben tenerse presentes, y los estudios hidrológicos, geológicos y metereológicos que aseguren que la ubicación del botadero no afectará a la población vecina.

Un énfasis particular en la selección del tipo de suelo que debe seleccionarse y las condiciones de este para una buena operación del sistema.

1. PLANNING OF DUMPS

For the approval of construction plans for solid waste dumps the following documents have to be given to the authorizying agency:

- explanatory report
- calculations and measurements of dump plant
- drawings
- expert assessments

Dr. P. Kolbusch + Partner, Chemical Engineering, Germany

1.1 Explanatory Report

This report must include all necessary data of the planning to enable a proper judgement of:

1) motives, tasks and contracts
2) choice of site
3) neighbourhood and areas of impact
4) area related to the refuse (waste), quantity, quality and type of waste collection and transport
5) orographic, meteorologic and hydraulic conditions of the site
6) site of drinking water resources in the affected area
7) geologic and hydrologic conditions of the site
8) infrastructure of the dump including site and type of buildings
9) volume and running time of the dump
10) availability of covering materials
11) machinery and employees
12) working data and regulations for preventive sanitation
13) costs for the plant including recultivation
14) actual use of the site
15) recultivation activities
16) use of site after recultivation
17) table of contents of all documents.

1.2 Calculations and Measurements of Dump

1) Figures on water supply plants
2) figures on waste water treatment (quantity, quality, treatment, control, sewer systems, hydraulic conditions)

3) figures on the recollection systems of leachate
4) figures on the recollection system of surface water
5) statics on the buildings
6) mechanic property of the soil

1.3 Maps and Drawings

1) Map of 1 : 100 000 to 1 : 200 000 including the waste recollection area and outlying road systems
2) Topographical map (1 : 10 000 to 1 : 50,000) including traffic, water supply, waste water, electrification) as well as the surface- and ground-water situation nearby the site.
3) Drawings 1 : 1 000 to 1 : 5 000 concerning the use of sites in the neigborhood including names of the owners and land registry numbers.
4) Drawings 1 : 1 000 to 1 : 5 000 with contour lines including all buildings (road constructions, fences, etc.) as well as ground water level and direction of ground water flow.
5) Sectional- and longitudinal drawing (1 : 1 000 to 1 : 5 000, relief 1 : 100) of the site and the foreseen dump masses including ground water levels (date of measurement) road and sewer constructions.
6) Construction drawings (buildings)
7) Drawings of the sewer systems for surface water, leaching water and waste water in the particular sections.
8) Dump management plan
9) Plan of recultivation during the running time of the disposal and after being filled up.

1.4 Expert Assessments

The following are generally necessary:

- Geological and hydrological assessments concerning the ground and ground water situation, permeability and requirements of sealing.

In special instances the following could prove necessary:

- a meteorological assessment
- an emission and immission assessment
- an assessment of mechanic soil conditions
- an assessment of sealing

1.5 Type of Wastes

Solid dumps may be used for

- domestic waste
- industrial wastes which are similar to domestic waste
- bulky waste
- street-sweepings
- market waste
- park and garden waste

Permission for dump should be given by the authorities according to the following rules:

Site and Capacity of the Disposal

- hydrological and geological conditions
- climatic conditions
- availability of covering material
- volume of the dump
- regional transport infrastructure
- facilities and employees
- control devices

Characteristics of Waste Material from the Point of View of Dump Management

- ton capacity of waste
- emissions (odor, dust, noise)
- quantities of different wastes (buffer)
- complications during disposal

Long Term Reactions of Waste

- treatment of leachates
- affect on the rivers
- chemical reactions and occurance of gases
- mechanical characteristics of the dump
- recultivation of the site

The assessment of the wastes according to the aspects mentioned may lead to the following decisions:

- the waste may be disposed without further treatment
- the waste may be disposed on certain conditions
- the waste has to be disposed on a special plant because of its type or quantity

2. ESTABLISHING DUMPS

2.1 Lane Constructions should be done According to the Following Rules:

- not more than 8 to 10 % grade
- the lane should allow for oncoming traffic (6,5 m) and should be marked and bordered.
- an internal traffic handling should be established by traffic sings and barriers to guide the trucks to the predetermined places of unloading
- trucks and carts have to use the lanes and unload at pre-

determined places, different for mechanical and manual unloading

- the lanes have to be trafficable during the rainy season
- in front of the gates, a turn-about must be possible for vehicles which are not allowed to enter.

2.2 Fencing

The dump has to be fenced to prevent the entrance of trespassers and wild deer. The fence should surround also the pits of the sewer system.

A plantation of trees and shrubs outside the fence is recommended.

2.3 Cleaning of the Tires

Traffic on public roads should not be affected by dirt from the dump. Therefore the pavement from the dump to the public road should be at least 300 m long, divided in two lanes for come and go. The pavement has to be cleaned frequently.

2.4 Entrance and Service Buildings

Registration and visual control is done at the entrance. In specific cases a sample of the waste will be taken.

At the entrance a sign should be fixed stating:

- the name of the plant
- name and address of the responsible authority
- name and address of the plant manager
- business hours

Checking of the trucks takes some time. Therefore enough space for back-up outside the dump should be given. For small quantities of private persons, containers should be available outside, which may also be used out of office hours. At the entrance a building for registration and control personnel must be erected; telephone is obligatory. The workshops may be integrated in the same building.

Large plants may include:

- office with telephone and weighing devices
- laboratory for rapid analyses and storage of samples
- workshop for utensils

Recording of weather conditions has to be done for assessment of the ground water situation of the disposal. The devices of measurement should be nearby the office.

The workshops should also be located nearby, and should be provided with tools and devices for repair.

The lanes and the ground of the works have to be reinforced in order to support the compactor.

The entrance should be constructed horizontally for at least 18 m to be able to install a weighing machine. Weighing enables and exact calculation of costs for the users, an exact control of the dump and further planning. A platform scale of 38 Mg capacity of 16 - 18 m length and 3 m width is recommended. The devices should register and record automatically, including data of type of waste, deliverer, date and hour.

Two weighings per vehicle are necessary if no figures of the empty vehicles are recorded. The ultimate number of weighings per hour is about 25.

2.5 Construction of the basis of the Site

Sites with tight soil should be chosen if possible. If not sealing of the basis and the flanks of the site is necessary in order to prevent the infiltration of leachate into the soil. This depends on the decisions of the responsible authority.

If sealing is necessary in accordance to the decision of the authority, the technical advices of 2.5.2. must be followed.

In establishing a dump site, the top soil must be stored for recultivation.

If the soil is firm enough, the site should be scraped open to a depth of 30 cm and compacted according to the rules of underground engineering. Afterwards the basis must be compacted and rolled to a designated angle (see also 2.5.3.).

2.5.1 Shaping of the Basis

Basing of dump sites may be done by

- natural sealings or
- artificial sealings.

Natural sealings consist of carefully spread and compacted layers of clay. The layers must be at least 60 cm thick in all places. They have to be compacted layer by layer to a density of $kf = 1 \cdot 10^{-8}$ m/s. The surface must be rolled with a slope to the drains. The sealing must be protected against draught, erosion and mechanic disturbance. Therefore it may be necessary to do the construction step by step.

Steep flanks, which can not be sealed at once must be sealed part for part after filling up waste. After removing the loose surface soil, the sealing has to be erected with a slope to the center of the site.

Artificial sealings consist of pre-fabricated sealings, such as

- plastic foils which are welded in situ
- bitumen on fabric carriers which are welded in situ.

Sealings, prepared in situ, such as

- coverings of mixtures of proper materials of soil in connection with synthetic resins, silicatic bindings or swelling agents (bentonite)
- bitumination, as in road constructions.

These sealings must not be faced apart, they are only one of the protecting measures, but of course one of high importance.

The proper formation of a sealing depends on the kind of sealing, the site, and the type and amount of wastes to deposit.

A sealing, which includes an artificial cover, will be formed as follows:

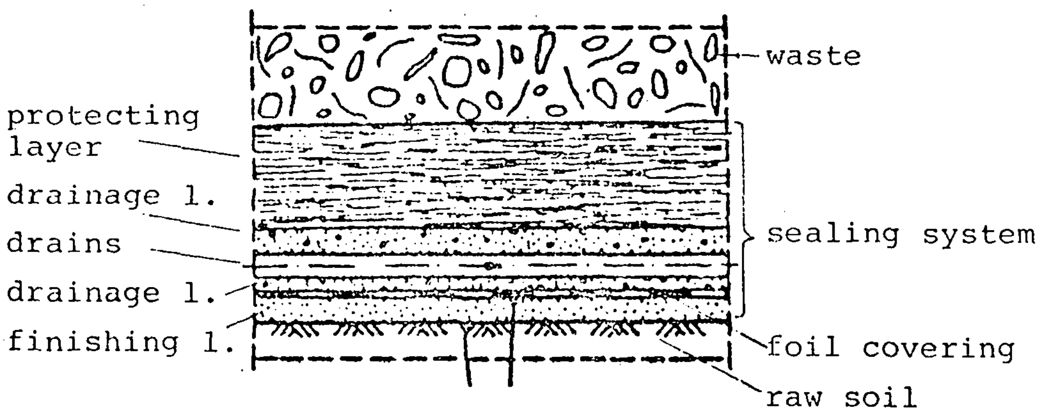


Fig. 1: Basic sealing - scematic

As experience in basic sealings is still being compiled, the planning will include tests of

- soil physics of the site as well as soil physics of the sealing material
- all questions of artificial sealings (type of material according to the type of wastes, type of connections for foils etc.)

These tests have to be done by authorized experts.

The sealing must also be tight after the dump has been filled up and recultivated so that no more contaminated leacnate can occur.

2.5.2 Collection of Leachate

Dumps with natural or artificial sealing have to be provided with a drainage layer or a drainage system, integrated into a protecting layer. The leachate has to be separated.

The system must allow a quick drain of the leachate to avoid a backup within the disposed wastes because:

- a back-up within wastes will promote leaching, leads to higher concentrations and will complicate the treatment.
- backed-up water increases the hydrostatic pressure on the sealing and thus results in increasing risk of leackage.

The drainage layer may be formed according to the following possibilities:

1) Conventional draining system integrated into a protecting layer of low permeable (fine) materials.

The drainage system consists of intake tubes, main drains, secondary drains, and control pits (e.g. man-holes). This system will be necessary because of the low permeability of the protecting layer. The drains should be able to serve as sewers as well. The type of drainage with protecting layer is recommended for natural sealing systems.

2) Drainage of high permeable (coarse) materials (plane filtration)

   a) without intake tubes
   b) provided with intake tubes

Intake tubes may increase the capacity of plane filtration. They must not ultimately be formed as slotted tubes but only trenches.

The leachate is resorbed by the plane filter and passed to the sewers, which pass it on outside the dump. Control pits and man holes along the sewer system may be necessary.

A hydraulic and static layout for the drainage tubes must be undertaken. The minimun width of tubes should be 100 mm, the minimum slant should be 1 %. The material should not be affected by the leachate (concrete corrosion).

The sewers should be installed straight on without any knees, they should not be moved by dumping activities. The compactor may not be used on layers less than 2 m thick to avoid disturbance of the tubes. The tubes have to be protected by compressive materials (gravel) in layers of 30 cm above the top of the tube.

To avoid pasting up the drains, air should be prevented from passing into the tubes by siphons or by ending the pipes beyond water-level. Conventional drainage requires layers of gravel which are able to serve as a drainage, if the drainage system pasted up. This is why the plane filtering is more advantag ared to the conventional system.

The control pits should be established outs s of waste. They should allow measurements and sample-taking

2.6 Ground Water and Surface Water

Ground water and surface water must strictly away from the dump so the amount of leachates will not be

A tube for surface water is only allowed to d the dump if it is absolutely tight, not corrosive, and gh to support the disposed masses.

The tube must be large enough to walk in for and repair work. Control pits have to be installed outside th of waste. Surface water within the site has to be collec ssed on in solid tubes.

Rain water without any contamination should on as well. On the slopes this could be done by ditches.

The quality of the surface water and ground to be controlled from time to time.

2.7 Machinery and Employees

Good filling of a dump requires suitable mach The minimun requirement on machinery for a dump is a com Besides this, machines for road cleaning, fire-engines, du l-machines and machines for earth work are recommended. Co must be used to deposit bulky wastes, they may work even an crawler-type vehicles. Thus passability of the dum r, hollows, fires, parasites and wind erosion is minimi

The number of vehicles required is determined daily amount of waste and by the type of waste. A big pa lky waste reduces the results of compacting. The compac ld show a good ground-clearance, strong armour and should b ss-country mobility.

Crawler-type vehicles are recommended for e ing and covering of the dump. Only small dump plants ma work by a modified compactor. Cleaning machines are ed to control dust and mud on the roads.

For a one shift management of a dump three persons will be necessary for reception weighing and control, guidance of vehicles, compacting and other jobs.

The employees must be realiable and well trained.

2.8 Gas Production

The gas production in dumps is carried out by microbiological processes. It will occur over the period of a couple of years.

The composition of the gas fluctuates. Contents of methane of 50 - 70 % and of CO_2 of 30 - 50 % may be typical. Low contents of H_2S, NH_3 and N will be found.

The gas may have an impact on the surrounding environment

- explosions and fire
- suffocation, if occured in closed rooms
- odour
- damage to plants.

In the event that the flanks of the disposal are more permeable for the gas than the masses of waste, the gas may occur in buildings (e. g. tubes, flats).

Risks from the gas of dumps which are not yet covered will never occur as the gas may pass through the whole surface. Besides this, bacteria on the surface of the disposal decompose part of the gas.

To avoid damages from gas the following steps must be undertaken:

- buildings, which may be influenced by penetration of gas, control pits and collecting pits etc. may only be entered after testing the oxygen contents or with respirator. The risk of explosion must be considered.
- The erection of buildings on recultivated dumps should be avoided if there have been no tests made on gas production prior to building, which showed negative results.
- Well covered dumps have to be provided with gas outlets to avoid damage on plants such as:
  - gas probes driven through the covering soil
  - chimneys or drains which must be established during filling

Collected gas may be burned or used for heating.

3. OPERATION OF THE DISPOSAL PLANT

3.1 In General

The method of operations for the employees of the disposal plant must be clearly fixed through operational instructions. These instructions must define - according to the injunction of the authorization - how the permitted types of waste shall be distributed at the disposal plant and who is to be responsible for the specific tasks and for the supervision of the work.

At the same time the regulation for use is necessary, defining the rights and duties of those delivering refuse.

It is important to note that:

- only the prescribed roads are to be used
- the waste material may only be deposited at the specified sites
- sorting through the waste by unauthorized persons is forbidden
- the employees of the waste disposal have the right of jurisdiction

3.2 Duties of the Plant Personnel

Plant personnel is responsible for correct functioning of the disposal according to the operational plan. The appropriate accident-prevention instructions must be followed.

The delivered waste must be checked. The depositing of forbidden matter must be refused and subsequently reported. Waste which has been accepted for depositing must be separated and registered according to type of waste.

The plant personnel must pay particular attention to the fact that no fires should break out and that difficulties due to odors, noise dust, paper flying around in the air and hordes of animals. must be avoided. The condition of the fence must at all times be controlled. Unallowed deposits in the area of the entrance and in surrounding field must immediately be removed. Maintenance and care of available scales, the meteorological measuring station as well as the observation well for ground water must be carried out as specified. Seepage must be checked regularly. The following must be recorded regularly, in the operations ledger which is dept at the plant:

- weather conditions: i. e. temperature, amount of precipitation and wind direction
- results of controlling the facilities for drainage, in particular sewage lines, the fencing around the disposal plant and surrounding areas to protect against forbidden deposits
- results from testing seepage
- unusual occurences i. e. accidents, fires, mechanical breakdowns.
- the type and amount of delivered waste, who delivered the waste, who produced the waste, data of receipt, area of disposal. The types of waste are to be specified according to the waste code given in the LAGA pamphlet concerning waste material. The disposals which are not yet equipped with scales must record the amount of delivered waste in volume.
- clearance of the drain pool stating amoung
- type and extent of recultivation plans
- area of disposal used daily

work done by personnel; by machines

3.3 Preceipt Control

Permission to deposit waste must be controlled before dumping.

Immediate checking of the delivered waste of the dumping grounds is based mainly on:

- accompaning papers from the deliverer
- weight of waste
- on-the-spot investigation of the waste (note the color, consisting, odor, mixture, packaging)

Important here is a comparison based on the declaration given with delivery of the waste material and the actual delivered waste. When in doubt samples of the delivered waste must be taken.

These precautionary measures must be taken by plant personnel in the area where the scales are and while the waste vehicles are dumping. This area must be equipped with a communications system (for example a short-wave radio).

In case of doubt concerning the identity of waste matter:

- At the receipt control de acceptance of the waste must be refused and the refusal registered;
- during unloading of the vehicle or depositing the waste matter, immediate suspension of dumping or depositing; the waste that has been unloaded or deposited must be secured from precipitation or trespassers; a sampling of the waste must be taken at once. The producer of the waste, the disposal manager and persons responsible for disposal must be informed.

Information concerning the delivered waste matter must be recorded in the plant ledger.

3.4 Installation Engineering

Installation of solid waste matter

Following delivery, transfer or preliminary treatment the waste matter is to be deposited as compactly as possible.

Depositing is done by means of compressors and caterpillar tractors. In the case of landfill, the waste matter is spread out over the flat or inclined area and broken up, crushed and pressed down by the compressor which is driven over the waste several times. The compressed layer may not be higher than 30 - 50 m.

Depositing of wastes that cannot be broken up, as well as sludge, canin certain cases be carried out by means of a disposal pit. In such instances solid waste from housing developments must be dumped in layers not exceeding 2 m, so that it can be shoved off from the previously compressed waste (landfill) over the edge of the dumping pit. This domestic waste must be unloaded 10 m from the edge of the pit, crushed by the compressor driving back and forht over the waste and then plowed over the edge of the pit. The

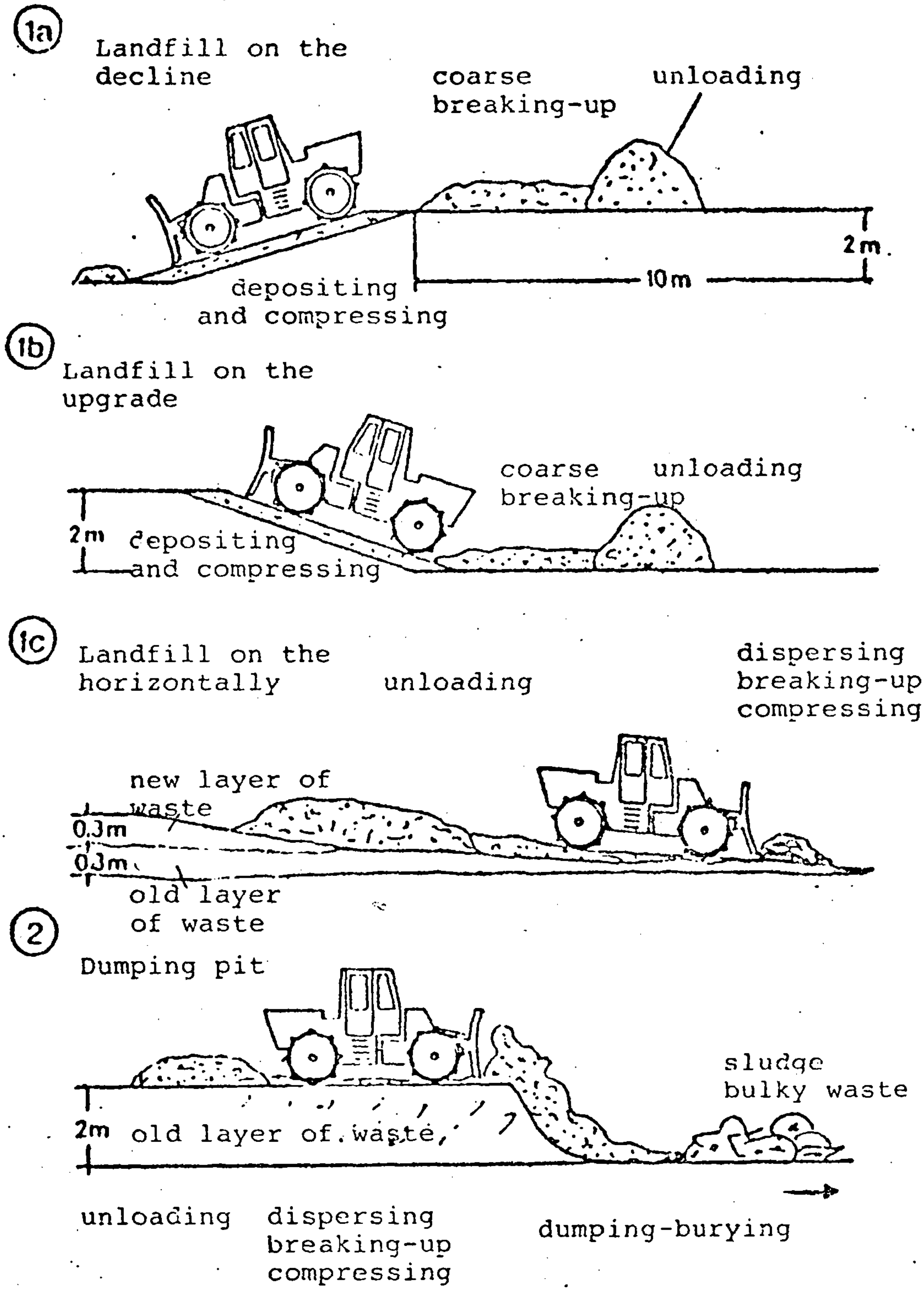


Fig. 2: Installation techniques

resulting slope should be compressed and covered at the end of each work day.

Bulky waste and sludge must be unloaded at the foot of the disposal edge and buried by subsequent waste dumped over it.

Landfill and disposal pit has to be undertaken on a place as small as possible, but enough to move the vehicles needed. Both techniques are shown in figure 2.

Installation has to be done considering minimization of seepage. This may be taken into account by the installation methods (slopes to the flanks, installation step by step.)

Rotted wastes are also installed by compacting. Another method will be the shredding of wastes before installation e. g. combined with taking out of scrap. A disadvantage will be the blowing of paper and plastics by wind. An advantage will be lower efforts to the installation. Delivery vehicles must not pass the landfill. The costs of this method is higher than using a compressor.

Depositing of Drained-off Sludge from Municipal Waste Water Treatment Plants

Completely rotted and aerob-stabilized sludge are mainly acceptable for deposit; raw sludge can only be deposited when the necessary steps have been taken to control the development of odors - for example, drainage. Ordinarily it is not necessary to sanitize the sludge prior to dumping. Sludge consisting of up to 65 % water can - by present knowledge - be deposited without any restrictions. The point of time for delivery of sludge is dependent on the type and amount of sludge and on agreement from the disposal management. Further, the delivery of sludge must be coordinated with that of solid waste.

The depositing of limited amounts of sludge containing a high water percentage can be consented to, if:

- the ton capacity and firmness of the disposal are not impaired, whereby amount in relationship to the solid waste must be heeded;
- the regulated depositing is guaranteed according to aesthetic and sanitary aspects and odor emission is prevented.

In respect to the stability and firmness of the disposal, the drained sludge should be deposited away from sloping areas. In depositing continuous layers of sludge should be avoided. Also to be avoided is the depositing of sludge directly at the disposal base.

Depositing of Industrial Sludge

Industrial sludge can be deposited (according to paragraph 4.4.1 and 4.4.2) in an inviolable manner, as far as it is allowed for the specific disposal.

3.5 Covering the Disposal Area

At the end of the working day the waste must be deposited in such a manner as to avoid encroachment on the vicinity through paper flying in the air, hordes of animals, fires and unaesthetic views of the disposal area..

The precautions necessary to fulfill these requirements depend on the location of the disposal and the tupe of deposited waste; in the case of spread out disposal areas also on the location of deposit areas as protection measures for the vicinity. If during the process of depositing it is not possible to obtain a flat and relatively firm surface and paper, plastic etc. can be blown away, it will be necessary to cover up the area daily.

For covering, materials, which cannot easily be blown away, from which hazardous components cannot be leached and which allow driving over the covered area are suitable. Excavated earth, not too coarse construction debris, as well as other industrial waste can be used for covering. How suitable the material is can be assertained through laboratory testing.

By using the compressors when depositing waste the necessity for covering can possibly be avoided. This is particularly true for depositing in larger areas because this method does not result in slopes. The mechanism of the steel wheels crushes otherwise easily used waste matter.

Slope level areas of the disposal which are covered by cohesive material, enable precipitation to run off shallowly; this on the other hand can lead to water backing up in the mass of waste as well as water seeping out of the slope, thus preventing gases to escape, unless additional construction measures are.taken.

3.6.1 Hordes of Animals

The massive occurence of birds in the area of the disposal is due to the feeding possibilities on the organic waste. Experiments at domestic disposals have shown that through scare tactics, for example the installation of warning shots system, only drive away the birds for a short time as the birds soon become accustomed to such annoyances.

This situation can be corrected only by keeping the deposit areas of the disposal as small as possible. Also covering up the deposit areas each day will help control the bird problem.

3.6.2 Fire Prevention

In order to avoid the bread out of fires in the disposal waste must be carefully deposited and compressed as firmly as possible. The causes of fires which occacionally bread out are:

- arsow,
- careless use of open fire, and
- hot waste matter.

In general, the covering up of fires with special smothering materials has proven sufficent. For this reason enough smothering material must always be availabe at the disposal. If the fire is smoldering deep within the dump deposits, it will be necessary to dig out the source of the fire. In this case one must reckon with the possibility of the fire flairing up for a period of time. Experience has shown that water can extinguish surface fires only. Precautionary measures and persons responsible for such emergency must be written into the plant manual.

4. TREATMENT OF LEACHATE

4.1 In General

Leachate must be cleaned before being released into a water atery according to regulations.

The disposal should be connected to an existing sewer system. If this is not possible, leachate should be stored in a basin and transported to a treatment plant by trucks, or treated in an own treatment plant. Normally a mixture of leachate and municipal waste water is easier to be treated.

The volume of the basin must be adapted to the amount of leachate and transport intervals, at least for 1 week.

An aeration of the leachate may be necessary to prevent odour and to promote an aerobic cecomposition. Therefore the installation of a storage basin must also be foreseen in the case of sewer connection.

4.2 Quantity and Composition of Leachate

The quantity of leachate is depending on the specific rainfall conditions.

The composition of the leachate is depending on:

- the contens of water solube matter
- the physical conditions and chemical and biochemical reactions which take place within the waste masses and the leachate.
- the quantity, the location and the retention time of the leachate within the waste masses and the age of the disposal.

In general, these processes are influencing each other and cannot be determined exactly. Thus it is not possible to predict exactly the composition of the leachate. An assessment may be done using figures os similar disposals. If not possible, samples have to be taken and analysed.

Analysis of leachates showed the following figures:

pH	4 - 9	mg O_2/1
COD	2 000 - 62 000	mg O_2/1
BOD_5	60 - 45 000	mg O_2/1
ammonia	120 - 3 200	mg NH_4/1
chloride	750 - 5 200	mg Cl/1
sulphate	1 - 1 600	mg SO_4/1

Alkali and alkaline earth metals occur in high concentrations as well as heavy metals.

4.3 Treatment

The treatment of leachate may be done by aerated ponds or other biological treatments. Decomposition rates of 95 -99 % have been reached for BOD_5 and 20 to 50 % for COD. It must be mentioned, that the discharge showed a BOD_5 of 20 - 70 mg/1, the COD was up to 3,500 mg/1. The remaining organics may only be eliminated by precipitation or similar methods.

4.4 Leachate Analysis

The leachate must be analysed right after the start of the landfill. The figures requested are given within the licence.

Simple analysis may be carried out by the personnel of the plant, if they are qualified to use and take care to the equipment.

The following measurements may be undertaken:

- quantity of leachate
- color
- odor
- turbidity
- sediments
- temperature
- pH
- COD

4.5 Control of the Ground Water

For measurement and control of the ground water, control pits of a diameter of 150 mm have to be installed.

Number and specifications of the pits should be given by the authority. The pits have to be covered. One of the pits has to be installed above the disposal for comparative analysis.

Before starting the landfill, one sample of all pits must be taken and analysed.

5. RECULTIVATION

The integration of landfills into the surrounding natural area is called recultivation. This should be done step by step during filling and immediately after the disposal is completely filled up.

Recultivation has been carried out according to a recultivation plan which is part of the installation plan, the costs or recultivation are part of the dumping costs.

The installation of wastes, especially the last layer, must be done in consciousness of the further use of the recultivated area. In general wabble soils are used. The cover may be dropped if it is not necessary, or replaced by mixing of soil to the last layer of waste.

The diameter and types of the soil layers is determined by the expected use. Interactions between soil and waste masses on respect to gas and water flow and its affect on plants have to be considered. The surface should allow a rain water flow to the tanks with a slope of 3 %.

Erosion must be prevented by brushes and gras at the slopes of the landfill, or by artificial constructions.

6. SERVICE AND MAINTENANCE AFTER COMPLETION RECULTIVATION

After completion the following measures have to be undertaken:

- Maintenance of drains, sewers, pits and leachate treatment plants
- drainages, treatment and control of leachate
- maintenance of the ground water pits and ground water control
- maintenance of the degasification devices
- cultivation of trees and brushes

The financing of these measures has to be guranteed by a reserve.

Reference:

LAGA Deponie-merkblatt 4690, Sept. 1979

RESOLUCIONES PROPUESTAS DEL SEMINARIO PARA LOS GOBIERNOS DE CENTRO AMERICA EN EL MANEJO DE DESECHOS SOLIDOS

(Conclusiones de los Grupos de Trabajo)

LEGISLACION

- Los países centroamericanos deben tener una ley a nivel nacional sobre el manejo de los desechos sólidos, que incluya un artículo marco sobre desechos peligrosos (Desechos Especiales).

- La eliminación de desechos de empresas comerciales, industriales y otras, que a causa de su naturaleza, composición o cantidades, sean especialmente peligrosos o dañinos para la salud, el aire, el suelo o el agua, o que sean explosivos, inflamables o radioactivos, deben sujetarse a requisitos adicionales.

- Los Gobiernos nacionales deben incluir en su legislación comercial (de importaciones/exportaciones) un artículo que dicte que la importación de desechos especiales, se admita sólo con permiso especial, para impedir la importación incontrolada de desechos peligrosos de otros países.

- Se recomienda que los países centroamericanos traten de establecer normas y estatutos iguales para impedir competencia desleal entre ellos, así como gestionar la suscripción de convenios internacionales protectores del medio ambiente.

- Los países centroamericanos deben promover la asesoría de ICAITI como uno de los organismos de consultoría técnico-científica de la región.

- Gestionar la creación de sistemas educacionales que promuevan la protección del ambiente.

TRATAMIENTO DE LODOS PRIMARIOS

Uno de los requisitos mínimos que se intenta establecer en los países centroamericanos para contribuir a la protección del medio ambiente es la construcción de tanques de sedimentación primaria para los desechos líquidos industriales y domésticos. La operación de estos tratamientos primarios, genera lodos que han de ser removidos y tratados adecuadamente. Para ello se sugieren los siguientes criterios generales.

1. Clasificar los lodos en:

   1.1 Inorgánicos

      1.1.1 Inorgánicos peligrosos

      1.1.2 Inorgánicos no peligrosos

   1.2 Orgánicos

      1.2.1 Orgánicos peligrosos

      1.2.2 Orgánicos no peligrosos

Tratar los lodos anteriormente clasificados por separado; a veces se necesitará mezclar para su mejor tratamiento.

Evaluar las circunstancias específicas para el tratamiento de estos lodos (considerar necesidades de espacio, equipo, distancias para el transporte, aspectos económicos, etc.)

Transformar los lodos inorgánicos peligrosos en no peligrosos.

En casos bien definidos se recomienda la incineración a elevadas temperaturas utilizando condiciones adecuadas de operación para evitar la contaminación por compuestos peligrosos.

Cuando estos lodos peligrosos no puedan ser incinerados, deberán almacenarse en lugares apropiados para poder llevar un control de los mismos. En todos estos casos se debe procurar reducir el volumen para ahorrar espacio.

Los lodos inorgánicos no tóxicos pueden depositarse sin problemas en cualquier lugar apropiado.

Los lodos orgánicos no peligrosos deberán estabilizarse, o no, dependiendo del contenido de la materia orgánica que posee.

No se recomienda la incineración de ser posible otros tratamientos.

La mejor alternativa es el reciclaje para producir:

- Biogas
- Alimentos para animales
- Generación de energía
- Acondicionador de suelos "compost"

La producción del compost se puede hacer:

a) Con lodos industriales junto con los domésticos
b) Combinando lodos orgánicos industriales con basura orgánica de origen doméstico.

Para los lodos orgánicos peligrosos se pueden presentar dos opciones: mejorarlos como los inorgánicos peligrosos; evitando la putrefacción y/o reduciendo el volumen por medios físicos o químicos.

Mezclarlos con otros lodos no peligrosos para diluir las sustancias tóxicas y poderlos biodegradar ya que solos sería prácticamente imposible tratarlos biológicamente.

Una vez biodegradados se les puede tratar como lodos no tóxicos.

METODOS BASICOS PARA EL MANEJO Y RECICLAJE DE DESECHOS SOLIDOS

Aspectos generales que deben ser observados a nivel de recomendaciones sugeridas:

- Normalizar de una manera similar la presentación de informes sobre desechos sólidos, en todos los países centroamericanos, así como utilizar el sistema internacional de unidades para identificar dimensionales como masa, volumen, etc.

- Hacer una evaluación básica de la situación actual de los desechos sólidos en cada país, región o ciudad.

- Que la clasificación de los desechos sólidos se realice en todos los países en una forma uniforme, por ejemplo:

  - Material orgánico
  - Papel y cartón
  - Metales
  - Plásticos
  - Textiles (trapos)
  - Vidrio
  - Hule
  - Madera
  - Misceláneos

- Hacer análisis del tipo de transporte de los desechos para el manejo de los mismos.

- Realizar recolección separada de basura doméstica, de mercados, calles e industrias que permita clasificarla y medirla.

- Promover un cambio gradual de mentalidad hacia la utilización del reciclaje, como un método de protección ambiental.

- Considerar la posibilidad de iniciar procesos de reciclaje basados en plantas de producción de "compost".

- Previo al reciclaje se deberá organizar la clasificación de desechos tanto a nivel domiciliar como a nivel de disposición final por métodos manuales.

- Se recomienda como método más adecuado para la disposición final de desechos sólidos, el relleno sanitario por ser el más económico y tecnológica y sanitariamente aceptable.

- Para la selección del sitio del relleno sanitario se debe considerar las condiciones técnicas, económicas y sociales del lugar.

- Cuando un relleno sanitario se deje de utilizar debe dejarse constancia y señalamiento de que el lugar que ha sido utilizado como un relleno sanitario, para evitar el uso indebido en el futuro.

- Se sugiere separar y reciclar materiales que sean técnica y económicamente rentables antes del ingreso de los desechos al relleno sanitario.

- Se recomienda para lugares alejados del relleno sanitario el uso de estaciones de transferencia así como el de transporte adecuado.

- Colocación de recipientes públicos en los lugares necesarios.

- Someter a análisis estadístico los datos disponibles actualmente.

- Llevar estadísticas, a conveniencia de cada país, por métodos directos o indirectos, cuantificándolos adecuadamente en el sitio del relleno sanitario.

- Sobre la cantidad, composición y características de los desechos, usar el sistema internacional de unidades, ejemplo:
  - Volúmenes anuales en toneladas métricas (t)
  - Volúmenes diarios per cápita en kilogramo (kg)
  - Volúmenes diarios en toneladas métricas (t)

- Promover sistemas de prevención de producción de desechos.

- Deberá evitarse al máximo la utilización de incineración y pirólisis.

- Se recomienda un taller mecánico con sus respectivos almacenes de repuestos y herramientas para uso exclusivo del departamento de limpieza.

DESECHOS PELIGROSOS

Los desechos peligrosos deben ser objeto de una legislación específica que permita contar con un mecanismo que evite una disposición indebida, dentro del país.

- Se recomienda la elaboración de un listado de desechos potencialmente peligrosos, el cual deberá ser sometido a periódicas revisiones, previo inventario de industrias que manejen desechos peligrosos.

- Recomendar a los países de Centroamérica la adopción de un Reglamento Uniforme sobre sistema de recolección, almacenamiento, transporte, tratamiento y disposición de desechos peligrosos.

- Recomendar la creación de un sistema de permisos de actividades contaminantes que involucre autocontrol, bolsa de residuos, tecnologías, etc.

- Recomendar una planta centralizada de tratamiento para dar servicio a fábricas pequeñas, que generen desechos peligrosos. Establecer un relleno sanitario químico para la disposición final de los desechos peligrosos, especialmente acondicionado y preferiblemente cercando a un relleno sanitario normal para centralizar la disposición y manejarla económica y eficientemente.

- Promover el desarrollo y tecnificación de recursos humanos, necesarios para el manejo de los desechos peligrosos a través de programas educativos y de capacitación.

- Declarar que la contaminación por desechos peligrosos en los cuerpos de agua es un problema que requiere atención inmediata.

- En cuanto a los desechos radioactivos, los países centroamericanos deberán implementar la disposición, tal como lo establece la Comisión Internacional de Energía Atómica.