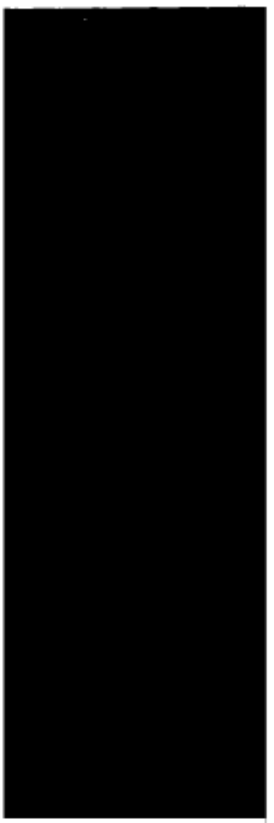
BIOGAS



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for Community Water Supply

BIOGAS

GUIDE FOR HOUSEWIVES

BORDA
Bremen Overseas Research and Development Association
Association Bremoise de Recherche et de Developpment d'outre Mer
Bremer Arbeitsgemeinschaft fur Uberseeforschung und Entwicklung

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BIOGAS
GUIDE FOR HOUSEWIVES

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Produced by BORDA team
Anand Kapoor, Kusum Karnik Neeti Badwe, Dr Asha Pratinidhi, Ludwig Sasse

Edited by Neeti Badwe and Ludwig Sasse

Designed by Anand Jogalekar

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There are many authors, craftsmen and research and social workers whose valuable experience and knowledge lay foundations of this book The book is mainly based on the literary works and accounts of experiences of many people from China, Germany India and Nepal The BORDA team is thankful to all of them

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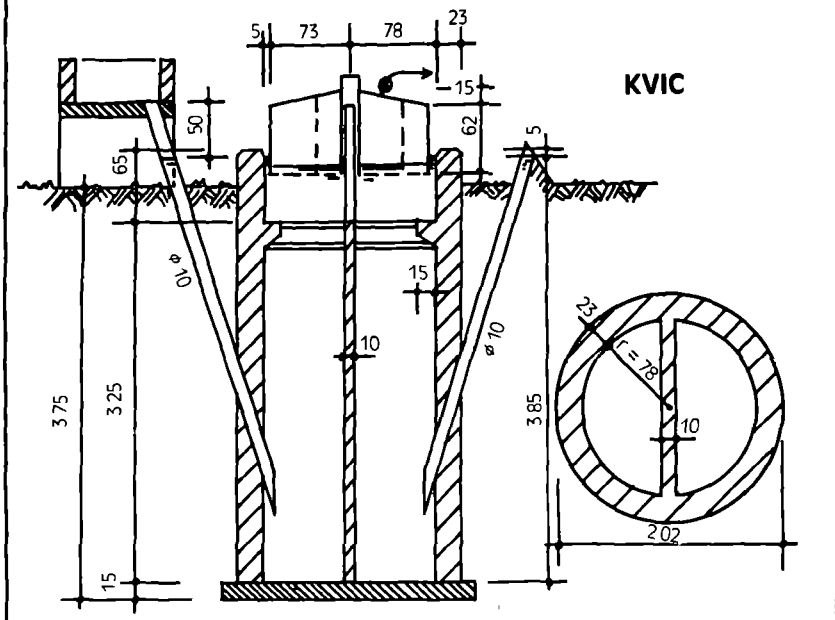

The KVIC plant is most common,

the ASTRA plant is an improvement,

the BORDA design reduces the cost of construction

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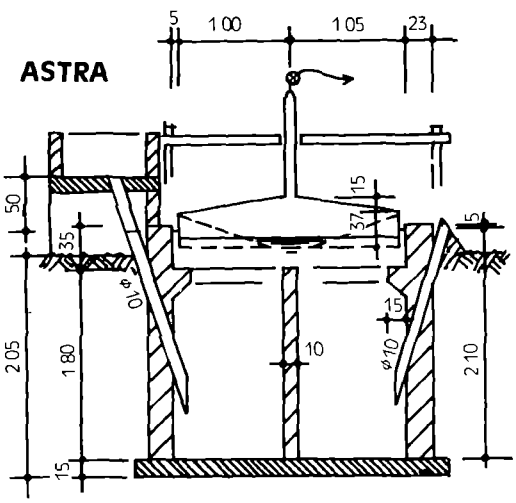
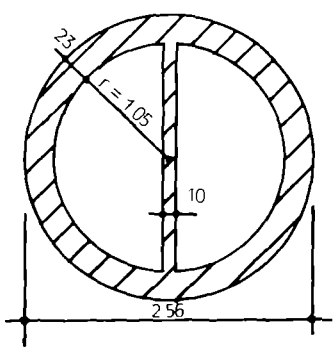
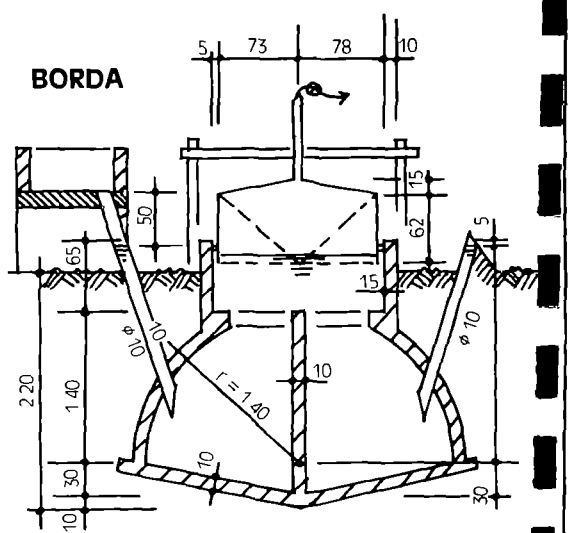
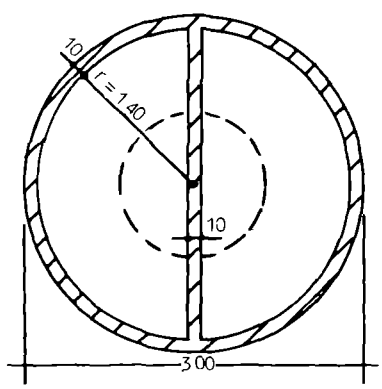








Biogas for Housewives

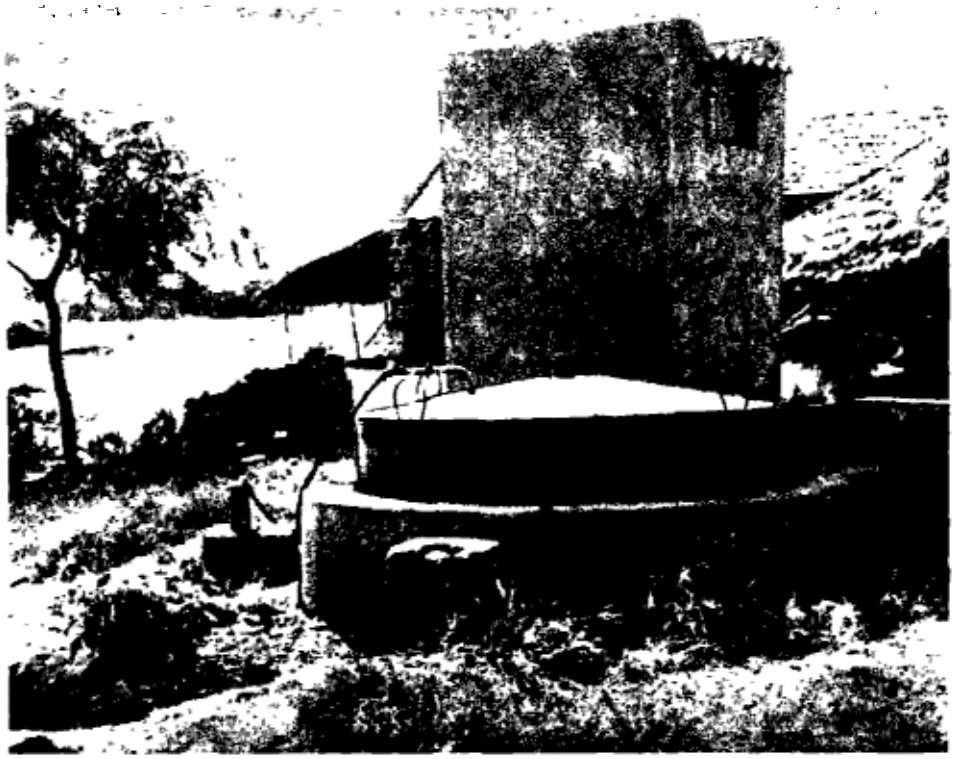
1. Introduction

This booklet is mainly meant for housewives in the rural areas The successful working of a biogas plant depends by and large on them
Almost everywhere in the world it is decided by men whether they should have a biogas plant on their farms or not They plan and construct it and are further instructed in its working and maintenance
But in practice the housewives have to look after it everyday, fill it up and keep it clean. They do this without ever being systematically instructed about the functioning of biogas-plant
We want to help change this situation
The duties of housewives all over the world are almost the same Therefore we think, that these photographs will communicate, even where people look and dress differently and have different life-styles
This booklet sums up the experiences and observations of housewives, technicians, social workers, lady doctors and lady teachers One can look upon this as a result of their collective efforts
We would like to thank all those who have contributed to bring out this booklet We present it in this form, hoping that it will be intelligible and comprehensible to all
Majority of women population all over does not get an opportunity to have even elementary education We hope that the social workers will find this booklet useful to inform and instruct the housewives about the systematic working of the biogas-plant

2. Why a Biogas Plant?

We do not want any longer to
— carry heavy bundles of firewood every morning and evening
— get up one hour earlier, so that tea is ready in time for the rest of the family
— have cough and burning eyes and a smoky kitchen
— clean blackened pots every day and night, so that men see and say that we are good housewives

And we know,
— we must save every tree Otherwise more trees are burnt, than planted
— our fields need fertilizers and dung is too valuable to burn



3. What is a Biogas Plant?

Biogas-plant consists of
— a pit to collect waste material — we call it digester
— and a gasholder to collect gas This either floats on the slurry or is a fixed dome, built on the digester
The plant is regularly filled with waste material, which is first mixed well with almost the same amount of water

Such waste material can be
— dung of cattle, pigs, horses, poultry sheep and goat,
— human excreta,
— agricultural waste like straw, grass, leaves or kitchen garbage
Organic substances are decomposed in the digester by bacterial action in airless condition

4. What is Biogas?

Biogas is
— a clean fuel
— almost odourless
— free from soot
— Biogas burns without smoke and can be used like kerosene or gas stored in cylinders
— Biogas keeps utensils clean
— Biogas does not cause irritation to eyes or throat

It is a popular belief, that biogas is unhygenic and it stinks, when it is produced from human excreta as well This is absolutely silly and simply not true

Biogas consists mainly of 60% methane (CH_4) and 40% carbon dioxide (CO_2)
$1m^3$ biogas has about 5500 kcal (5 8 kwh)

5. Biogas : A Substitute for Firewood

$1m^3$ biogas is equal to 3.6 kg of firewood

We can save a lot of time every year, because we don't have to collect firewood

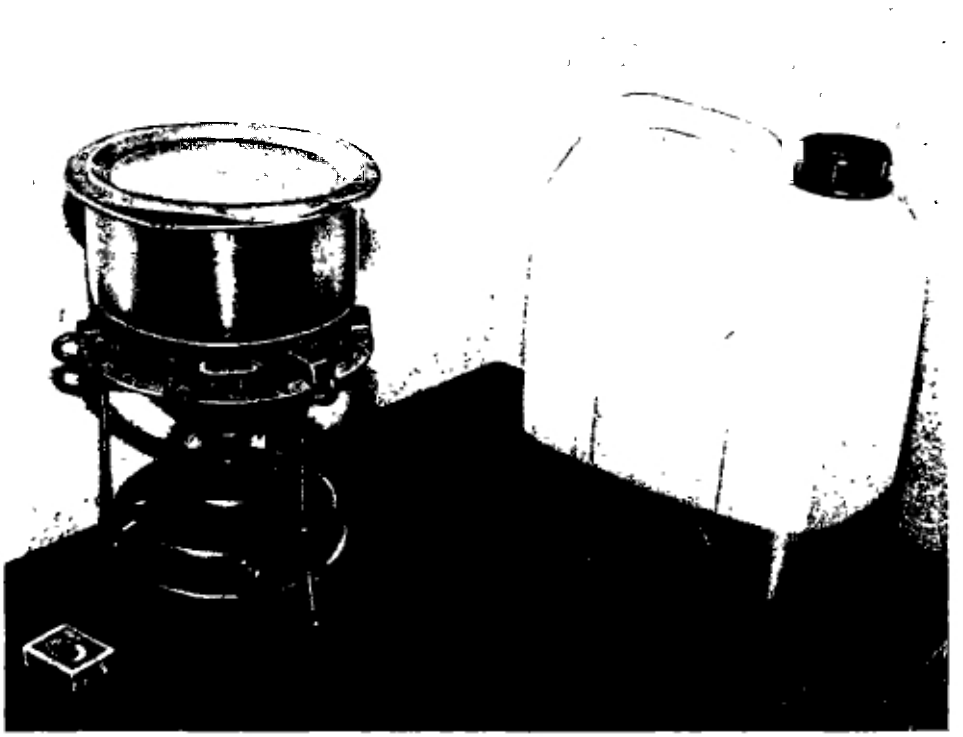
We spare forests, because we don't cut trees for fuel

We know that the roots of trees hold rain water and prevent erosion

We know that because of the shadow of trees, soil remains damp for a longer time

6. Biogas : A Substitute for Charcoal

$1m^3$ biogas is equal to 1 5 kg of charcoal
Every day we can save money by using biogas Every month it is a considerable amount and if we think of the whole year, it is quite a big saving
We also know that for years our forests are being destroyed for coal
We are cutting a lot more trees than what are being planted
We know, because of this our mountains are barren and in rainy season streams carry away large quantities of top-soil
We know, that our wells are often dry, because rain water flows away quickly



7. Biogas : A Substitute for Kerosene

$1m^3$ biogas is equal to 0.6 ltr Kerosene
By using biogas we don't just save money, but also get rid of the worries about availability and increasing prices of kerosene
We know, that our country has to export a lot of goods to be able to purchase kerosene
The goods that we export, we could use ourselves But we have to export them, so that we can buy kerosene
We know, that our biogas-plant will not only help us, but also our country

8. Biogas : A Substitute for Cow-dung Cakes

$1m^3$ biogas is equivalent to 13 kg of cowdung-cakes
Because we are poor, we have to burn dung and consequently we become even poorer
We know, that it is a waste to burn cowdung, because we need it more as fertilizer to maintain the quality of soil
We know, that the heat produced by burning biogas —which we obtain from dung —can be utilized in a better way than by burning cowdung cakes directly
We know that with a biogas plant we get both —fuel and fertilizer

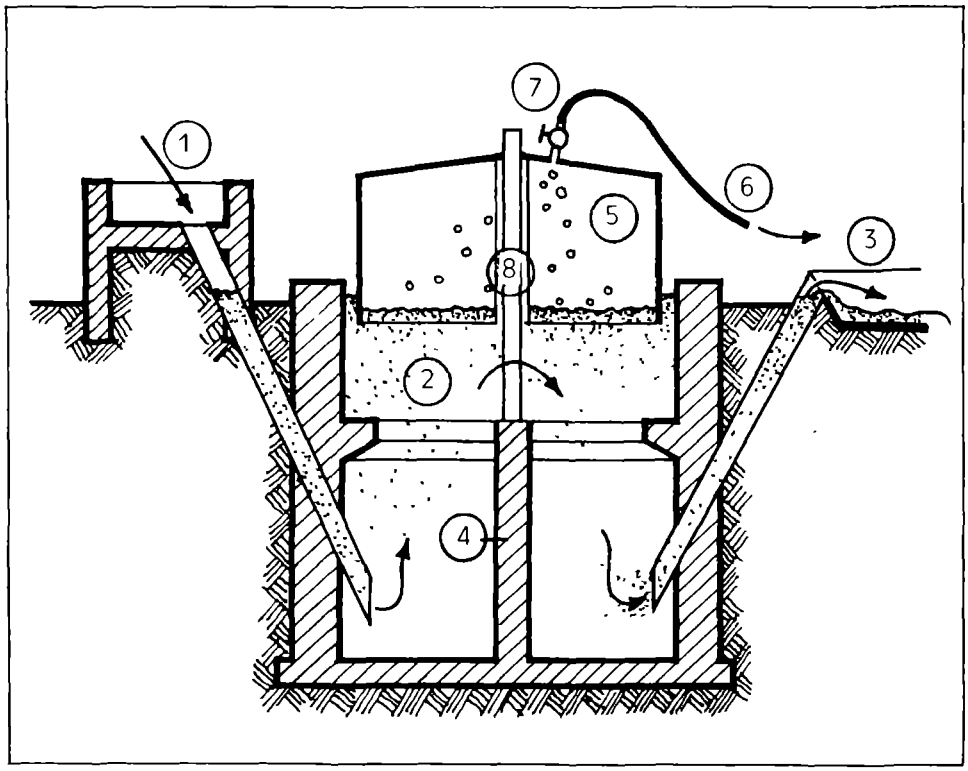
9. Slurry as Fertilizer

We know that sludge is a good fertilizer
Sludge is an even better fertilizer than fresh dung
Why?
Because it makes the soil soft and it contains more nitrogen in water soluble form than in fresh dung
This means, nitrogen can be absorbed more easily by the plants
Therefore sludge is more useful especially for fast-growing vegetables
We mix up sludge with a heap of compost (3 parts compost, 7 parts slurry) to prevent nitrogen escape in the air
Decomposed sludge is an ideal fertilizer for our kitchen garden

10. Use of Slurry as Fertilizer

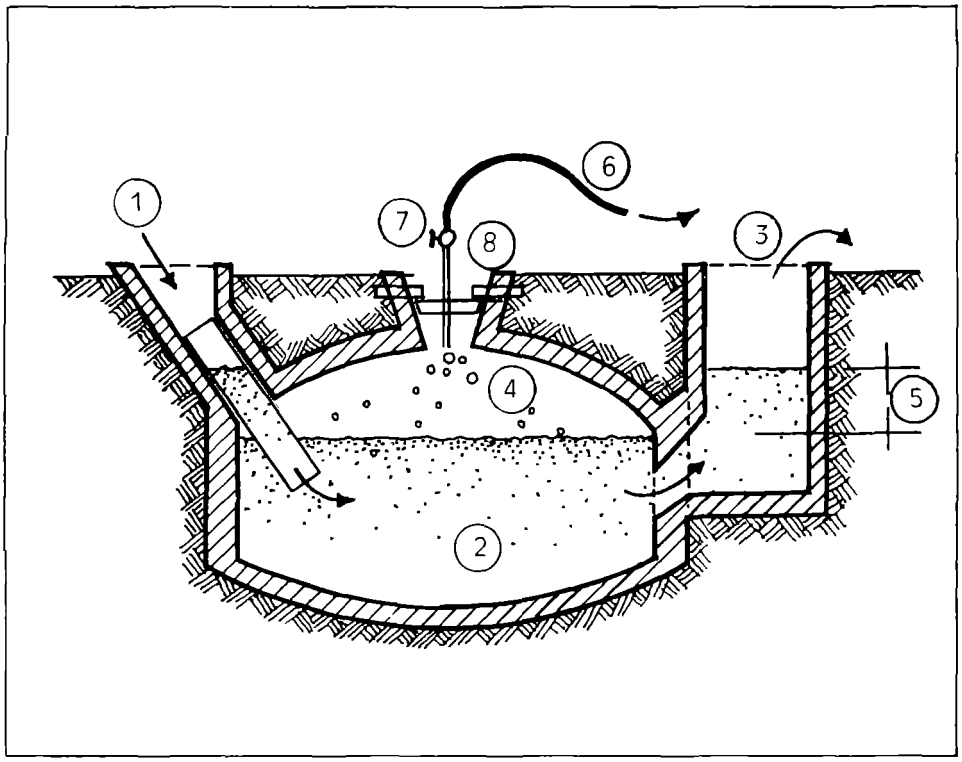
For slow-growing plants, like corns slurry is used as fertilizer right in the beginning.
Because bio-sludge is quickly absorbed and used by the plants, in a later stage we have to add some chemical fertilizers or again organic manure

With slurry corn ripens faster and probability of catching disease is minimised It has been proved, that lodging of rice from blast disease is reduced by 80% if slurry is used instead of only compost



11. Biogas System with a Floating Gasdome

Here is a cross-section of a plant, which is mainly used for cow-dung The shape of digester can be shallow, deep or domelike In the mixing-chamber (1), dung is mixed with water and the plant is filled For about 45 days it remains in the digester (2), before it comes to the outlet (3), there is a slanting partition wall (4), in the digester, so that the fresh dung, which is again filled in, does not directly escape to the outlet While slurry ferments, biogas is formed and collected in the floating dome (5) A pipeline (6), brings gas to the kitchen While gas is being consumed, dome sinks Between the gas-dome and gaspipe the main gas tap (7), is fitted in the beginning of the gaspipe The dome is fixed on a guide-pipe (8), so that the gas holder does not tilt In some designs of plants gas is carried from inside the dome to kitchen by an underground pipeline

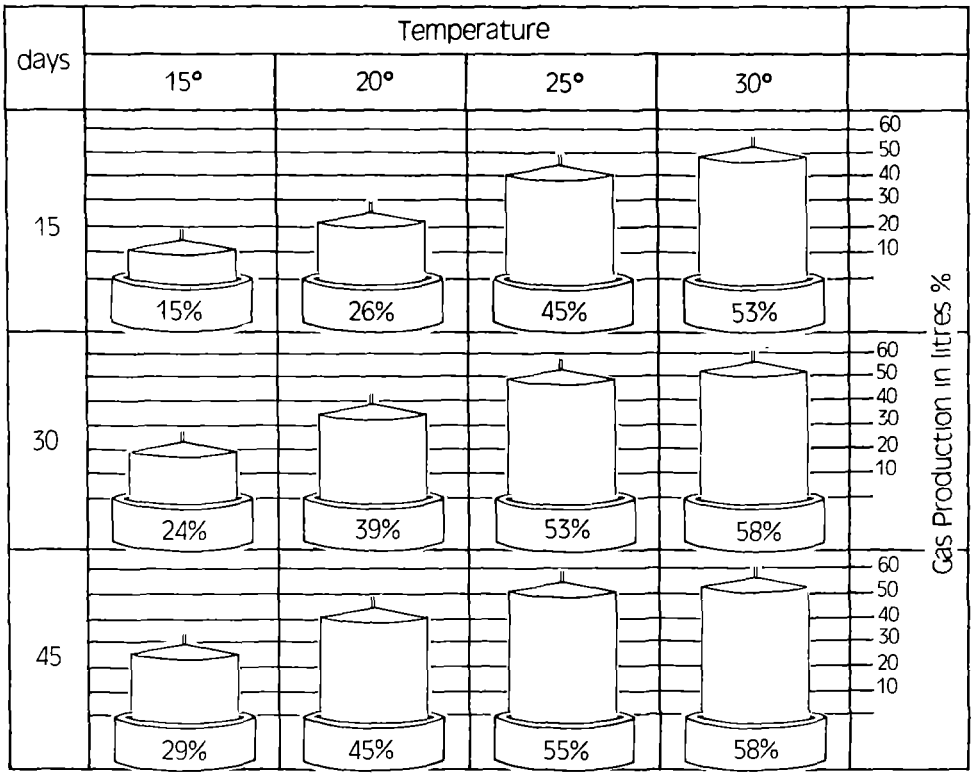


12. Biogas System with Fixed Dome

Here is a cross-section of plant, in which mainly straw and grass is used Millions of such plants are already in use in China

Dung-baskets (1) are used to fill the digester with dung and garbage mixed with water The sludge ferments in digester (2) before it escapes to the outlet (3) The gas is collected in dome (4) and the sludge is pushed down by its pressure With that the sludge rises on both the sides upwards in inlet and outlet chambers The difference between the levels of sludge in the digester and in inlet-outlet-chambers marks gas-pressure (5) Gas is carried to kitchen by a pipeline (6) The main gastap (7) is fitted to this pipeline right in the beginning

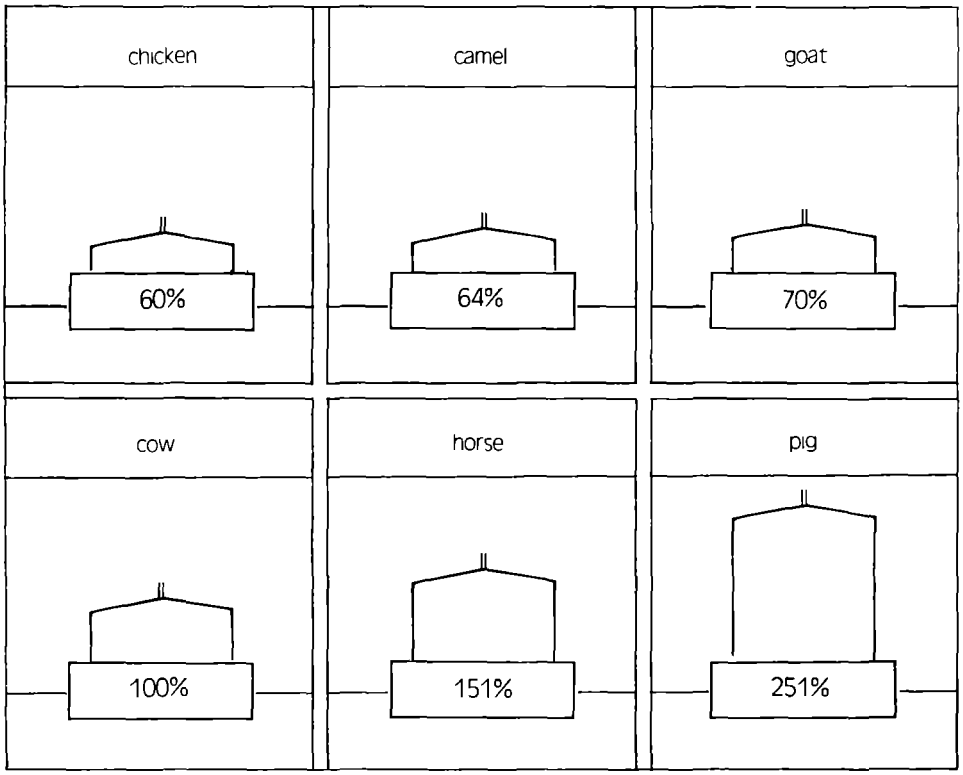
Even this plant we can fill and empty every day like the plant with floating dome But we can also fill in straw, grass, leaves etc once and take it out after months, when fertilizers are needed, from the upper opening (8) of the dome So we can even directly connect the drainage from toilets or supply other dung to the plant everyday



13. How Biogas Is Produced?

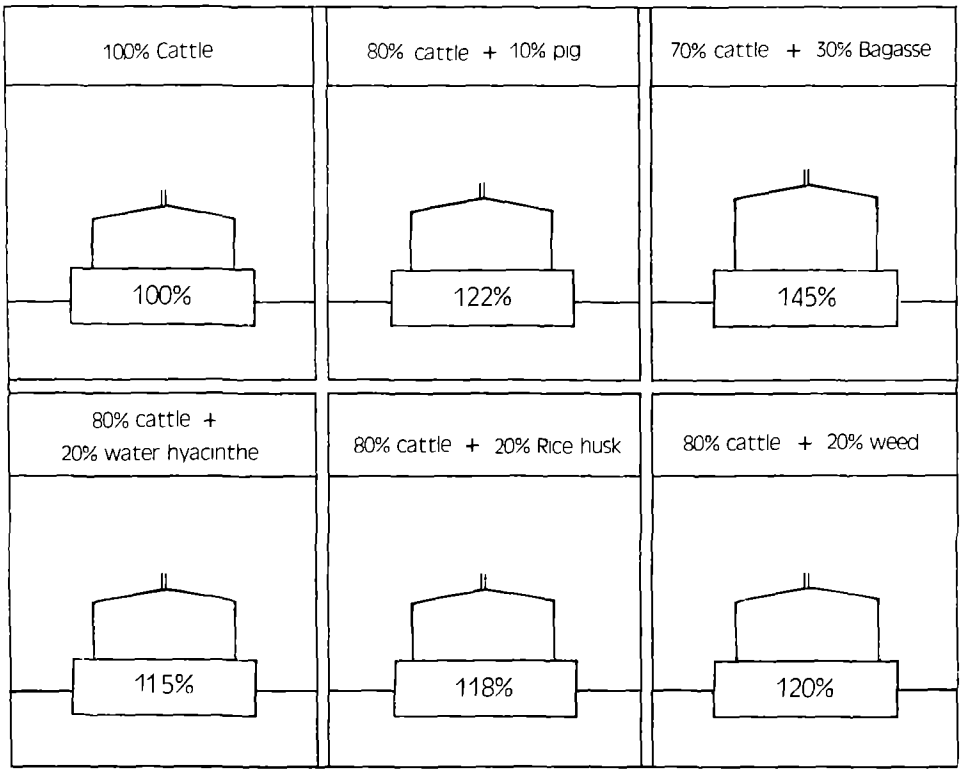
Biogas is produced by bacterial fermentation Bacteria are very small organisms and can not be seen by the naked eye The production of biogas also depends on atmospheric temperature

Bacteria require some specific time to produce gas from the dung and garbage More the heat, faster is the gas production Therefore, we can not produce more gas by filling the plant with more material because temperature is low The more we fill in, the faster it overflows, leaving even shorter time for bacteria to produce maximum quantity of gas Bacteria produce maximum gas at a constant temperature of 35°C In warm countries with 30°C during the day, the fermentation period is generally 45 days If this period is cut short, less gas is produced



14. Use of Organic Waste in Biogas Plants

Nearly all organic waste can be used in a Biogas plant The gas production differs With fresh cow dung 35 ltr gas per kg can be expected



15. Mixing of Different Organic Waste

The diagram shows how successful it is to mix various organic wastes

16 Dung : Suitable Waste Material for Biogas Plants

Cowdung is suitable for all sorts of biogas-plants It is homogeneous, not fibrous and mixes well with water It also contains enough methane producing bacteria and therefore gas production starts only after a short period Human excreta is also suitable to produce biogas If the drainage from toilets is directly attached to the biogas plant, spreading of worms and other pathogenes are automatically prevented

17. Biogas for Cooking

We construct this plant mainly for the convenience of cooking If we use gas carefully we can use it for a longer period
In a big family only 1 8 m^3 gas is required per day for cooking, provided we use it carefully and do not let half of it go waste through leakages in gas pipes

Per adult person per day 225 ltrs
i e 0 225 m^3 gas is consumed
If a family consists of 5 adults and 6 children, to calculate the gas-consumption, 2 children = 1 adult — i e 8 persons, gas consumption is 8 × 0 225 = 1 800 m^3 or 1800 ltr per day

Please read l in place of m^3 in the last column

1 ltr water boils in	10 min and	consumes 40 m^3 gas
5 ltr water boils in	33 min and	consumes 165 m^3 gas
To cook rice for 5 persons (500 g) it requires	30 min and	consumes 140 m^3 gas
To cook rice for 10 persons (1000 g)it requires	37 min and	consumes 170 m^3 gas
To cook dal for 5 persons (350 g)it requires	60 min and	consumes 270 m^3 gas
To cook dal for 10 persons it requires	70 min and	consumes 300 m^3 gas
To make tea for 5 persons (5 cups) it requires	5 min and	consumes 40 m^3 gas
To make ten chapaties it requires	40 min and	consumes 350 m^3 gas
For making chapaties we require two burners, one for frying on pan and another for roasting directly on flames		

18. How Much Gas is Required for Cooking?

The experienced women, who use gas for cooking, say "Cooking is no more a tedious job Its much more convenient and easy to cook on gas No hardwork and botheration of handling thorny bushes and collecting firewood No problem of lighting damp sticks No smoke and eye ailments
Its less troublesome and less tiring to cook on gas We just have to light matchstick and open the gastap and there we have the fire ready!
Besides we save time and money and more over national wealth, by conserving trees
For a more happy and comfortable life use gas!"

(Note The above statistics would be useful for the housewives as a guideline)

19. Other Uses of Biogas :

Of course for light One gas lamp consumes around 0 14m^3 gas per hr , that means consumption is high Therefore it is advisable to use it, only if there is no electricity
If there is enough gas at our disposal, we should run a diesel generator on gas to produce electricity (70% biogas, 30% Diesel) An engine consumes around 0 40 m^3 per hr per hp With that, of course, one can pump water or run machines There are also refrigerators running on biogas, consumption is around 2 4 m^3 a day for a 200 ltr refrigerator
But in case of smaller biogas-plants like ours, gas should be used in the first place for cooking

20. Two Fold Advantage of using Dung in Biogas Plant

We know the uses of biogas-plants and we also have the relevant statistics

1 m^3 gas is equivalent to 0 6 ltr of kerosene

1 m^3 gas is equivalent to 1 5 kg of coal

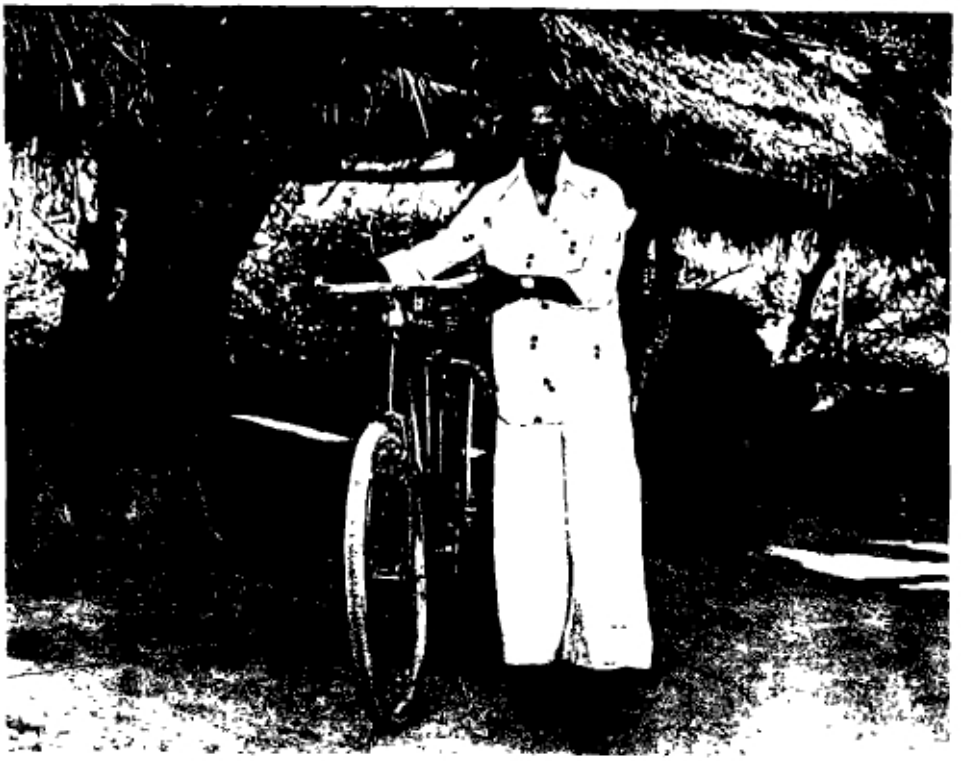
1 m^3 gas is equivalent to 3 6 kg of wood

The fermented slurry is richer as a fertilizer by 10% than the normal dung Using one tonne of slurry is like gaining 100 kg additional dung

By using biogas we save all the dung, and by using slurry as fertilizer we gain even 10% more, i e we profit by 110%, if we use biogas for cooking instead of burning cowdung cakes

Now we also know, how much a biogas plant costs The gasholder costs about $^1/_3$ of the whole plant The longer the plant is used, the more economic it will be, because we don't have to replace the parts so soon

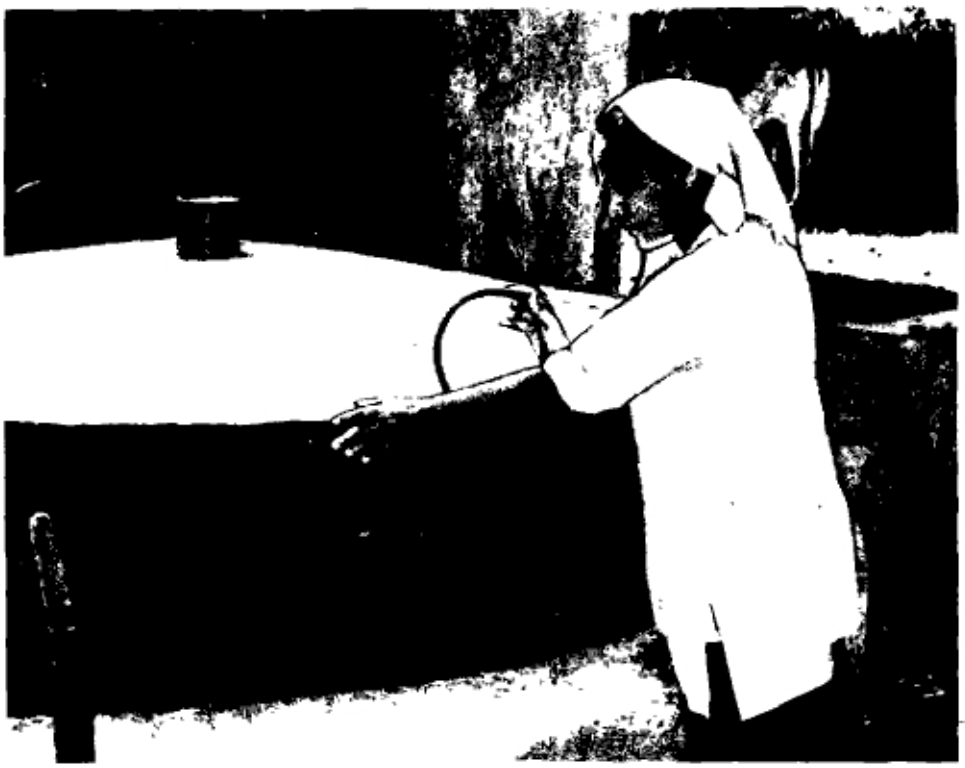
By regular and careful maintenance we can save money



21. Biogas Plant . Easier to Maintain than a Bicycle

Sometimes it is said, that a biogas system is too complicated to be a success in villages
This is nonsense
A bicycle is much more complicated than a bio-gas system, and there are millions of cyclists in villages all over the world

In most of the villages, there are shops for repairing bicycles Why cannot a bicycle-mechanic be also a biogas-mechanic?
The housewives themselves can carry-out most of the maintenance and repair work



22. How to Maintain a Biogas Plant?

In case of a floating gas-holder, we must turn it at the time of every filling to break the hard layer of scum, which accummulates on the top

See, that we don't break off the gas-connection

In case of a plant with a fixed gas holder, we must stir it every day

23. How to use Agricultural Waste Material?

Straw, grass and kitchen garbage must be chopped fine, before it is filled in the biogas plant, — water hyacinth leaves should be crushed and chopped fine

If we want to use long fibrous waste material, there should be provision to empty this plant easily The inlet and outlet passages must be broad enough and it should be possible to stir the slurry inside the plant

24. Filling Gas Plant

In any case the filling must be mixed well with water For 10 kg fresh cow-dung we require 10 ltr of water For 10 kg dry cow-dung we require 20 to 30 ltr of water Warm water is even more suitable for this mixture
We should take precaution, that oils or chemical don't get mixed in the slurry, as they poison it By using urine instead of water gas-production can be increased
It is better to fill the plant every second day (naturally with double the amount of material) Thus we get even more gas

25. Advantages of using Warm Waste Material

Once the dung is mixed with water we should keep it in the sun for a day and fill the plant in the afternoon, when it is most warm

If we cover the mixture with a plastic sheet it is heated even better and more gas is produced

26. Precautions for Winter

In winter we should cover the gas-holder with straw, so that the sludge remains warm If nights are chilly, we must cover the whole plant with a kind of green house

27. For Smooth Functioning of the Plant : Remove the Layer of Scum

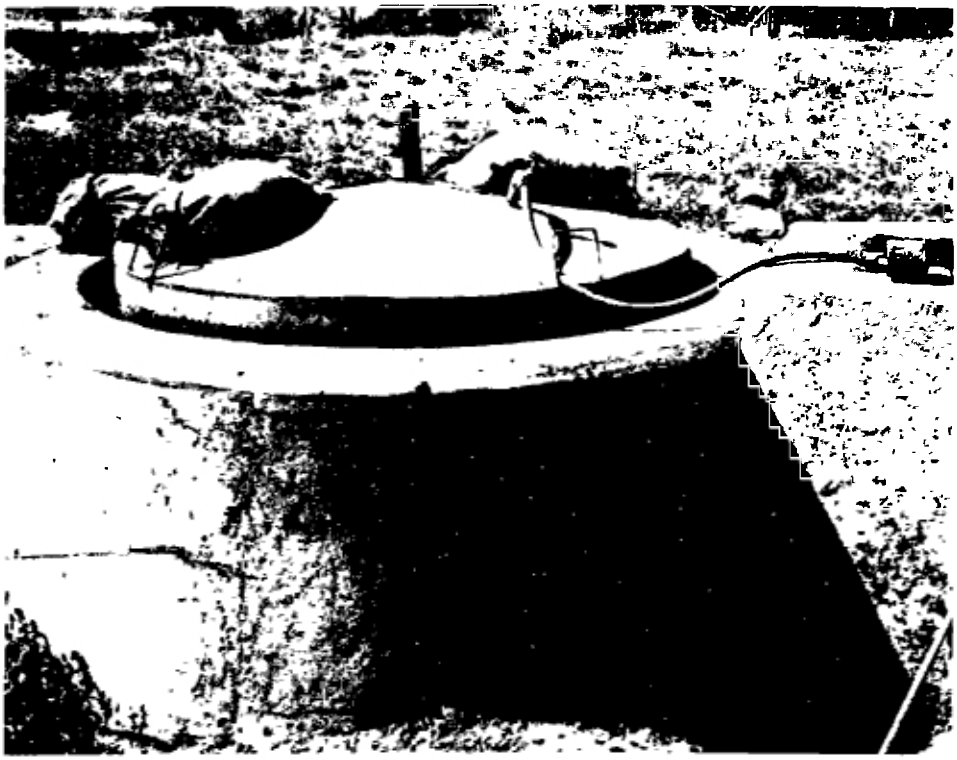
In plants with floating gas-holder scum sticks to the gas-holder, and then the gas-holder rusts faster. Therefore we should remove this layer once in a week

28. Wash the Walls of the Gasholder

When we remove the floating layer of sludge in plants with floating gas holders we should also wash sides of the gas-holder lightly Then the gasholder doesn't rust much and it remains intact for a longer time When we wash it, some water flows into the plant So mix less water with the dung on that day

29. Paint the Gasholder

We must paint the gas-holder once every year or at least once every two years
We close the main gas-tap and let the gas-holder raise to its maximum height
After we scrape the old paint and especially the rust with a wire-brush, we wash the gas-holder clean and let it dry
Then we give at least one coat of red-oxide as base and twice oilpaint or bituminous paint Epoxyd paint is the best, but also the costliest
If we live close to the sea, where things rust faster, we must paint even more often If crude oil is regularly available, the steel gasholder can be painted with it Here we must note, that mineral oils affect cement badly and in course of time cement gasholders may be damaged if we use crude oil



30. How to Increase the Gas Pressure?

If gas-pressure is less, we should lay stones or sandbags on the gashoder to increase the pressure

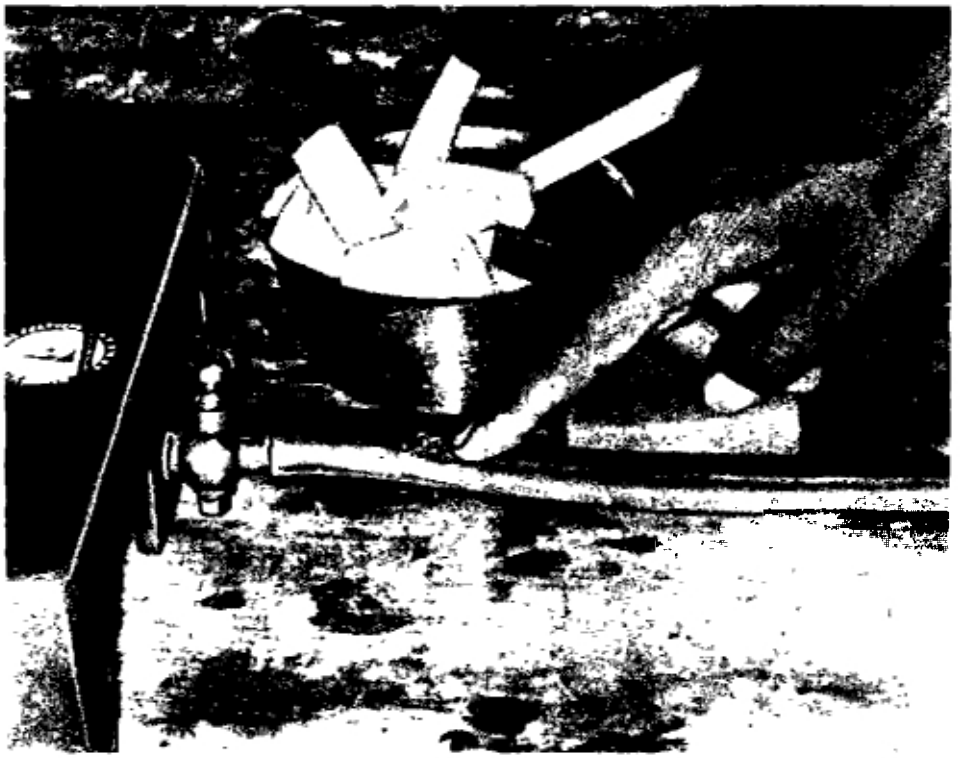
Caution With too much pressure there is more gas-consumption and more wastage of gas, if there are any leakages

31. Odourless Slurry : Sign for Good Functioning of the Plant

When slurry is odourless, we know that the plant is working well and the material filled in is digested well Excess of green leaves, grass, apple peelings in the plant, make the slurry too acidic and it smells sour or stinks In that case we should fill in only water or water with lime (calcium) or with some soap for a few days If it doesn't improve even after some weeks, we must empty the whole plant

32. How to Repair a Gastube?

The gas-tube sometimes gets damaged, often where it is bent In the picture someone has tried to repair it with a tape This is not the proper method Easier and better would be to cut the tube and attach again to the pipe, usually the tube is long enough When the tube is to be replaced, we should choose a flexible material



33. How to Find Out the Leakage?

When we think, there is a leakage in the tube, we should paint soapwater on that place On the holes we see soap bubles The best thing is to repair it immediately That is to cut it short or replace it But before that we should not forget to turn off the main gastap at the gasholder

34. Precautions : If Gas Leaks

If the gas tube comes off suddenly and we are not able to turn off the main tap immediately or if it smells strongly of gas and we are not able to find the leakage

— Open all the windows and doors

— Do not light a fire

We should hold the tube tight, so that the gas doesn't escape till people have left the house or someone has turned off the main tap of the gasplant

Only when there is no smell of gas there is no longer danger of explosion

35. How to Check Gas Consumption?

How to check gas-consumption?
The easiest way will be to see how much the gasholder sinks while cooking
Before cooking we measure the difference between the top of the gasholder and the wall of digester suppose it is 30 c m After cooking we measure the difference again and now it is 25 c m That means the gasholder has sunk 5 cm (or 0 05m)
How much gas does it hold?
The diameter of the dome is 1 60 m
i e the radius is 0 80 m
the cross-section area of the dome is calculated by
$r^2\pi$ (π is a fixed value of 3 14, which is required for calculations of a circle)
$0\,80 \times 0\,80 \times 3\,14 = 2\,00\ m^2$
The volume occupied or gas used is
$2\,00\ m^2 \times 0\,05\ m = 0\,100\ m^3$ or 100 ltr
The housewives can take help of teachers if they are not used to calculating In this way we can measure the gas consumption in the morning, afternoon and the evening, when we cook or make tea
This is our gas-consumption for the day We divide that with number of persons and - know the gas consumption per person
If the result differs much from 0 225 m^3, either we are too conservative or too wasteful in using gas or we have made a mistake, so better calculate it once again

36. How to Find Out Gas Production?

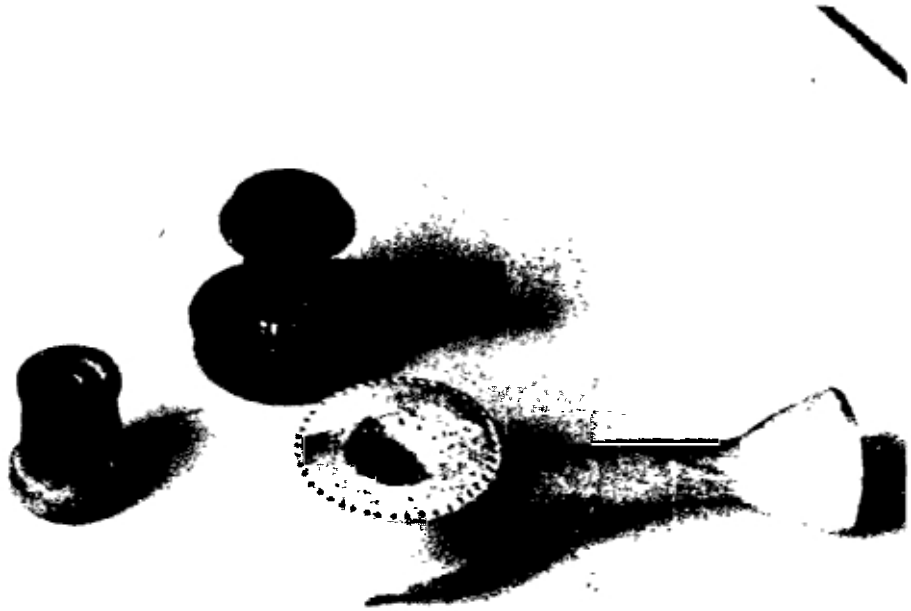
We measure and calculate the gas-production in the same way as we do for gas-comsumption We first measure the height of the exposed wall of the gas-holder from the digester after cooking and then before cooking for the next meal We also measure the height for the last-time in the day after dinner and then before break-fast When we add it together we get a production for the day

If we want to know, whether our plant is functioning well, we must know how much dung we fill in Therefore we must weigh exactly, how much dung we fill in everyday
1 kg fresh dung must give at least 30 ltr gas i e 0 030 m^3 Usually it is around 0 035m^3 per kg
As a thumb rule one can say that the dung of one cow produces enough gas to cook for one person

37. Burners and Air Supply

Gas consumption depends very much on the burner A good gasburner requires less gas A good burner is so made that air is mixed well in the appropriate quantity If too little air is mixed, gas doesn't burn fully If too much air is mixed, the heat produced is not concentrated at one place

i e flame is not hot enough
Of good burners, we can adjust air supply The best way is to try out at which point water takes the least time to boil If we cannot adjust it, we can request the biogas servicemen to give a demonstration
We must clean burners regularly



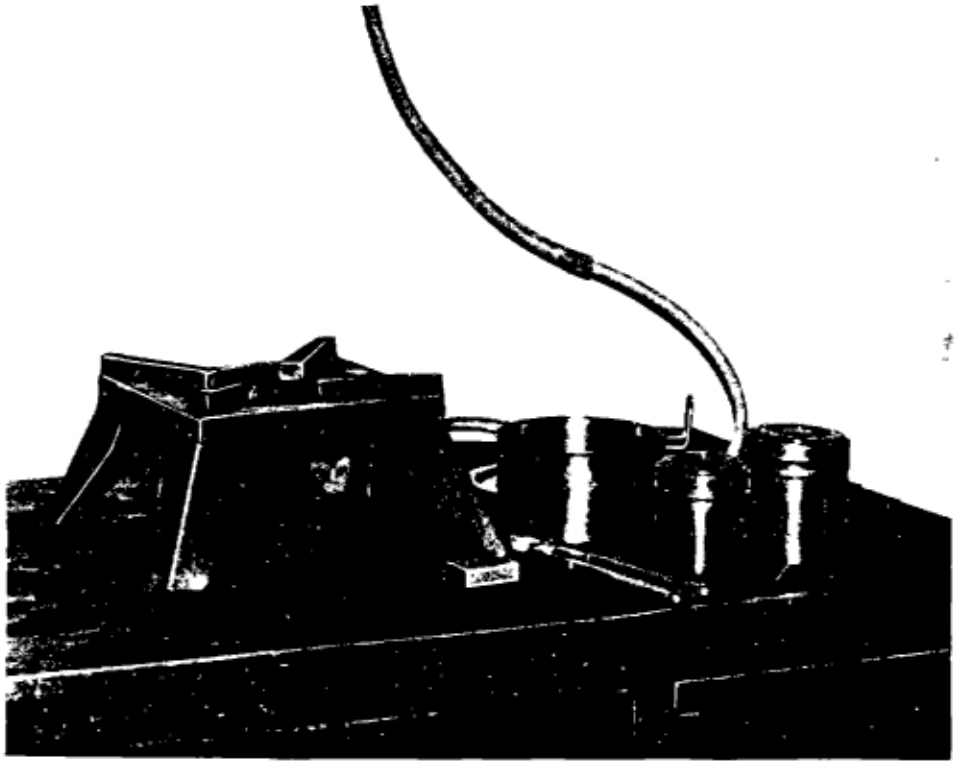
38. How to Make a Burner?

Good burners are costly One who wants to save money can get a burner made by a potter or use a container of clay filled with stones which doesn't rust
But we must see, that 5 times as much air is supplied to the gas, so that it burns well
The size of the holes of the burner should be adjusted accordingly
Remember if the burner is not constructed well we use more gas!

39. How to Use Gas Most Profitably?

The gas is best used, when the flames don't heat up air but the pot

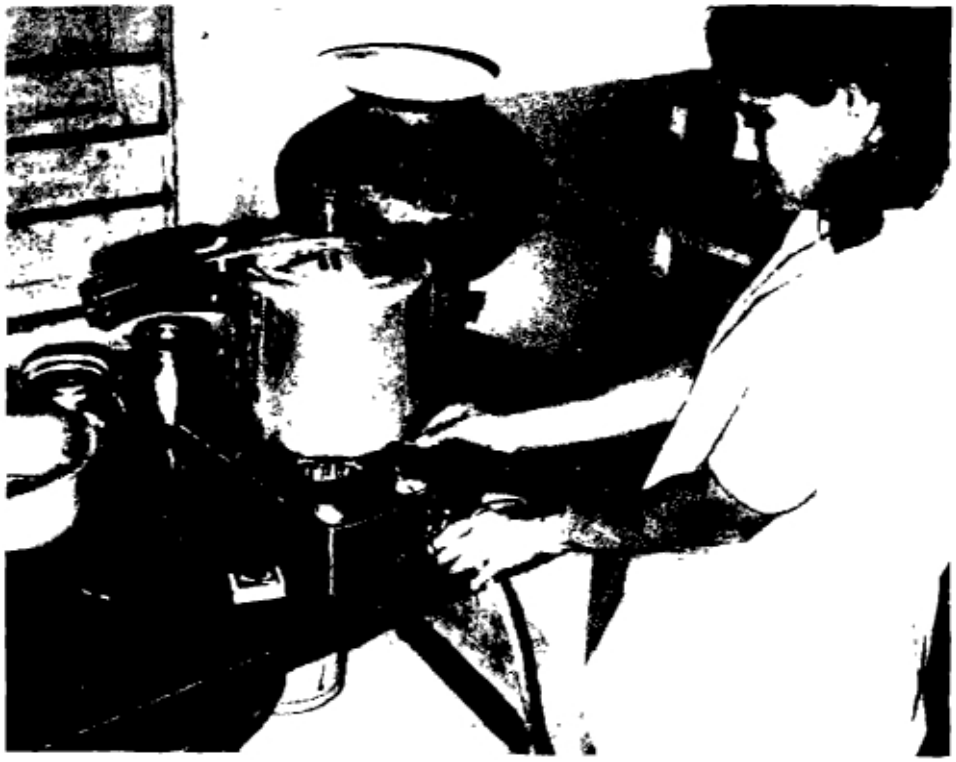
1) The bottom of the pot must rest at the point, where the flame is hotest The distance between the burner and the pot should be around 2 5 cm = 1"
2) At least on three sides around the cooking place there must be a small wall of clay, so that the pot remains hot longer and the cool air around doesn't cool it down fast
3) We must keep a lid on the pot, whenever possible
4) Regulating the flame
   The flame shouldn't be too big, as the heat is wasted, neither should it be too small as it will be ineffective That is the air will cool down the pots faster than they are being heated
5) We should not regulate the size of flames by lowering or increasing air supply The air supply must be adjusted only once in the beginning



40. Don't Waste Gas!

Gas is unnecessarily consumed, if the flame is already burning before you mix up the spices etc

So do the necessary preparations, like cutting the vegetable first and then lighting a matchstick and then switchwing on the gas



41. And Remember

First strike the match and then switch on the gas

42. And something more : Cleaning the Plant

Empty the plant from above Enter inside, when it is empty and ventilated Enter only with an electric torch and never with an open flame
To be sure, that the air inside is breathable, lower a hen tied with a string into the digester as precaution and see that it does not suffer from any ill-effects

Tie the person with a rope, before he gets into the digester If he feels uneasy others should pull him out immediately In any case they should not enter the digester while trying to help him, because they will also have the same trouble

43. Help Yourself : Use Biogas

An isolated gas-plant is of little help If all our neighbours have gas plants, many trees will be saved and a lot of good manure will be available and there will be less pests on the fields When we adults make efforts to improve our surroundings, the children will naturally join us
It will be a great help if every child plants his tree, takes care of the weak plants and waters them regularly

44. Biogas means Better and Happier Living

Rs. 10/-