World Water Solutions 1999

THE INDUSTRY REFERENCE FOR WATER PROFESSIONALS

PUBLISHED IN SUPPORT OF

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THE WORLD WATER COUNCIL

DVGW

DVGW DEUTSCHER VEREIN DES GAS- UND WASSERFACHES

Why our technology is taking root all over the world

The environment used to be especially a matter of commerce and very little of technology. However, for some time now the environment belongs to the field of high technology : a proven technology guarantees the best results and the lowest cost price.

Quite a number of economic and environmental errors can be attributed to misunderstanding and disrespect of the laws of nature. The essential aspect of the technology is based on the comprehension of these laws.

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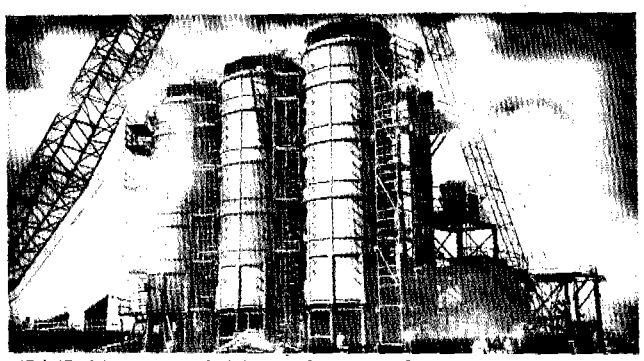
SEGHERSbetter technology operates for more than 20 years and in more than 40 countries, in the field of environmental technology and develops high-tech solutions with a very high efficiency (zero emission).

For the benefit of our environment.

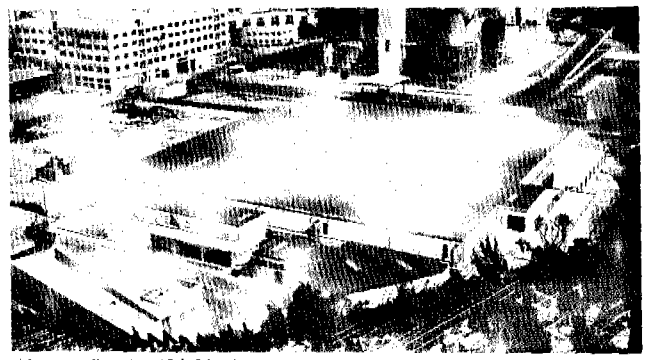
It is time : our environment is nearing her end.



SEGHERSsludge Dryer & Pelletizer, Baltimore USA.
Evaporation capacity 18.000 kg H₂O/h.
One of the largest sludge dryer & pelletizer plants in the world.

SEGHERSsludge Dryer & Pelletizer

Indirect multi-stage tray dryer-pelletizer, heated with either thermal oil or steam. Dust-free and granular sludge pellets with a dry substance content above 90% are obtained in one single process. The vertical construction allows optimal use of space.



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World Water Solutions

No.1 1999

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Foreword

Water is essential to all forms of life, ecosystems and human activity. The world's fresh water resources are finite in nature; and at the same time, only a small fraction is accessible and readily available for human use and for ecological systems.

Wisely used, water means harvests, health, prosperity and ecological abundance for the peoples and the nations of the earth. When badly managed or out of control, water contributes to economic underdevelopment, poverty, diseases, floods, droughts, erosion, salinisation, waterlogging, silting, environmental degradation and human conflict.

The World Water Council was established as an international non-governmental water policy think tank to deal with water issues of global concern and to meet the challenges to the present and future sustainability of the planet. One of its first priorities is the development of the 'world water vision' for life and the environment for the 21st century. The Vision for World Water is fundamental to unifying world leaders and decision makers towards shared objectives, clearly defined targets and realistic commitment. The World Water Council realises the importance of such action and accords it top priority in its programme of work.

In order to communicate the Vision to major world bodies, the Council has set up the World Commission on Water for the 21st century, comprising 21 well-known world leaders and decision makers who shall advise, validate and review, both the intermediate and final Vision document. The Commission will be assisted by specialised panels of experts drawn from among the world water leaders.

The final Vision document is expected to be presented publicly during the World Water Council Second World Water Forum scheduled for March 2000 in The Hague, The Netherlands.

In the meantime, this edition of *World Water Solutions* brings you a range of articles covering a variety of issues, from waste water management and treatment to IT and technology, providing invaluable information for all those involved in the water industry.

Mahmoud Abu-Zeid

By Dr Mahmoud Abu-Zeid, President World Water Council; Minister of Public Works and Water Resources, Egypt

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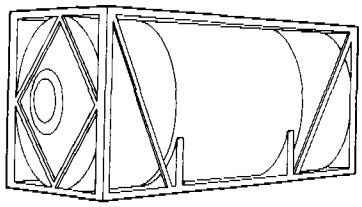
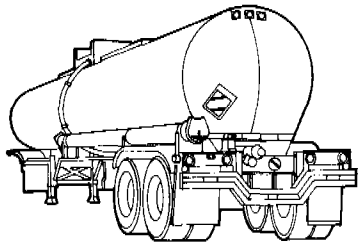
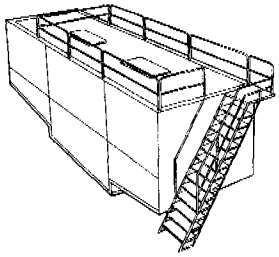


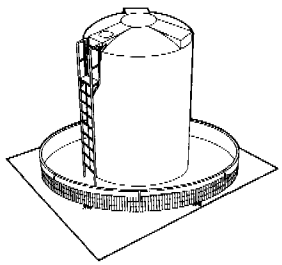
5,300 Gallon
ISO Tank Container



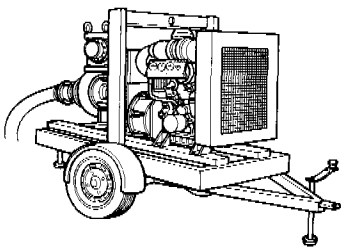
5,800 Gallon
Stainless Steel Tank Trailer



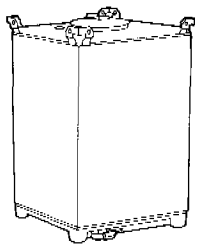
17,400 Gallon
Steel Tank



5,400 Gallon
Polyethylene Tank



Pumps, Pipe & Hose
50mm to 300mm



450 Gallon
Stainless Steel Tank

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Eco-friendly waste management

SEGHERSbetter technology is a rapidly expanding company that, with its state-of-the-art technology, has successfully penetrated the fast-growing market for waste management and the environment

The people of Denmark are very environmentally aware; and, because of this 'green thinking', both Danish authorities and Danish companies are always looking for new and better technology to solve environmental problems in the best possible way. As a result, the Avødre waste water treatment plant (WWTP) in Copenhagen chose SEGHERSbetter technology to resolve its sludge problem. The plant has signed an agreement with SEGHERSbetter technology, for the purchase of a new sludge evaporation/combustion plant.

The new sludge evaporation/combustion plant is to replace that already in existence. The current incineration plant has been in operation since 1975 and incinerates approximately 7,000 tonnes of sludge each year (dry-matter weight). The decision to build a new plant was taken because it was judged that this would be the best solution both at a financial level and in order to ensure optimum environmental protection. The new plant has a capacity of 8,000 tonnes of dry matter and a reservoir has been installed in case this quantity of sludge should be exceeded. The plant will be the only one of its kind on Danish soil.

With this new sludge evaporator/combustor Denmark is acquiring one of the most advanced sludge treatment installations in Europe. To further reduce its effect on the environment, the plant has also opted for a flue gas cleaning plant which meets much more stringent requirements than those imposed by the Danish authorities when approving plant. The maximum amount of dust, heavy metals, acidic gases and dioxins will be recovered from the flue gases, so that current legal requirements are easily achieved.

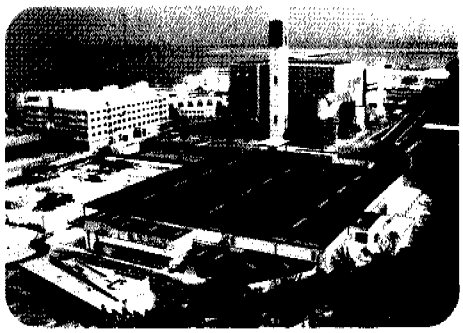
The main advantages of the system are that it offers efficient and complete evaporation and combustion and low operational costs

SEGHERS' sludge evaporator/combustor at Copenhagen, Denmark

The main advantages of the system are that it offers efficient and complete evaporation and combustion and low operational costs (since all the energy is returned to the furnace, auto-thermal operation is easily achieved, and this results in much lower electricity consumption).

SEGHERSbetter technology for WATER is a technology supplier for industrial and municipal waste water treatment as well as for the production of process and drinking water. In addition, the company offers solutions for manure and compost processing, on-site soil decontamination and off-gas treatment. It designs, engineers, builds and provides process control for plant, and can even operate plant if required.

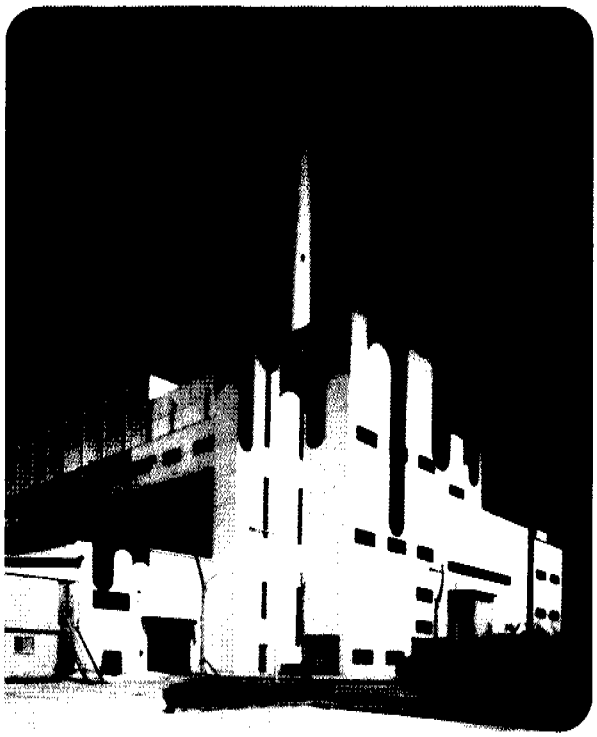
The increasing world population and accompanying pollution has led to serious drinking water shortages. To help with this, SEGHERSbetter technology for WATER offers one of the most widespread technologies for sewage treatment: the UNITANK. This system is based on the biological treatment of industrial and municipal sewage, with additional physical and chemical treatment if necessary. This technology is compact and has minimal environmental impact. SEGHERSbetter technology for WATER is a world leader in its industry sector and has developed this presence thanks to its network of sales offices, licensees and joint ventures.



SEGHERS' zero-emission UNITANK

SEGHERSbetter technology for WATER is renowned for winning an important order for a process water treatment plant (demineralisation and softening) for APC, one of the largest petroleum refineries in Egypt. In addition, more than 200 waste water treatment plants and more than 1,000 water treatment plants have been equipped thanks to the excellent, cost-effective solutions provided to the customer by SEGHERSbetter technology for WATER, which demonstrates its commitment to projects from start to finish.

As discussed above, dealing with the current and future waste mountains of the world is, and will be, a great challenge. SEGHERSbetter technology for Solids+Air offers unique total solutions for waste power plants, sludge drying/pelletising, sludge evaporation/combustion, medical waste and flue gas cleaning. This also covers the analysis, engineering, construction and operation of plant.



SEGHERS' waste-to-power plant in Seoul, Korea

The SEGHERS Waste-to-Power Plant is the best solution for those companies needing help to cope with the continuously increasing amounts of solid waste generated in the industrial world as well as the increasing shortage of available landfill space. It has already proved itself in many plants worldwide. The technology used ensures lower capital investment coupled with higher throughput and energy production.

The SEGHERS Multi-stage combustion grate is the only mass-combustion system with an independent waste throughput and waste mixing/aeration action. This unique principle of decomposing vertical (mixing/aeration) and horizontal movement (throughput) allows systems to adapt easily to short- and long-term fluctuations in waste composition.

The grate used offers multi-stage combustion zones allowing a combined process of drying, gasification and burn-out to take place. To achieve perfect control of this process, the furnace is composed of multiple grates which can be of different lengths, thus creating three distinctive grates: the drying grate; the gasification grate; and the burn-out grate.

The steering and control unit of the SEGHERS Intelligent Grate Master (SIGMA) can take full control of furnaces and all related processes, such as energy recovery and flue gas cleaning. Also available is SEGHERS' Sludge Dryer and Pelletiser - ideal for drying and pelletising municipal and industrial sludge in one stage. Its evaporation capacity ranges from 150 to over 7000kg H_2O per unit per hour. The system produces dust-free sterile pellets with an average diameter of 2mm and a dry solids content of between 90 and 98 per cent. These pellets can be used for many applications:

- organic fertiliser (as a slow-release fertiliser or soil improver, providing a natural source of nitrogen, phosphorus and other nutrients; the pellets have been successfully applied to lawns and golf courses, and used in horticulture)
- sludge-derived fuel (due to the high heating value of the pellets, they can be used as an excellent fuel for co-combustion or as a feedstock for gasification)
- sludge-derived products (advanced research is opening up various new applications for the pellets - sludge to methanol, oil from sludge production and conversion of sludge into activated carbon, for instance). ●

FOR FURTHER INFORMATION:

Please contact: SEGHERSbetter technology Group, Hoofd 1, B-2830 Belgium Tel: + 32 (0)3 880 77 00 Fax: + 32 (0)3 880 77 99 E-mail: info@seghers-group.com
Website: www.seghers-group.com

World water watch

The latest European legislation affecting water quality and quantity

Helmut Blöch, Head of the **Water Protection Sector** of the **European Commission**

Early European water legislation began, in a 'first wave', with standards for those of our rivers and lakes used for drinking water abstraction in 1975, and culminated in 1980 in setting binding quality targets for drinking water. It also included quality objective legislation on fishing waters, shellfishing waters, bathing waters and groundwater. Its main emission control element was the *Dangerous Substances Directive*.

Addressing pollution from urban waste water and from agriculture, in 1988 the Frankfurt ministerial seminar on water reviewed the existing legislation and identified a number of improvements that could be made and gaps that could be filled. This resulted in the second phase of water legislation, the first results of this were, in 1991, the adoption of the *Urban Waste Water Treatment Directive*, providing for secondary (biological) waste water treatment, and even more stringent treatment where necessary, and the *Nitrates Directive*, addressing water pollution by nitrates from agriculture.

Other legislative results of these developments were Commission proposals for action on a new *Drinking Water Directive*, reviewing quality standards and, where necessary, tightening them (final adoption foreseen for 1998), and a *Directive for Integrated Pollution and Prevention Control (IPPC)*, adopted in 1996.

The arrival of this second wave of legislation meant that all of those involved in European Community water legislation (the Council, the European Parliament, the member states, regional and local authorities, water users, green groups and consumer groups) have found themselves 'drowning' in water-related proposals! Just as the real problems and costs of implementing the *Nitrates Directive* and the *Urban Waste Water Treatment Directive* were being faced, the Commission laid on the table four more directives and an action programme.

The New European Water Policy

Pressure for a fundamental rethink of Community water policy came to a head in mid-1995. The Commission – which had already been considering the need for a more global approach to water policy – accepted requests from the European Parliament's environment committee and from the Council of Environment Ministers. While EU actions such as the *Drinking Water Directive* and the *Urban Waste Water Directive* can duly be considered milestones, European water policy had to address the increasing awareness of citizens and other involved parties of their water. At the same time, water policy and water management had to address problems in a coherent way. This is why the Commission developed its new European Water Policy in an open consultation process involving all interested parties.

The Communication was formally addressed to the Council and the European Parliament, as well as to all interested parties, such as local and regional authorities, water users and non-governmental organisations (NGOs). A score of organisations and individuals responded in writing, most of the comments welcoming the broad outline given by the Commission.

As the culmination point of this open process, EU Environment Commissioner Ritt Bjerregard hosted a two-day water conference in May 1996. This was attended by some 250 delegates, including representatives of member states, regional and local authorities, enforcement agencies, water providers, industry, agriculture and, last but not least, consumers and environmentalists. Following this wide-ranging consultation of interested parties – including the Brussels Water Conference – the Commission presented its proposal for a *Water Framework Directive*, with the following main objectives:

- expanding the scope of water protection to all waters, surface waters and groundwater
- achieving 'good status' for all waters
- water management based on river basins
- 'combined approach' of emission limit values and quality standards
- getting the prices right
- getting the citizen involved
- streamlining legislation.

Expanding the scope of water protection

All of Europe's waters will be subject to protection under the *Water Framework Directive*, including surface

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C.W. Neal Corp, a market leader for 30 years, provides high-quality, reliable flexible membrane storage systems that require minimal maintenance.

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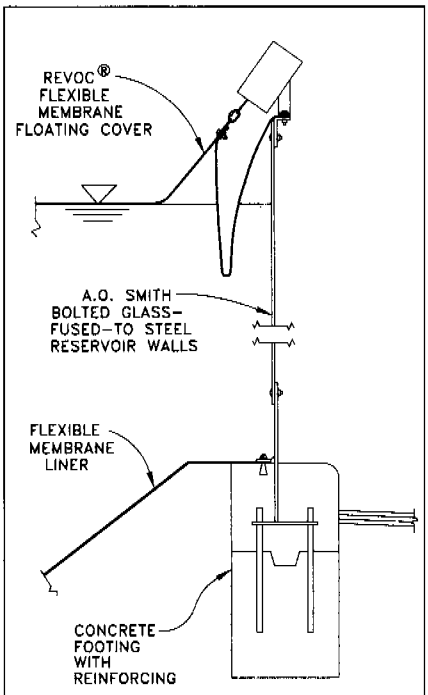

ECONOSTORE™ STORAGE SYSTEM

For further information circle (4)

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Water is available in abundance and yet it is so valuable. Pure process water is an expensive raw material and the quality of cooling and waste water is subject to strict regulations. Over many years KEMA has gained a great deal of expertise in the field of industrial water utilization, resulting in practical advice and countless innovations. Like the ones concerning growth reduction in cooling water systems, recycling of process water and management systems for conditioning. Or the use of ozone and ultraviolet radiation, biological processes and several membrane technologies for waste water treatment.

The strength of our "signature" lies in optimum adjustment between research, engineering, practical experience and thorough knowledge of legal provisions.

Except in the field of water, you are also likely to run into KEMA in the field of energy, environmental and quality management. As a contractor carrying out a subproject, or as a provider of a total solution.

KEMA is a global service organization with a staff of 1,400 people, serving international customers from the main office in Arnhem and various other locations throughout Europe, the US and Asia. Our customers include government agencies, power companies, processing companies, service companies and investment companies.

When we as KEMA put our trademark on something, then we're making it our business.

If you'd like more details about our activities, please contact us by phone at +31 26 3 56 37 15 or via internet: http://www.kema.nl

We make it our business.

KEMA

For further information circle (5)

waters and groundwater. (At present only a limited number of waters for specific human use, such as the aforementioned fishing waters, shellfishing waters and bathing waters, are protected under European legislation.)

Unlike previous water legislation, the *Framework Directive* covers surface water and groundwater together, as well as estuaries and marine waters. Its purpose is threefold: to prevent further deterioration in, and to protect and enhance the status of aquatic ecosystems; to promote sustainable water consumption based on the long-term protection of available water resources; and to contribute to the provision of a supply of water in the qualities and quantities needed for its sustainable use.

'Good status' for all waters by 2010

Under the terms of the Directive, member states will have to ensure that 'good status' is achieved or preserved in all waters by 2010. For groundwater, good status is measured in terms of both quantity and chemical purity; for surface waters, ecological quality is an additional criterion. Member states will need to establish programmes for systematically monitoring the quality and quantity of their groundwater and surface water.

Water management based on river basins

Waters do not respect administrative boundaries. Therefore the *Framework Directive* will – based on experiences gained in various regions throughout Europe – set the objective of water management based on river basins, as the natural geographic and hydrological unit.

Regions and river basins like those in the Maas, Schelde or Rhine basins have served as a positive example for this approach to water management, with their co-operation and joint setting of objectives across member states' borders, or in the case of the Rhine, the Oder/Odra or the Elbe/Labe, even beyond EU member states.

Programme of measures

Central to each river basin management plan will be the requirement for member states to establish a programme of measures to ensure that all waters in the river basin achieve the objective of good water status. The starting point for this programme is the full implementation of any relevant national or local legislation as well as of 11 items of Community legislation on water and related issues, including horizontal measures such as the *Directive on Environmental Impact Assessment* and the IPPC Directive. If this basic set of measures is not enough to ensure that the goal of good water status is reached, the programme must be supplemented with whatever further measures are necessary. These might include stricter controls on polluting emissions from industry or agriculture as well as from urban waste water sources.

Getting the price right

The need to conserve adequate supplies of a resource for which demand is continuously increasing is also one of the drivers behind what is arguably one of the Directive's most important innovations – the introduction of 'full cost-recovery' pricing. By 2010, member states will be required to ensure that the price charged to water consumers – such as for the abstraction and distribution of fresh water and the collection and treatment of waste water – reflects the true costs.

Getting the citizen involved

Caring for Europe's waters will require more involvement on the part of citizens, interested parties and non-governmental organisations (NGOs). To this end, the *Water Framework Directive* will require information and consultation when river basin management plans are established.

Streamlining legislation

Seven old directives are to be repealed. The *Framework Directive* will rationalise the Community's water legislation by replacing seven of the 'first wave' directives: on surface water and the two related directives on measurement methods and sampling frequencies, and exchanges of information on fresh water quality; the fishing water, shellfishing water, and groundwater directives; and the directive on dangerous substances discharges. The operative provisions of these directives will be taken over in the framework directive, allowing them to be repealed.

Conclusion

Europe's waters are in need of more protection and increased efforts to get them clean or to keep them clean. After 25 years of European water legislation this is a demand not only from the scientific community and other experts, but also, to an ever-increasing extent from citizens and environmental organisations.

The challenge of water protection is one of the great challenges for the European Union as it approaches the new millennium. Let us seize the initiative generated by the present political process on the *Water Framework Directive* for the benefit of all Europe's citizens and waters. ●

Please note that this contribution reflects the views of the author and not necessarily those of the European Commission

Water system management

Hydroconsult is a design, engineering and consulting company with 45 years' experience in the field of water systems and ecological structures

During its existence Hydroconsult has become a highly specialised company solving all the basic problems of water system management and structures, including environmental concerns. At present, Hydroconsult is involved in the design and construction of hydrotechnical structures, drinking and service water supply equipment, water supply and sewerage networks, and waste water treatment of all kinds.

Hydroconsult's experts work on complex designs at the highest level, as well as participating in a number of development and research tasks in co-operation with scientific, expert and supplying institutes and companies. Thanks to this experience, Hydroconsult can offer the most up-to-date and effective solutions – whatever the project.

Hydroconsult is active in the following fields:

- hydrotechnics and hydropower development
- solid waste treatment
- reclaiming of land and recultivation
- ecological structures
- waste water treatment
- structural engineering.

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Leachate treatment that really works

Treatment of landfill leachate is an important environmental issue in industrialised countries and Hadwaco's evaporation technology offers a successful method of dealing with it

The EU has recently issued new directives for landfill sites, while Spain and Italy – to name but two countries – have already set strict discharge limits on purified leachate quality. Hadwaco's evaporation-based solution for the treatment of landfill leachate is very effective in purifying leachate, meaning that requirements can be met, with lower operating costs than for other equally efficient methods.

Hadwaco's process was chosen to carry out leachate treatment at the Can Mata Landfill site in Barcelona, Spain. Plant was delivered in May 1998 to BFI Iberica, a subsidiary of international waste management company Browning Ferris Industries, and began operations in summer 1998. Can Mata Landfill is located some 35km north-west of Barcelona; it has an area of 34ha and a waste capacity of 5 million m^3. All criteria for a modern landfill are effectively fulfilled – electricity, for example, is produced from landfill gas – and emissions are continuously monitored.

Purified leachate is used for irrigation at Can Mata and concentrate is returned to the landfill body. Nitrogen is the most critical parameter in the purification process; ammonium nitrogen can be kept non-volatile by low pH evaporation. In this case, because of the high nitrogen content, evaporation is carried out in neutral conditions and ammonium is separated using air stripping. The ammonium-containing air from the stripper is washed with sulphuric acid solution in a scrubber. The end product, ammonium sulphate, is used as raw material in fertiliser production. Purification efficiency is 99.6 per cent giving a final nitrogen content of 15mg/l in discharge water. Another benefit of this process is that nitrogen will be purged out and not returned to the landfill. Increasing nitrogen content in the landfill body can, in the long term, have a negative effect on landfill gas production.

Prior to signing the Can Mata contract, extensive laboratory and evaporation tests were conducted to determine the characteristics of the leachate. Final evaluations were made through pilot tests at the landfill site during summer 1997.

Advantages of Hadwaco technology

Due to high nitrogen content and inappropriate nutrient proportions in landfill leachate, the purification efficiency of biological processes is moderate; furthermore, salts and heavy metals cannot be separated biologically. Evaporation is ideal for separating dissolved substances that cannot be removed using conventional chemical or biological methods.

Compared to membrane processes – such as reverse osmosis (RO) – evaporation is clearly superior in terms of purification quality and recovery rate. Hadwaco evaporators separate nutrients, heavy metals, organic chloride compounds and a number of other substances from water. Compared to RO, evaporation is less sensitive to alterations in the leachate quality and tolerates better solid substances and salt precipitates.

Evaporation is ideal for the purification of landfill leachate. However, conventional evaporators have high capital and operating costs. As a result of the main innovation of Hadwaco's technology – the polymeric heat transfer surface – the situation has changed. The low-cost heat transfer surface allows the use of large surface areas, which directly results in reduced energy use. Furthermore, polymeric materials are highly corrosion-resistant.

Another landfill leachate treatment plant was commissioned in Borgotaro, northern Italy, in summer 1998. In addition to full-scale landfill applications, Hadwaco evaporators have been delivered to a number of industrial customers: the largest plant currently operational is in a paper mill in Saudi Arabia with a capacity of 1,200m^3 of purified water per day.

Other applications include deliveries to a steel mill in South Africa (360m^3 per day), an industrial wiper laundry in The Netherlands (180m^3 per day), a tank-truck washing shop in Sweden (50m^3 per day) and a metal surface treatment plant in Finland (50m^3 per day). The number of new deliveries is expected to grow rapidly.

Hadwaco has been awarded first prize in the national eco-design category of the European Better Environment Awards for Industry (EBEAFI 98). Its winning qualities were cited as innovation, environmental friendliness and economical feasibility. ●

Hadwaco's unique evaporator refines your effluent into clean recyclable water in an efficient and affordable way.

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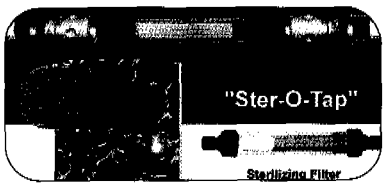
High-quality water – guaranteed

The Ster-O-Tap from US-based Alamo Water Refiners, Inc offers its users top-quality filtered water and, say its makers, it is unparalleled in capacity, capability and price

The Ster-O-Tap is a reusable ultra- or micro-filtration cartridge composed of many permanently hydrophilic (water-loving as opposed to water-repelling) capillary membranes, bundled and fixed into a single cartridge or tube in a dead-end mode. Although dead-end filtration is a common technique, the application of a bundle of asymmetric capillary membranes in dead-end mode (with the flow pattern as illustrated in the accompanying graphic) is new and utilises the unique properties of this membrane to the fullest.

Ster-O-Tap provides the dealer with a product that can provide the best quality of physically filtered water, unparalleled in terms of capacity, capability and price. Depending on membrane configuration, it is a technology that can remove all impurities: fungi, algae, bacteria, cysts, spores and other living organisms, and much more. Also, unlike many other filtration devices on the market today, it can be serviced on-site and integrity-tested by the dealer. Its ability to be backwashed and (non-chemically) heat sterilised could be one of its greatest strengths as far as the service-orientated dealer is concerned.



Ster-O-Tap has its origins in the flat-sheet medical membranes used in rapid blood analysis. Some of the applications of the original membrane include diabetic-testing strips, cholesterol-testing strips, and pregnancy testing kits. The extremely accurate control of the pore structure and hydrophilic (liquid-loving) benefits in the manufacturing of the membrane mean that it has become the industry standard.

Ster-O-Tap provides the dealer with a product that can provide the best quality of physically filtered water

The Ster-O-Tap has evolved from the same accurate flat-sheet membrane manufacturing process into a capillary (tubular) membrane form. Due to demand for a larger volume of filter medium (water), the capillary membrane was chosen as it is able to offer an overall higher surface area within a much smaller area.

The capillaries, which are sealed on one end, are embedded in an epoxy resin on the other side in a tubular cartridge. The water flows through the membrane wall, where the pore size decreases in the flow of water, to the inner bore of the capillary and then leaves the cartridge as filtered water. This asymmetric pore structure allows for feed components to be removed easily from the structure by reversing the flow through the membrane wall and backwashing from the small to the large pores.

This new technology has the capacity to make virtually any water source biologically sterile

The combination of hydrophilicity, asymmetric pore structure and very high overall porosity, creates a pure-water permeability that was previously unheard of in the industry. A small amount of membrane surface and little pressure is needed to generate a significant flow of effluent water through the membrane. This new technology has the capacity to make virtually any water source biologically sterile with minimal maintenance. In addition, it is possible that it could change the way all biological hazards are prevented in future. ●

FOR FURTHER INFORMATION:

Please contact: Alamo Water Refiners, Inc, 13700 Highway 90 W, San Antonio, Texas, USA Tel: + 1 210 677 8400 Fax: + 1 210 677 8402

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SOFTENERS, FILTERS, RO, DI, AND MORE

Germany's water technology under the microscope

Dr Ing Hans-Joachim Malzer and Professor Dr Ing Rolf Gimbel of the DVGW (Germany's national water authority) report on the latest advances in the country's water technology

In Germany, the use of river water for in drinking-water treatment was quite common in the last century, especially in the major cities and regions of high population. However, at the end of the last century, several cholera and typhus epidemics broke out in some of these places due to insufficient water treatment. Today, German water plants treating river water use bank filtration, groundwater recharge or slow sand filtration – safe and efficient processes for the elimination of pathogenic micro-organisms.

In addition, in the last few years, people have become more and more conscious of the disadvantages of the treatment of groundwater, because its effects mean that the water level is lowered if too much water is taken from the aquifer for long periods. It is also felt that river water quality could be improved using waste water treatment plants. The use of river water has, indeed, become more common in drinking water treatment, especially in regions of high population and low groundwater resources.[1] Yet, in most cases, it is not used directly; instead, bank filtration or groundwater recharge is carried out as shown in *Figure 1*.

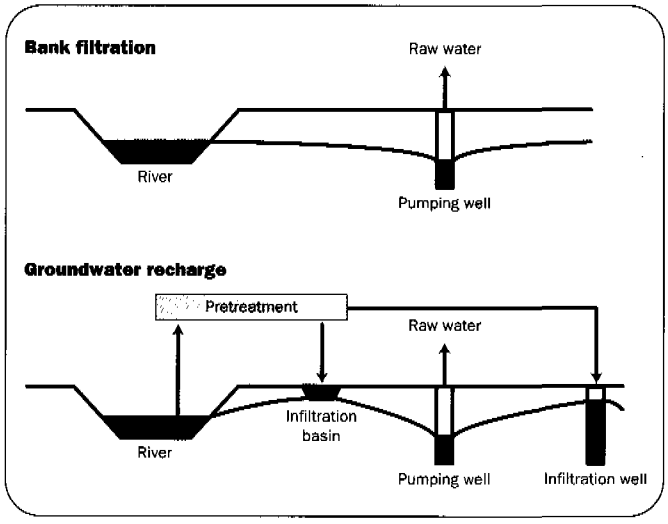

Figure 1: Bank filtration and groundwater recharge

In bank filtration, the pumping wells are located parallel to the river. The river water infiltrates into the aquifer and is taken out after subsoil passage. With groundwater recharge, the water is taken directly from the river. After pretreatment it is infiltrated again into the aquifer. This infiltration can be carried out using wells or basins, which act as slow sand filters. Using this reinfiltration the aquifer is recharged and the pumping well protected against possible shock loads of pollutants in the river. The subsoil passage of the water acts as a natural treatment step. The main processes that take place in the subsoil are:

- diffusion and dispersion
- mixing
- sorption
- ion exchange
- solution and precipitation
- hydrolysation
- biodegradation
- equalisation of temperature
- filtration, and
- elimination of pathogenic micro-organisms.

Concentrations of pollutants in the river may be reduced by diffusion, dispersion and by mixing with unpolluted groundwater in the aquifer or the pumping well. Inorganic pollutants may be reduced by sorption, precipitation and ion exchange. Organic pollutants may be reduced using sorption or biodegradation. Changes in temperature of the river water are equalised and particular substances eliminated using filtration. In particular, concentrations of pathogenic micro-organisms are effectively reduced by the subsoil passage.[2]

In the treatment of river water, turbidities must be reduced. These turbidities may consist of inorganic and organic particular matter which may be partially biodegradable. In winter, when the water temperature

may be quite low, nitrification processes become very slow and, as a result, river water often contains ammonium which must be oxidised in the treatment process. In summer, the oxygen concentration in the river water may decrease due to its lower solubility at higher temperatures. Anaerobic zones may occur in the aquifer due to high oxygen consumption for the nitrification and biodegradation of dissolved and particular organic matter, causing denitrification and a resulting solution of iron and manganese if these are contained in the aquifer.

Due to such biodegradation processes in the aquifer, the water may contain an excess of carbon dioxide and decarbonisation may be necessary. As the river is exposed to possible pollution by waste-water compounds, accidental spills or run-off, organic micropollutants must be contained or their sudden occurrence can be expected. There are many ways in which all the necessary treatment steps can be covered and their combination depends on the composition and variation of river-water compounds.

In *Table 1*, examples for bank filtration and groundwater recharge treatment are given. In the bank filtration process the riverbed acts as a self-cleaning cross-flow filter and turbidities are reduced very effectively. The subsoil passage acts as a first treatment step, and bacteria, viruses and biodegradable substances are all reduced using bank filtration until the water is taken out at the pumping well. If using ozonation, organic compounds are oxidised, but not mineralised, and biodegradability is improved. Using filtration, iron, manganese and residual turbidities are reduced, ammonium is oxidised and dissolved organic carbons are reduced. Using a granular activated carbon (GAC) filter, organic substances are reduced by adsorption and biodegradation. After disinfection and pH adjustment, the water can be distributed as drinking water.

Table 1

Process schemes for bank filtration and groundwater recharge treatment

Bank filtration	*Groundwater recharge*
Pumping well	River
Ozonation	Pre-ozonation
DM filtration	Flocculation
GAC filtration	Sedimentation
Disinfection	Main ozonation
pH adjustment	DM filtration
	GAC filtration
	Infiltration
	Pumping well
	Disinfection
	pH adjustment

Using groundwater recharge, water is taken from the river and pre-ozonated to improve the flocculation of turbidities. After sedimentation, the main ozonation is carried out to improve the biodegradability of organic substances. Using dual-media filtration, ammonium is nitrificated and dissolved organic carbon degradated. Then the GAC filter acts as a biologically active adsorption filter. The pretreated water is infiltrated using infiltration basins and wells. During subsoil passage, additional cleaning can be observed and the DOC is reduced once again.

Treatment of water from lakes and reservoirs

The water quality of lakes and reservoirs is strongly influenced by seasonal changes such as temperature variation, light intensity and rainfall. The self-cleaning processes in lakes and reservoirs are restricted to biodegradation and sedimentation. However, depositions at the bottom of lakes and reservoirs may be remobilised under some chemical conditions. Generally, lakes and reservoirs act as a sink for any pollutants and nutrients, that have accumulated. This accumulation of nutrients leads to eutrophication and deterioration of water quality. This means that the treatment of water from lakes and reservoirs must be adapted to seasonal changes and to the degree of trophication. Algae will grow according to the degree of trophication, and reduction of algae is one of the most important points in the treatment of reservoir or lake water. The degree of trophication is mainly responsible for the concentration of phosphorous compounds.

Besides the elimination of algae, the elimination of pathogenic micro-organisms such as bacteria, viruses and parasites is also important. Lakes and reservoirs may be protected against pollution and nutrients by strict pollution controls but major loads of turbidities are always possible and can occur as the result of heavy rainfalls, for instance.

In summer, algae production takes place in the upper part of a lake or a reservoir. Due to photo-assimilation, the CO_2 concentration is reduced, and the pH and oxygen concentration rise. If the algae die later in the year they form sediment at the bottom of the lake or reservoir and will be biodegraded. Anaerobic conditions may occur and iron and manganese concentration may rise; even denitrification, desulphurication and methane formation may be observed. The higher the degree of eutrophication the higher the algae growth and the more advanced the anaerobic processes at the bottom.

Pesticides and algae-made substances causing bad taste and odours may also occur in raw water and must be reduced.

Table 2 lists possible process schemes for the treatment of water from lakes and reservoirs according to their degree of trophication.[3] (These schemes are only proposals and may be varied according to individual treatment problems.)

Most of the lakes in Germany are oligotrophic or oligotrophic-mesotrophic. In oligotrophic cases, the addition of potassium permanganate may be necessary in order to oxidise manganese. Special attention should be paid to flocculation, which should be optimised with regard to the elimination of turbidity, algae and dissolved organic carbons. Adjustment of pH, flash mixing and a multi-tank aggregation step may be necessary to eliminate organic colloids and small algae. The addition of an anionic flocculant aid, like polyacrylate, may also be advisable. Following filtration over a dual-media (DM) filter, the water will be disinfected and stabilised.

If oligotrophic-mesotrophic water is to be treated, the addition of powdered activated carbon (PAC) may be necessary to reduce algae-borne substances causing bad taste and odours. The addition of PAC may also be necessary if pesticides occur seasonally in the water. PAC is eliminated by the flocculation and DM filtration step. Secondary flocculation may be necessary to reduce residual turbidities before marble filtration where the final demanganisation and deacidification take place.

In the case of mesotrophic-eutrophic water, micro-straining as the first step will reduce algae concentration. Pre-ozonation may be necessary to deactivate mobile algae and micro-organisms and to improve the elimination of algae and turbidity by flocculation/filtration. High ozone dosages at the pre-ozonation stage should be avoided because ozone may break up the algae cells and oxidise the manganese up to permanganate. After flocculation, DM filtration, secondary flocculation and marble filtration, the main ozonation will oxidise taste- and odour-causing substances, and improve the biodegradability of dissolved organics. Granular activated carbon (GAC) filtration will simultaneously act as an adsorption filter and a biodegradation filter. Finally, the water is disinfected and stabilised.

Table 2

Process schemes for lake and reservoir water treatment

Oligotrophic	*Oligotrophic-mesotrophic*	*Mesotrophic eutrophic*
$KMnO_4$	PAC	Micro-straining
Flocculation	$KMnO_4$	$KMnO_4$ or O_3
Disinfection	Flocculation	Flocculation
pH adjustment	DM filtration	DM filtration
	Secondary flocculation	Secondary flocculation
	Marble filtration	Marble filtration
	Disinfection	Ozonation
	pH adjustment	GAC filtration
		Disinfection
		pH adjustment

Disinfection

The spreading of epidemics by infected drinking water is always a worrying possibility. The first way to avoid occurrence of pathogenic micro-organisms in drinking water should be to use unpolluted, well-protected groundwater. This should be taken from an aquifer with fine pores and good filtration characteristics. Such water, however, is not always available in the necessary qualities and amounts. In such cases, other water must be taken and treated for the drinking water supply. Disinfection should finally guarantee the hygienic security of drinking water, and is the last stage of the multi-barrier system (pollution control, water treatment, disinfection) for safe drinking water supplies.

Using disinfection, pathogenic germs – viruses, bacteria and parasites – are killed or deactivated and numbers of micro-organisms are generally reduced. Drinking water must not be sterile but

Table 3

Limits for disinfectants and disinfection by-products

Limit	*Chlorine, hypochlorites (free chlorine)*	*Chlorine dioxide*	*Ozone*
Maximum addition (mg/l)	1.2	0.4	10
Maximum concentration after disinfection (mg/l)	0.3	0.2	0.05
Minimum concentration after disinfection (mg/l)	0.1	0.05	
Disinfection by-product	THM	Chlorite	THM
Limit for disinfection by-product (mg/l)	0.01	0.2	0.01

Note: *THM = chloroform + monobrome dichloromethane + dibromemonochloromethane + bromoforme*

neither must it contain pathogenic micro-organisms. *Table 3* lists the limits specified by German drinking water regulations for the use of chemical disinfectants.

If chlorine or hypochlorites are used, hypochloric acid will be formed in reaction with water. Hypochloric acid is an effective disinfectant, but it dissociates pH values over about pH6 to protons and hypochlorites, which have a much lower disinfection efficiency than hypochloric acid. At a pH of about 7.5 almost equal amounts of hypochlorite and hypochloric acid can be found. Hypochloric acid reacts with ammonium to form chloroamines, which have poor disinfection efficiency and cause bad taste and odours. The direct use of chloroamines for disinfection is forbidden in Germany. If water contains higher amounts of humic acids and/or bromide the formation of trihalomethanes (THM) is possible. These substances are thought to be carcinogenic and their concentration is therefore limited to 10mg/l. THM formation is increased by higher temperatures and pH values. Maximum and minimum concentrations of disinfectant after disinfection are not given to ensure protection of the distribution network but to ensure sufficient addition of disinfectant.[4]

Chlorine dioxide has become more and more important to disinfection in recent years. Chlorine dioxide does not form trihalomethanes and does not react with ammonium, yet it oxidises dissolved organic carbon compounds and is reduced to chlorite. Chlorite concentration is limited by German drinking water regulations to a concentration of 0.2mg/l. If the concentration of dissolved organic carbon exceeds 2mg/l it may be expected that the maximum allowable concentration of 0.4mg/l chlorine dioxide will be exceeded to achieve a residual minimum concentration of 0.05mg/l; the maximum concentration of chlorite will also be exceeded.

Ozone has a much higher disinfection efficiency than hypochloric acid or chlorine dioxide. It reacts quite quickly; are this means that long periods of disinfection for protection of the distribution network is not possible using ozone for disinfection. Ozonation improves the biodegradability of organic substances and, therefore, the chances of regermination after ozonation are quite high. Ozonation is not commonly used for final disinfection in Germany, but it is frequently used in surface water treatment in combination with biodegradation stages

such as those using GAC filters. If water contains bromide it is possible that bromomethanes and bromate will be formed by ozonation, which may then restrict the use of ozone.

Because of its high energy consumption, thermal disinfection is not used at water plants. Nevertheless, thermal disinfection is a useful means of disinfecting warm water supplies and distribution systems, and of avoiding the growth of thermophile micro-organisms, especially legionella.

The use of UV light for disinfection is a fairly new process. UV light damages the DNA of micro-organisms and prevents them from reproducing. UV disinfection does not produce detectable disinfection by-products and neither does it improve the biodegradability of DOC. If high nitrate concentrations occur in water, the formation of nitrite may be possible (regulations limit this to 0.1mg/l).

New tasks for drinking water treatment

Chemicals and/or energy are used in drinking water treatment processes; these are added to the treatment process, together with the raw water. However, waste is produced as well as the drinking water and water quality is not always improved in all parameters. Using the treatment process, substances are not only taken out of the water but new substances may also be introduced or formed by chemical reactions.

In general, the major new tasks in Germany for drinking water treatment can be summarised as follows:[5]

- minimising consumption of chemicals
- minimising waste production
- minimising formation of undesired by-products, and
- minimising energy consumption.

The first two points are both connected with the same problem. Waste produced in drinking water treatment consists not only of those substances that have been taken out of the raw water but also contains substances that have been added during the treatment process or which are a reaction product of these added substances. An example of this is flocculation. A large amount of the sludge produced originates from added flocculants. Therefore, optimisation of existing flocculation processes is one possible solution. Another possibility may be the use of physical water treatment technologies, like membrane processes, for instance. In Germany, these processes are currently only used in demonstration plants. Particularly where the treatment of surface water is concerned, ultra-filtration and micro-filtration may be suitable because these methods guarantee reliable elimination of micro-organisms such as viruses, algae and parasites.

Minimisation of waste is important for other reasons too. German law demands that: waste output should be reduced wherever possible; waste should be re-used if possible; and waste should be deposited only if it cannot be re-used. However, waste-disposal fees are increasing and many water plants have been forced to investigate the possible re-use of water-plant sludges. Such possibilities include: the re-use of calcium carbonate sludges in the cement or paper industries; iron, manganese and alum sludges may be re-used in the brick industry; and iron sludges may be used in waste water treatment for the reduction of phosphates and hydrogen sulphide.

The minimisation of undesirable by-products mainly refers to disinfection. One possible way to avoid the formation of undesirable disinfection by-products would be to improve treatment processes in a way that means that the concentration of biodegradable substances and micro-organisms in drinking water will become so low that disinfection will be completely unnecessary. Another possibility could be the use of UV light for disinfection (as mentioned above).

Finally, as far as the environment is concerned, it's clear that energy consumption should be minimised wherever possible (depending on individual cases and treatment processes). Nevertheless, it would appear that intensive water pollution control is the basis for a safe drinking water supply – and the industry should strive for improvement wherever necessary in future. ●

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The water master

Bratislava-based Vodohospodarska Vystavba offers a range of support

The main activities of Vodohospodarska Vystavba Bratislava are the preparation, design and construction of water-management projects, hydro-electric power plants, civil engineering, ecological, agricultural, transport and other construction projects throughout the territory of the Slovak Republic. It is also involved in the execution of technical and safety supervision of water-management structures. As an independent legal entity, the organisation is authorised to perform:

- investment and engineering activities in water management - zoning preparation of construction sites and settlement of property rights, construction, machinery and technological equipment, technical supervision at construction sites and so on
- planning and design - preparation of water-management studies, pre-engineering and engineering site development
- special activities - including technical and safety supervision of water-management projects, geological works, surveying and investor counselling
- housing and residential construction
- infrastructure (including amenities for residential blocks and industrial sites)
- water-management development - including waste water treatment plants and sludge treatment technology.

In the past, the company has contributed significantly to the development of the power sector by exploitation of the hydro-electric potential of Slovak rivers and, specifically, the Vah and the Danube. Since its launch, it has provided for the preparation and realisation of more than 350 investment projects in sectors including water-management, engineering and infrastructure, hydro-electric power, agriculture, water, and road transport. ●

Engineering excellence

A world-class specialist in water treatment engineering, Degrémont designs, builds and operates drinking water plants, sewage treatment plants, industrial process water plants and treatment plants for industrial waste water. In addition to its activities in systems engineering, Degrémont has developed expertise in water conditioning. The conditioning business makes and sells chemical reagents used in water treatment

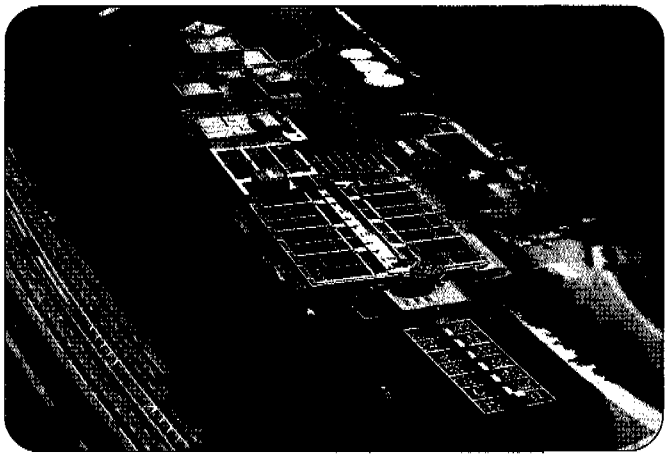
With its network of specialist firms, Degrémont ranks among the main players in this field in Europe and, indeed, the world. Backed by a vast network of subsidiaries based in the major countries of the world, Degrémont generates more than 65 per cent of its sales outside France.

For almost 60 years, Degrémont has offered customers a wide range of processes and technologies. Today, its expertise encompasses the entire water cycle. In the field of drinking water, Degrémont has developed high-performance processes for treating water with membranes, sold under the name 'Aquasource'. Degrémont supplies ultrafiltration, nanofiltration and reverse osmosis membranes for use in clarification or desalination. Membrane technology is flexible to use and produces water of excellent quality.

Degrémont also uses ozone-based technologies to improve the quality of drinking water. An excellent oxidising agent, ozone avoids the use of chlorine and gives water a pleasant taste. Also used to bleach paper pulp, ozone technology offers high levels of performance and is likely to develop through many industrial applications. (Ozonia, a joint subsidiary of Degrémont and Air Liquide, is a world leader in ozone technology.)

Degrémont recently developed a range of high-speed settling tanks, which will considerably improve plant operation. Known as 'Densadegs', these are 'universal' units, suitable for producing drinking water – settling and lime softening functions – and also for the treatment of waste water. In the latter case, Densadegs are used in primary treatment (physical/chemical) but also in tertiary treatment (phosphate removal). Further, Densadegs are well suited to the treatment of storm water because their high settling rate enables them to treat large volumes of effluent in record time.

In the field of biofiltration, Degrémont is continuously improving its range of highly respected products. These include the Biofor Plus, a new generation of attached-growth biofilters designed to treat all types of effluent and notably storm water. The Biofor and Densadegs together have been chosen to provide the tertiary treatment stage for the Colombes plant just outside Paris.



Biofor biofilters are designed to treat all types of effluent and notably storm water (shown here at Grenoble, France)

With its network of specialist firms (as here, in Nice) Degrémont ranks among the main water-engineering players in Europe

In the city of Marseille, Degrémont was chosen to build and operate the sludge treatment plant. The sludge is treated using a thermal process that enables its re-use in agriculture or sylviculture

The world's most modern plant in terms of its technology (1,000,000 m³/d in dry weather), Colombes is also notable for its compact design and integration with its urban setting.

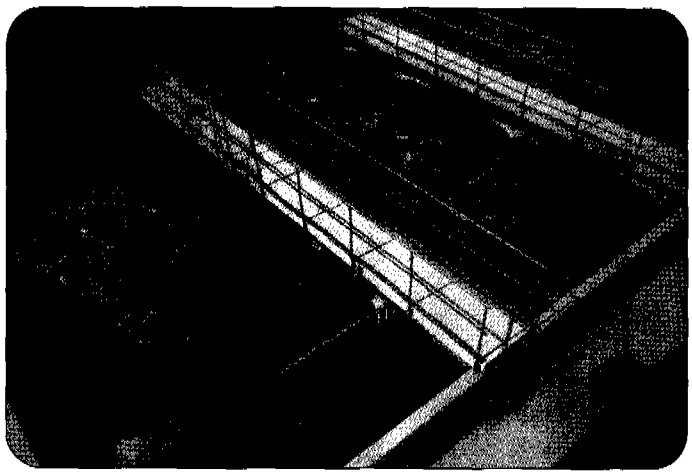
The treatment of industrial water, another major concern for the group, is also the focus of major efforts in research & development. The group is developing specific processes for this market, based on its long years of expertise acquired through continuous contact with customers. To this end, Degrémont is developing the concept of 'global water management'. This involves treating water with a view to re-using it, minimising the quantity withdrawn and the quantity discharged, and developing solutions that are optimised from a technical, economic and environmental standpoint.

The Membrane Bioreactor (BRM) is used to treat industrial effluents and produce water that can be directly reused for certain applications (washing, cooling or watering). The BRM can also be used in the preliminary treatment of process water.

Responding to the major challenge of treating sludge - the main by-product of waste water treatment plants - Degrémont has developed a complete range of units and processes: dewatering, composting and/or drying for disposal or landfill, incineration with household waste (IC 850 process). Degrémont recently extended its range of processes by acquiring the licence for the Niro process, whereby the sludge is incinerated in a fluidised bed furnace.

A company with thousands of customer references worldwide, Degrémont is reputed for its innovative technology and for the quality, reliability and high professional standards of its staff. The group also invests alongside its customers as part of BOT (Build Operate Transfer) contracts or as an operator. In this way, the company seeks to provide an effective response tailored to the diverse forms of this activity, which is essential to the future of humanity. ●

The Membrane Bioreactor (BRM) is used to treat industrial effluent and to produce water that can be directly reused



Biofor (pictured) and Densadeg have been chosen to provide the tertiary treatment stage for the Colombes plant, close to Paris

Managing liquid assets

The VpA, formed to act as mediator between private companies and local authorities, has helped to improve water supply and waste water management in Germany ... economically

Friedemann Koch, General Manager, **VpA** (Germany's association of private waste water management)

The Federal Republic of Germany is in the fortunate position of having sufficient water available. Despite its numerous rivers and lakes, however, the majority of water extracted comes from underground reservoirs. Around 63 per cent of the 5,775 million cubic kilometres of water extracted by public works are currently taken from groundwater. Precipitation slowly sinks through the soil to replenish, more or less completely, these reservoirs – among the largest in Europe.

Since 1990, water extraction has fallen by roughly a billion cubic metres. The reason for this is that average water consumption per person is currently 133 litres per day, which corresponds to consumption levels of 20 years ago. This fall in consumption is based on the use of water-efficient appliances and fixtures at home and increased recycling of water by industry, according to the closed-system principle.

With the use of 'intelligent' water-recycling equipment, businesses have been able to reduce their water consumption by over a third in the past 20 years. However, pollution of water bodies has, despite all precautions and the high numbers of people connected to public sewerage systems, reached a level where existing water resources can be used directly as drinking water in only a few cases.

In the debate on water quality, however, the criterion 'drinkable' is only of limited use. The regulations and legal limits for drinking water quality in legislation are insufficient to guarantee comprehensive protection for water bodies as aquatic ecosystems. In the final analysis, even the lowest concentrations of pollutants in water lead to a reduction in biodiversity or an increase in altered, unhealthy organisms.

Even if the ideal state of these environments will possibly always remain a (nonetheless useful) dream, the quality of German waters, and with it the habitats of plants and animals, has improved overall in recent years. The Federal Ministries for the Environment and for Food attribute the perceptible overall improvement in water quality 'above all to an improvement in water supply and waste water disposal in cities, local communities and industry'. Innovative concepts in industry, such as water-recycling systems, or individually tailored waste water treatment technologies, such as upgrading the technology of existing treatment works or the use of countless newly constructed facilities, have made this positive trend possible.

There are not 'only' environmental reasons for continuing to follow this course and, among other things, practising 'precautionary' water conservation. A study of the influence of water pollution on the costs of water supply in Germany (*Einfluss der Gewasserverschmutzung auf die Kosten der Wasserversorgung in der Bundesrepublik Deutschland*), conducted for the Federal Environmental Agency, shows that the costs of water pollution are eventually higher than the costs of precautionary action to protect water resources.

For many years it was assumed that groundwater was scarcely influenced by human activity. However, the opposite is the case: not only is the enormous demand for water in major cities resulting in what has, until now, remained regional falls in the water table, but the continuing sealing off of the Earth's surface is intensifying this negative trend, as precipitation can no longer sink slowly into the ground, but runs into surface water or sewerage systems. This leads to, among other things, increasingly severe flooding with its associated damage and costs. Meanwhile, the quantity of groundwater is falling; at the same time, the concentration of pollutants in that which remains is increasing.

Damage to groundwater resources is generally long-term, and can be 'repaired' – if at all – only at great cost. Modification or decomposition of chemicals takes place more slowly than in surface water and, because of the gentler flow, pollutants also remain where they are longer. This is the reason why, even after emission of the substance has ceased, pollution can remain for years, if not decades, afterwards. The pesticide Atrazine can serve

as an example here: although its use in water conservation areas has been prohibited since 1988, it can still be found in groundwater today.

While nitrates and pesticides are acknowledged as problematic substances, damage to groundwater from the deposition of atmospheric pollutants is only slowly penetrating public awareness. Organic pollutants such as CFCs can harm underground springs more severely than surface waters.

Sources of water pollution

Waste water, or sewage, can be defined in general as water whose natural properties have been altered through domestic, commercial, industrial or agricultural use. But rainwater, running off roofs and streets into the sewerage system, is considered waste water too. Depending on where it came from, this 'dirty water' contains a variety of impurities. These are divided into:

- easily biodegradable organic chemicals
- scarcely biodegradable organic chemicals
- plant nutrients
- heavy metal compounds
- salts
- waste heat.

For this reason, sources of water pollution can be found all over the place. However, intensive agriculture, in particular, contributes to groundwater pollution with pesticides and, above all, nitrates from nitrogen fertilisers, for example. The Federal Environmental Agency takes the view that over 10 per cent of German groundwater is already so polluted with pesticides that it can no longer be used for drinking water. Across Europe, over 800 different pesticide agents are licensed, in Germany 'only' 200.

Damage to groundwater from the deposition of atmospheric pollutants is only slowly penetrating public awareness

The German Association for Water Protection (Vereinigung Deutscher Gewasserschutz) has found that agriculture's share in nitrogen pollution of water bodies is 50 per cent. This is no surprise; the Federal Environmental Agency estimates that, of the 220 kilograms of nitrogen spread on 1 hectare on average per year, some 100 kilograms remain in the soil after harvest. The wind and rain then cause them to be disseminated further, in ways that are as undesirable as they are difficult to determine precisely.

The fact that water pollution from grazing land is (in contrast to what had previously been assumed) hardly less than that from arable land, can be seen from the experiences of the Water Conservation and Infrastructure Agency of the Canton of Zurich. In studies aimed at determining precisely the nutrient loads from effluents and precipitation entering Lake Huttner, phosphorous pollution turned out to be three times the critical level for that particular lake. The phosphate load from fertilisers and manure originated in intensively farmed grazing land in the surrounding area.

While old drinking-water pipes can sometimes lead to considerable accumulation of pollutants (such as heavy metals and PACs) in 'our primary source of nourishment', the main problem in sewerage systems comes from leaking pipes. According to municipal and local authorities in western Germany, some 20 per cent of public pipelines have some construction fault. The working group on mains construction and maintenance at the University of Bochum estimates the proportion of defective sewerage in eastern Germany to be 55 per cent.

Leaking or defective pipes can lead to dirty water escaping and polluting the soil and groundwater. Scientists in Bochum have calculated that around 330 million cubic metres of waste water, along with the 'chemical zoo' this contains, seep unmonitored underground every year. This 'exfiltration' would correspond to a waste water loss of 1.5 litres per person per day.

Composition of waste water

The substances found in the greatest concentrations in domestic waste water are biodegradable organic substances, nutrients and anions; dangerous components are only present in less significant quantities. Thus concentrations of the AOX (adsorbable organic halogen compounds) group and of the heavy metals - lead, copper, cadmium, zinc, nickel and chrome - all lie below one milligram per litre; and this despite the fact that washing and cleansing agents, many of which contain chlorine splitting substances, can react with organic substances in waste water and contribute to a considerable increase in substances of the AOX group in the sewerage system.

However, pharmaceutical waste also enters domestic waste water. Food technologists in Berlin, for example, discovered the medicine Clofibrate in mains water from the Spree. It had got into waste water via urine, as in the case of other medication. The concentration was above the limit for pesticides.

The situation with commercial and industrial waste water is significantly different from the domestic case, and especially different where indirect emitters introduce hazardous sewage into the sewerage system.

Here, concentrations of AOX and heavy metals have been measured at 10 to 200 times the content of domestic waste water. Sewage from mixed areas shows lower concentrations than that from purely industrial areas, because of the proportion of domestic waste water it contains.

It is not only waste water from production that contributes to the overall pollution of water bodies. Pollutants that are 'released' into the atmosphere through high chimneys in some companies fall as rain elsewhere, and thereby pollute the surface water there, or even seep into the groundwater. This is without considering any accidents that release enormous quantities of toxic substances at once, possibly triggering catastrophic fatalities among fish, and leaving their traces in sediment for many years to come. The fire at Swiss chemicals firm Sandoz in late autumn 1986 serves as an example of this kind of accident.

Country	Level of connection (%)
Germany	92
France	51
Italy	82
Greece	58
Finland	78
Luxembourg	99
The Netherlands	97
Portugal	55
Spain	82
United Kingdom	97

Source: Bundesverband Gas-Wasser

Level of connection of population to existing sewerage

Country	Level of connection (%)
Germany	97
France	73
Italy	65
Greece	75
Finland	100
Luxembourg	90
The Netherlands	98
Portugal	23
Spain	41
United Kingdom	83

Source: Bundesverband Gas-Wasser

Level of connection of existing sewerage to central treatment works

Most accidents are, fortunately enough, less spectacular. However, their total number reveals a not inconsiderable potential risk. For example, in 1993 the number of reported accidents involving substances hazardous to water was recorded as over 2,000, involving, first and foremost, accidents with mineral oil products, heating oil or fuels.

The law

In Germany, the Federal Government provides the legal framework for water management and the individual states fill in this framework with legislation containing the necessary procedural and organisational regulations. In June 1996, the lower house of the Federal Government (Bundestag) passed the sixth amendment to the Water Management Act, which, alongside the Waste Water Charges Act, is probably the most important law for protecting water bodies. It opened up waste water law to greater participation from private firms.

Legal regulations for water conservation are nonetheless extremely complex and varied. The medium of water gains additional protection in, for example, the Federal Epidemics Act (hygiene), the Drinking Water Ordinance, the Fertilisers Act and the Building Statutes. Voluntary commitments by industry, for example on the use of highly volatile CFCs, complement or replace legal regulations.

At the start of the 1970s, the European Community passed the first guidelines in a European water conservation policy. There are now numerous guidelines, most of which relate to the use of water bodies and provide minimum standards for quality targets. One of the water policy goals of the European Union is, first, to see that the populations of member states are all connected to sewerage systems and treatment works.

The *Council Guidelines on the Treatment of Local Waste Water* lay down the number of residents at which waste water treatment plants must be built or upgraded, and the timescale within which this must occur. The deadlines lie between 1998 and 2005. By 2005 at the latest, the waste water of virtually every resident of the EU should be at least biologically purified. As a first step in groundwater protection, the EU Commission has decreed that member states produce maps showing significant groundwater resources and the sources of pollution. Only then can groundwater be protected through countryside planning.

Waste water treatment techniques

Components in waste water can mostly be split and decomposed through oxidation. Thus, the higher the oxygen content, the better a water body and the better a treatment plant can purify the water. Treatment plants can involve three levels of treatment: mechanical, biological and chemical.

The route through the treatment plant taken by waste water is generally as follows. First, the waste water passes through a screen, or rake. This sifts out the coarse dirt, which can then be disposed of safely, for example in a waste incineration plant. The next stage of treatment is the so-called grit chamber. Here the water flows more slowly, and sedimentation, where heavier particles sink to the floor, begins. These particles are periodically sucked away and, before final disposal in landfills, are stored temporarily in silos. In the preliminary sedimentation tank the water finally comes almost to a

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standstill. Suspended matter separates out and floating material is skimmed off. A scraper sweeps the sludge at the bottom into the raw sludge concentrator where, with the help of gravity, as much water as possible is removed from the sludge. This concludes the mechanical treatment stage.

The concentrated sludge is taken to the digestion tower, where it is broken down by anaerobic bacteria (which require no oxygen). This produces gas, which is now used by many facilities for energy production. At this stage of the process, the raw sludge is dried out in the concentrator and then disposed of as sewage sludge.

Current legislation places emphasis on further treatment of waste water

The majority of the dirt and pollutants is still, however, in the water. This flows into the activation tank, where it is intensively enriched with fresh air, either under pressure or mechanically.

At the biological treatment stage, the decomposition of organic substances takes place as if in a natural body of water. Aerobic bacteria, which consume oxygen, decompose the organic impurities. To prevent the bacteria becoming 'short of air', the sludge must be kept in continual motion. A different process, suitable for smaller quantities of waste water, is bio-filtration. This takes place in a cylinder filled with volcanic rock or special plastic, where the waste water is dropped downward and is aerated from below. Micro-organisms colonise the chamber like a 'biological lawn' and break down the organic chemicals. The activated sludge settles in the final sedimentation tank, from where it is taken to the raw sludge concentrator and, finally, as the sludge from the preliminary sedimentation tank, to the digestion tower.

Current legislation places emphasis on further treatment of waste water, primarily to eliminate phosphorous and nitrogen compounds. This stage of the process requires the third treatment level. Here also, there are various possible techniques. A precipitant (iron, aluminium or other salt) can be added, for example, to precipitate the chemicals disposed in the water (such as phosphates). The impurities have a negative surface charge that keeps them suspended as a result of mutual repulsion. The addition of positively charged ions causes the impurities to conglomerate, after which they can be separated out through sedimentation.

An alternative technique, which also satisfies the requirements of their treatment level, makes use of a totally different procedure. It does without precipitants, using instead biological decomposition through the addition of pure oxygen. This causes more biomass to form, which is then able to break down a greater load of impurities. The nitrification (an aerobic process) that sets in leads to the oxidation of ammonium to nitrate. In the subsequent denitrification (an anaerobic process), bacteria use the nitrate as oxygen supply. The remaining nitrogen can then escape into the atmosphere.

In rural areas, where connection to a conventional treatment works is too expensive, vegetative purification treatment plants represent an environmentally friendly alternative. The Federal Environmental Agency (FEA) concluded an eight-year study of such plants in 1995, with the conclusion: 'These natural sewage treatment systems can be used today for volumes of domestic waste water equivalent to that from some 5 to 500 residents. For treatment of commercial waste water they are unsuitable as the only treatment process.'

Vegetative treatment plants consist typically of a settling tank where primary sedimentation takes place, the vegetated soil filter, which is implanted with various plant species (such as reeds) and, finally, a poor or small retention tank for oxygen enrichment. The FEA determined that the best performance was to be found in plants using sand or gravel floors under intermittent use. Under these conditions, over 95 per cent efficiency for decomposition of organic substances and up to 99 per cent for nutrients was shown over almost 10 years of use.

A clear improvement in water quality can be expected from the use of membrane processes at the final treatment level, particularly as the water can be disinfected without the use of chemicals. Treating industrial and commercial waste water makes heavy demands on technology. Waste water treatment must be virtually 'made to measure' for each user. Waste water from hospitals requires different treatment to that from the metals-processing industry or photographic businesses.

The techniques can be divided up essentially into 'treatment' and 'reprocessing' processes. In the so-called treatment processes, the substances contained are transformed in biological, oxidisant or catalytic techniques. Reprocessing either separates out or concentrates the substances contained in the water by means of mechanical, thermic and membrane-assisted techniques.

Combined processes, such as high-intensity biological procedures, where a membrane stage contributes to a drastic rise in biomass concentration and thereby to an improvement in decomposition in the bio-reactor, have been tried and tested. Nevertheless, every process must be adapted specifically to suit each individual case. ●

Making water work harder

New developments in industrial water management and technology

Today, water-related issues are more prominent than ever before. New developments focus on reuse options, in both recovering water and the components in it, preferably at low energy consumption levels. Biotechnology is producing both *biogas* (energy) and more compact processes (small reactors, low investment costs, leading to lower operational costs). Combi-processes (biological and chemical conversion) make it possible to treat 'difficult' waste water.

In physico-chemical treatment processes, there have been enormous developments in membrane-based processes. The latest is the use of hybrid membrane processes, integrating the advantages of the following working principles: membrane separation combined with adsorption (membrane assisted affinity separations - MAAS), extraction (pertraction and emulsion pertraction), evaporation/absorption (trans membrane chemo sorption - TMCS), crystallisation (membrane assisted crystallisation - MAC) and distillation (MEMSTILL). These technologies combine sustainability with economic feasibility.

Besides water technology, there is a growing interest in water management. In applying water cascading, water can be used more than once. At present, there are a number of methodologies and tools (software, sensors and so on) on the market. It should also become evident in the future that the water market is taking up the challenge and opportunities offered by sustainable development. ●

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For further information circle 33

In pursuit of purity

Improving the quality of drinking water is an on-going aim within the water industry. A new kind of technology from Germany has been designed to achieve just that

Anthropogenic acidification and eutrophication threaten the quality of drinking water. Acidic waters generally have elevated metal concentrations and promote corrosion of water pipes. Eutrophicated waters exhibit a high content in nutrients, extensive algal growth, and normally have alkaline conditions as well as leading to increased corrosion. For this reason, raw waters increasingly need corrective treatment.

Soell Ecological Processing Ltd, based in Germany, has developed a new compound to treat fresh water. Its worldwide-patented CarbonAdd is a pure inorganic multicomponent buffering system. It consists of a mixture of calcium salts, sodium hydrogen carbonate, soda and calcite, and is almost universally suitable for most water conditions. All ingredients also occur in natural waters and their use is permitted for drinking water conditioning.

The primary effects of CarbonAdd are:

- adjustment of pH level – depending on raw water conditions, pH is adjusted between 7.0 and 8.3 (CarbonAdd is suitable for both acid and alkaline waters)
- stabilisation of the pH level between 7.0 and 8.3
- hardening is moderate and can be chosen by the variable dosage of $CaCl_2$ and Na_2CO_3.

The dosage of Na_2CO_3 may be adequate when treating acid water rich in CO_2. The solubility product of calcite can be surpassed deliberately because calcium, hydrogen carbonate and carbonate are dosed in different salts. Small quantities of calcite acting as seed crystals reduce kinetic barriers. The effect is that the saturation index of calcite (Langelier index) can be set at ≈ 0. With respect to corrosion, the water is optimally adjusted. Additionally, metals (such as aluminium, iron and copper) are eliminated through precipitation. Since the composition of the mixture is variable and the primary effects can be predicted by computer modelling, the treatment can be tailor-made for specific problems.

CarbonAdd can be used for conditioning drinking water by dosing the compound into a drinking-water volume stream or by directly treating acidified or eutrophicated lakes and drinking-water reservoirs. Both methods have already been tested. It is possible to cover a wide range of uses by working with different sizes of plant group.

The CarbonAdd system has a wide range of uses

The first processing plant working with CarbonAdd, ensuring an independent water supply for smaller communities, is operating at Issigau in Bavaria (see the accompanying diagram). It treats from 8–11m³ of water per day. The raw water has a pH of <6.5. After a dosage of 125g/m³ CarbonAdd, the water is stabilised (saturation index ≈ 0) and the pH is set at 8.3. The reaction velocity is high, so the size of the processing plant is small compared with other plants in common use. This results in a clear reduction of investment costs. Running costs are low and any sludge incurred can be used in agriculture, depending on the quality of the raw water.

CarbonAdd has proved to be an easy, low-cost method of drinking water treatment. It can adjust a number of relevant quality parameters for drinking water in a single step and satisfies European drinking water regulations. ●

Ozone treatment options

There are many essential considerations for designers of ozone treatment systems – including organic and inorganic load, ozone dissolution, ozone injection alternatives and post-ozonation requirements

The reaction of ozone with most organic compounds may be modelled using a first-order kinetic equation: $\ln (C/C_0) = -kt$ (1) where k is the reaction rate constant. The value of k is found by carrying out laboratory experiments, typical values ranging from $4x10^{-3}$ sec^{-1} to $4x10^{-4}sec^{-1}$. Measured under ambient conditions and neutral pH, k may be adjusted to account for the effects of pressure, temperature and pH as follows: $k''=k'(b\ P/P_a)(c\ T/T_a)(d\ pH/7)$ (2) where the subscript (a) represents ambient conditions.

Although Equation 2 implies that the reaction rate increases with increasing temperature, as is generally the case, it must be kept in mind that ozone solubility is adversely affected by increasing temperature.

The effects of these variables are captured in OZOCAL, software developed by Ozomax Ltd. OZOCAL estimates the ozone dosage required to treat a given effluent based on its analysis. Typically, for organic contaminants 0.1 to 1.6 g O_3/g COD is needed. The oxidation of heavy metals such as iron and manganese generally occurs in stoichiometric proportions.

Ozone dissolution

For the diffusion of ozone from a gas bubble to an aqueous fluid the boundary conditions are such that the Fick's law simplifies to: $N_A = d_L{}^*C$ (6) where C is the ozone concentration within the bubble and dL is the mass-transfer coefficient as defined in Equation 7: $d_L = 2D_{AB}/D_P + N$ (7) where Dp is the bubble diameter and N is a function of the Schmidt Number.

Equations 6 and 7 reveal two very important characteristics of ozone dissolution:

- O_3 dissolution increases with increasing gaseous ozone concentration
- O_3 dissolution increases with decreasing bubble diameter.

To take advantage of these two points the ozonator must be designed to efficiently dissipate heat which would otherwise cause the premature conversion of the ozone to oxygen thus lowering its concentration. Also, an oxygen feed may be used to yield higher ozone concentrations than those obtained from air. Second, the ozone/water contact should be made under pressure in order to produce small bubbles.

The maximum number of moles of O_3 transferred to the solution may be calculated from: $M_{O3} = N_A{}^*S{}^*t$ (8) where S = total bubble surface area and t = contact time. This reveals a third important ozone dissolution characteristic: O_3 dissolution increases with increasing retention time.

Increased understanding of ozone oxidation has led to the broadening of its applications

Ozone injection

The principle methods currently used to introduce ozone into water and waste water are: contact column; venture injection; and centrifugal injection.

Post-ozonation requirements

The ozonation treatment step is usually followed by the following steps:

- clarification – to precipitate oxidised organic and inorganic matter
- filtration (nano, sand, charcoal) – to remove precipitants. The use of activated carbon filters has the added advantage of adsorbing the excess unreacted, unrecycled ozone and allows it to convert back to oxygen
- O_3 destruct in air vents – may be accomplished using thermal, catalytic or ultraviolet destruction.

This increased understanding of ozone oxidation has led to the broadening of its applications, making it one of the fastest-growing market sectors within the drinking water and waste water treatment industry. Other industries employing ozone treatment include agriculture, food, pharmaceuticals and electronics. Lower ozone production costs have allowed this material from the past to have modern applications. ●

Amir Salama RE MSc, Ozomax Ltd

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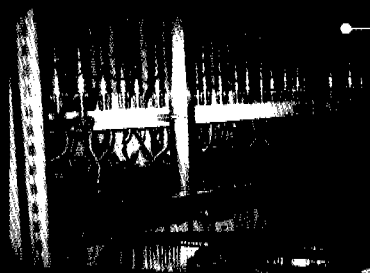

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Water management for profit and quality

Utopia is the only place where water management isn't needed; here the water system is up-to-date, gravity-fed and completely self-regulating ... and the quality of water is always perfect. However, the real world isn't like that at all and that's why effective water management techniques are a vital requirement

Until quite recently, the use of computerised analysis tools for water networks was of concern mainly to researchers and experts in engineering departments. Although the theory and basic algorithms behind the applications are very much the same today as they were 20 years ago, progress in hardware and software technology has moved water control functions into the control room ... and they are there to stay.

The growing acceptance of, and interest in, water management applications ('tools' or 'functions') by water supply utilities is partly a consequence of the higher degree of 'computer maturity' in society at large, but it is also an expression of the tougher competition among utilities. This has highlighted a need for greater efficiency and to reduce costs for electricity and maintenance. In some places, new legislation and environmental considerations have been the driving force behind stricter quality standards. While the magic touch of an experienced operator will never be obsolete, the fact that water management applications are efficient tools that enable a water utility to attain its quality, security, cost and reliability objectives is now generally recognised.

The potential benefits of effective water management, in terms of cost savings and water availability, are enormous, but which applications to choose in a specific case is largely a question of what yields the highest return on investment. Each utility and each network has its unique characteristics that have to be taken into account. A utility might, for instance, have a high electricity bill because much pumping has to be done and it will, therefore, see substantial savings in implementing applications for optimising pumping schedules and pump optimisation. Another utility may be struggling with leaks that it cannot locate and would therefore benefit from leak detection, leak location and pressure control applications.

From the user's perspective, one can distinguish at least three different areas where WM applications are an advantage:

- the control room
- customer service
- network planning/training.

Naturally, the availability of accurate on-line process readings has to be considered when determining how to apply sophisticated network analysis and decision-support functions. In some cases, inadequate records of network equipment and components and the lack of comprehensive on-line measurements will restrict the practical implementation of certain applications.

If not already available, the creation of an accurate model of the actual network is a major initial investment. The hydraulic characteristics of all the network facilities must be available as well as accurate records of how they are all interconnected. The characteristics of every pump must be known and the elevation data provided for all junctions, reservoirs, standpipes, well water levels and pressure regulating valves. Once all the data have been sorted and tabulated and the model established, the ground has been prepared for the implementation of a wide range of sophisticated applications.

The on-line simulation of the water supply network is a typical task for an advanced application software package. It computes actual flow, pressure and temperature at any location in the network in real time. When working in conjunction with a SCADA system, it can handle not only all the hydraulic parameters, but also the dynamic characteristics of the control

You only realise what something is worth when you haven't got enough of it.

Proper water management can help.

"As the demand for fresh water grows and supplies diminish, it is important to know what resources are left at a regional or national level and to start economising in time."

It is also important for the resources to be divided justly in the best interests of everyone between private households, industry and agriculture.

To do this, it is necessary to gather all the informations and be able to evaluate it so that reserves can be built up or preserved in the right places, projections be made on consumption and contingency plans prepared for how to deal with the various scenarious.

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For further information circle (18)

ABB and its S.P.I.D.E.R. systems

By adding S.P.I.D.E.R. NEPTUNE to its well-known range of S.P.I.D.E.R. automation systems, ABB has set the standard for state-of-the-art fully integrated SCADA water management systems, the main features of which are:

- genuine real-time operation between SCADA and WM functions with direct database access
- a well-conceived design permitting all WM function modules to exchange data in real time with each other and with the SCADA system
- Windows-based, fully graphic human/machine interface (HMI) with access for the SCADA HMI and built to the same standards (all WM functions can be operated from the same workplace and the results presented in operational SCADA station and overview displays)
- single source data engineering (that is, no separate maintenance of WM data or displays)
- the same hardware platform as SCADA (this means that WM functions can use the SCADA server or run on their own server).

S.P.I.D.E.R. NEPTUNE includes a wide range of specialised modules for the management of both water transmission and distribution systems. Its open modular structure provides a platform with well-defined interfaces for data exchange and add-on modules. It has been designed to be flexible and easy to upgrade to ensure a long life-cycle and to preserve capital investment in today's rapidly changing world of hardware and software.

equipment and communication lines. When calculating the actual state of the network, the program uses a subset of the field data as boundary conditions and compares the results with other field data (referred to as 'redundant measurements').

In this comparison, the program performs the delicate task of determining the probable cause for deviations between measured and calculated data: that is, it distinguishes between a leak, a bad measurement and incorrect model data. When a leak occurs, it causes the redundant measurements to change and they then differ in relation to the corresponding estimated values. The task of the simulation program is to add a fictitious outflow to the network that makes the simulated values match the redundant measurements again. The flow rate and location determined then coincide with those of the actual leak. The solution offered by Switzerland-based ABB Network Partner Limited also uses several different evaluation strategies to check measurements continuously for patterns typical of leaks. Sophisticated fuzzy-logic techniques process the results to minimise the number of false alarms without diminishing leak-detection sensitivity.

Both simulation and signal pattern evaluation approaches have their merits and they have to be used together to obtain the best results for burst pipes and slight leaks. Even with the best quality pipes, careful routing, active and passive corrosion prevention and so on, the probability of a leak can only be reduced – never eliminated. The early detection of leaks is of vital importance to a water-supply utility because, apart from avoiding loss of water and possibly damage to property, it provides a basis for effective operations and maintenance planning.

By combining on-line simulation with a demand forecast program, a state-prediction tool is created that provides the operator with fast and accurate advance information on how the state of the network is expected to develop. The speed of simulation is so high that pressure/flow profile changes over a period of hours can be computed within a very short time. The state-prediction function performs its simulation on the basis of flow rates provided by the demand forecast function. For this reason, the capacity of the demand-forecast function has to be sufficient to produce forecasts not only for the whole network, but for each individual distribution point as well.

Any state prediction, reservoir scheduling or other kind of application that depends on data provided by the demand-forecasting function can only be as good as the data fed into it. Therefore, it is of the utmost importance that the demand-forecast program be reliable and able to adapt to seasonal fluctuations, changes in demography and other dynamic factors without any reduction in accuracy.

Neural network technology is another elegant way of solving the demand-forecasting problem. This approach has proved to be ideally suited to utility-forecasting problems and provides better results than any other standard method. Unlike conventional techniques involving programming and the application of complex rules and algorithms, neural networks develop their own solutions to problems by learning from examples taken from the real world. They are highly fault tolerant and place no limit on the number of external factors included in the forecast; they are equally applicable to short-, medium- and long-term forecasting. ●

FOR FURTHER INFORMATION:

Please see ABB's advertisement on page 35

The CFD solution

Optimising the design of chlorination and storage tanks with Computational Fluid Dynamics (CFD)

Olivier Chataigner and Dominique Gatel, **Compagnie Générale des Eaux**

Jacques Cavard, **Syndicat des Eaux d'Ile-de-France**

Retention time in clearwell and storage tanks is one of the key factors in optimising water quality. In a study, the hydraulic of an existing facility and a projected one were evaluated thanks to the use of Computational Fluid Dynamics (CFD). Results show the possibilities of improving hydraulic efficiency with appropriate layouts. Practical design recommendations are made for the construction and retrofitting of chlorination and storage tanks. The impact of water circulation within the tanks on disinfection is also evaluated with regards to the Surface Water Treatment Rule (SWTR).

Storage tanks are commonly used in water treatment plants (WTP) to satisfy demand fluctuation due to the distribution system and to provide storage for emergencies. As a consequence of the above objectives high retention time may threaten the water quality.[1,2,3,4] Post-chlorination reactors are another class of tank that provide contact between water and chlorine. They operate under steady-state conditions. Their role is to satisfy disinfection requirements while limiting the formation of chlorination by-products.

Water circulation within the tanks directly influences water quality

The water circulation within the tanks directly influences the retention time distribution (RTD) and consequently the water quality. RTD is regulated by the works geometry and the hydraulic load. Tracer is one way to determine the temporal and spatial distribution of water within and leaving the tank. However, this technique cannot be used to establish the performance of projected works. A second approach consists of modelling storage and post-chlorination facilities using a Computational Fluid Dynamics (CFD) code. CFD can be used to study tanks under a wide range of operating conditions (flowrate, valves and so on) and before the facilities are built or modified.

In the hydraulic model the water remains in the tank for a theoretical residence time (T), equal to the tank volume divided by the intake flow. However, the masses of water passing through the tank follow different routes. Certain of these water masses will take preferential routes through the tank and leave the tank before the time T, while others will follow the recirculation zones and be discharged by the tank after time T. Consequently, the hydraulic performance of a reactor can be defined by the distribution of the transit times of the different water masses simultaneously entering the tank.

During the study, the flow was imposed by defining a constant speed on the intake section. The outlet is treated as being a constant pressure. The free surface has been assimilated with a symmetry zone in order to avoid normal speeds. An additional calculation simulates the propagation of a tracer in the tank and gives access to the time characteristics.

Results

Post-treatment permits a visualisation of the entire flow within the simulated tank. In this way, the short-circuit and recirculation zones prejudicial to good quality control of the produced water can be characterised. The visualisation of the speed fields requires the creation of projection surfaces for a three-dimensional analysis of the problem. Horizontal surfaces were used to analyse the speed fields. An analysis of hydraulic efficiency requires to be established the residence time distribution given by the tracing simulation. Free chlorine is applied at the inlet, and the chlorine residual is supposed to be close to 2.0mg/L at the outlet. (An average pH of 7.5 has been used in the calculation.)

Conclusions

Complex chemical and biological reactions occur in chlorination and storage tanks and will directly influence the water quality. A better knowledge of the hydraulic dynamics and the transport mechanisms can help to optimise design and operation practises. This study shows that CFD is a useful tool to determine the retention time for various geometries and flowrates. For the tested layout, we can confirm that the installation of baffles within chlorination and storage tanks is an efficient means of reducing the dispersion of residence times. The location of the inlet and outlet on the same side of the tank without any additional layout should be avoided – this creates a high level of short-circuiting and a significant recirculation volume within the basin. In such a case, moving the outlet to the other side with a pipe is a less efficient way of reducing the dispersion of the residence time distribution than installing a baffle.

Acknowledgement

The authors wish to acknowledge the support of Xavier Dimey, Armelle Valentin and Nicolas Flamant from the Compagnie Generale des Eaux. Their contributions in the simulations are greatly appreciated. ●

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The ultraviolet option

Revolutionary self-cleaning ultraviolet (UV) technology from Trojan Technologies

Ultraviolet (UV) has gained acceptance as an alternative to chlorination for the disinfection of secondary, tertiary and reuse waste water effluents. Ultraviolet light photochemically alters the nucleic acids and effectively inactivates the microbes by preventing replication of the former and, therefore, microbial growth.

The temperature and pH of waste water do not influence the ability of UV to alter nucleic acids. A microbe-inactivating dose of UV can be applied in seconds as the waste water flows past the UV lamps. UV systems require much less space than does chlorination.

The Trojan System UV4000 technology uses high-intensity lamps to reduce the number required to deliver UV doses, and incorporates an automatic cleaning mechanism. The system extends the range of UV disinfection to include poorer-quality effluents (for example, primary effluents for ocean discharge, treated CSO and other stormwater discharges) as well as high-volume waste water treatment plants for which the number of low-intensity UV lamps and/or the operating costs to clean the lamps are too high. ●

Key benefits of Trojan System UV4000J

- dramatic reduction in space requirements
- low installation costs
- extended range of UV applications
- reduced operational requirements
- lower lamp replacement costs

Water's auto-economisers

World Water Solutions *finds that, in many regions of the United States, automated management is the new force behind water company cost savings*

Early in the nineteenth century, a private company built one of New York City's earliest reservoirs in downtown Manhattan, and piped the water through wooden mains. Its name was the Manhattan Company, better known today as Chase Manhattan. Today, privatisation of US water operations is once more high on the agenda and, whether in private or public hands, a major part of operational savings is the adoption of computer-based management systems.

New York contemplates spending more than US$10 billion up to 2006 on water and sewage projects. A major part of the spend will go towards the completion of a third, huge tunnel to bring water into this major US city. City engineers have, until now, been afraid that, if they close the two existing tunnels, they will never be able to open them again. Neither of the two has had a full inspection since they were opened, the first in 1917 and the second in 1936.

The city plans to spend more than it has invested in the system since its creation in the early nineteenth century. Capital spending has, in recent years, increased to US$1.2 billion per annum, and privatisation is a much-discussed issue.

Until very recently, US local authorities had typically privatised by awarding contracts, not by selling assets. Indianapolis, for example, recently handed out one of the largest privatisation contracts so far. Its five-year, US$72-million sewage treatment agreement is expected to save the city US$65 million over the period.

The biggest question in the industry is how to finance future infrastructure expenditure. Better drinking water and new technologies for treating sewage call for huge outlays. All of New York's accounting is based on the assumption that, while revenues will increase by 31 per cent during the current five-year period, operating costs will, astonishingly, climb just 8 per cent. A slip in revenues or a modest rise in costs, and the outcome will be financially untenable.

Not just in New York, but in every region, reduced spending or increased charges are on the cards. One major reason for adopting new technologies is that a smaller workforce may well be required. For example, the workforce running the Indianapolis sewage system fell from 328 to 205 once it was privatised. To this end, one key area of cost control is the adoption of automated technologies. Computer-based control systems have already proved their worth. Such new technology is currently helping water officials ensure a reliable supply of fresh water in Southern Nevada, where the population grows by 3,500 new residents each month.

'Our current system has the capacity to treat and transmit 400 million gallons of drinking water each day,' says Richard Wellington, project manager for the Southern Nevada Water Authority system. 'Our current demand is over 330 million gallons, and growth will soon outpace our capability.

'With the construction projects that are already planned and under way, we will expand that capacity to 600 million gallons per day. The Southern Nevada Water System needed to get a handle on our equipment assets and stock inventory in order to manage that increase.'

Wellington says that the search for a supplier for the region's maintenance management and inventory control system began with 60 possible vendors being considered by consultant, Westin Engineering. That number was reduced to ten, then to three. Southern Nevada Water System's own maintenance technicians were then asked to make their evaluations and the Indus International Enterprise MPAC product was chosen.

Privatisation of US water operations is high on the agenda and a major part of operational savings is the adoption of computer-based management systems

The software now runs Southern Nevada Water's maintenance operation as they monitor its equipment, such as filters and large pumps. The software provides historical data on maintenance records and schedules regular inspections of all equipment as well as tracking warehouse inventories.

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Control Microsystems has what you need for water and wastewater SCADA. Our TeleSAFE and SCADAPack PLC/RTUs are famous for their durability, ease of use, and low cost. Our operator workstation software is renowned for its simplicity and high performance. And almost two decades of SCADA experience means that Control Microsystems has the know-how and track record to make your SCADA system work.

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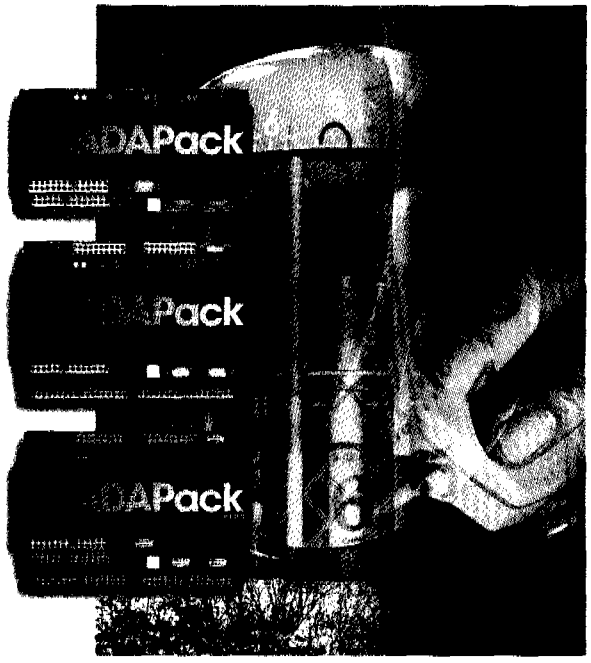

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For further information circle (21)

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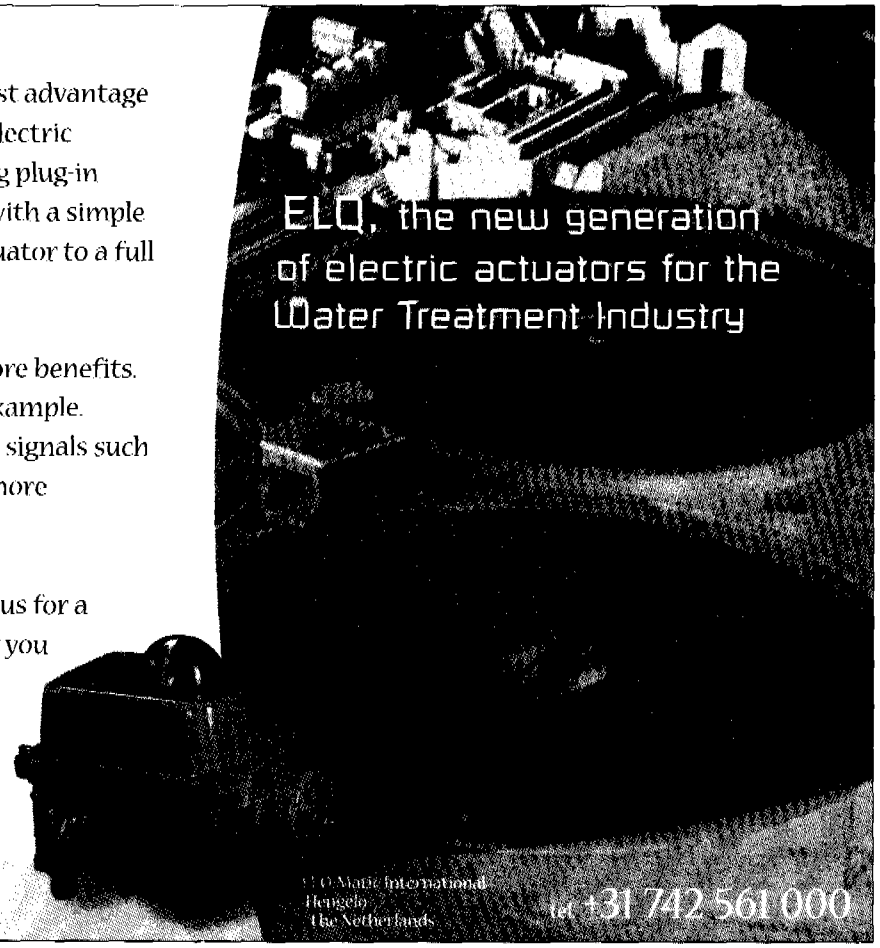

For further information circle (22)

Increased supplies of fresh water are vital in US states such as Nevada where cities like Las Vegas (above) number among the country's fastest-growing population centres

This supply of fresh water is critical in Nevada's climate, especially with the continuous influx of new residents. Ensuring that the state's water-processing equipment is properly maintained is just as critical. The Southern Nevada Water Authority can now provide historical data on maintenance actions and equipment failures more efficiently and can show on-screen the detailed steps it goes through to ensure the highest possible water quality.

Wellington adds: 'We went live after only eight months of hard work by a great implementation team of maintenance technicians, warehouse specialists, maintenance schedulers, database and network managers. Our legacy systems, which consisted of a manual system for unscheduled maintenance, historical records and a computer system that could only process work orders, are now redundant. With the capability to schedule preventative maintenance and to track equipment history and inventory levels, we expect that our long-term savings will be significant. Because, with this system, we can anticipate when maintenance is required, we will extend the operating life of our existing equipment.'

With enterprise management software, the Water Authority system will be able to schedule the work of technicians and order parts and materials as the need arises, as well as optimising stock levels to make more economical use of warehouse space.

In addition, the Southern Nevada Water Authority is developing a new water treatment plant in the city of Henderson (located close to Las Vegas). Wellington says that these plans call for an expanded use of Indus' EMPAC product to include the new plant, which will be controlled remotely from the present facility.

Indus International, based in Chertsey, England, believes that Enterprise MPAC improves production capacity and labour productivity, and reduces materials management and operating costs. Says the company's Richard Fenton: 'The system lists and queries the attributes of assets, and its functions help manage the human and material resources dedicated to inspection, repair and management. It is an all-systems, enterprise-wide package that interfaces and integrates with all other company systems, from payroll to customer-facing operations to maintenance.

'Management information is a by-product of the minute-by-minute operations. Faults, repairs and inspections, and a history of each asset, can be looked-up on-line, through diagrams, drawings, technical specifications and so on, to help effect repairs.'

Systems that can automate processes while ensuring reliability will play a significant role in the water industry in the coming period

It's clear that any business depends on the effective use of its capital assets, whether in rail, power, gas or water. Indeed, it seems that systems that can automate the processes involved while ensuring reliability in terms of product quality will play a significant role in the water industry in the coming period. ●

John Coops

The SCADA system

Implementing a Supervisory Control and Data Acquisition (SCADA) system into a project brings with it many benefits

SCADA (Supervisory Control and Data Acquisition) is a network of electronic monitoring and control equipment installed at remote locations such as pumping stations, wells, elevated storage tanks, valve chambers and reservoirs.

The remote devices (sometimes called SCADA Controllers or Remote Terminal Units) communicate with a host computer at a central monitoring location called the Master Station. From this location, usually a treatment plant, operators can remotely supervise and adjust the operation of the process. Pumps can be controlled, valves can be opened and closed, and setpoints for variables such as elevated storage tank levels can be adjusted.

The operator views a graphical representation of the process on a video display, and uses a keyboard, trackball or mouse to make the adjustments. Printers log alarms as they occur and keep a record of operator actions. In short, SCADA allows the complete supervision, documentation and operation of water treatment and distribution processes from a central location.

The flexibility of modern-day SCADA system components dictates that no longer is it necessary to expend substantial funds, ostensibly just for the design, but rather these systems can be developed with a concerted effort by in-house personnel with no sacrifice in technological versatility. If there is a need for additional technical expertise, help can be provided by the manufacturer of the components.

In addition to meeting basic system requirements, consideration must also be given to developing a user-friendly system that will satisfy both technical and human requirements of the application. In any SCADA system design effort, whether in-house or contracted out to some other entity, there exists today a very important concept that should be examined closely and investigated thoroughly: is the hardware system being considered of a non-proprietary design that allows interchangeability of components regardless of manufacturer? This concept is known as 'open architecture' and will determine how easy your system is to repair and/or upgrade in the future. The more 'open' the architecture, the less restrictive and proprietary the system will be. The less restrictive and proprietary the system, the easier it will be to upgrade or replace the equipment in the future.

To ensure that a user avoids the 'closed-system' syndrome, one of the many available industry-standard and non-proprietary protocols should be selected for the SCADA design. Control Microsystems is a Canadian company, founded in 1980, that specialises in the design, manufacture, and marketing of high-quality products used in SCADA, remote monitoring and control applications. All of its products are manufactured as standard production items for off-the-shelf delivery to customers worldwide. Its equipment is installed in Canada, the USA, Mexico, Chile, Argentina, the UK, Ireland, Spain, Hungary, South Korea, Indonesia, Egypt, Hungary, Russia, Brazil, South Africa, China, Hong Kong and India ... to name but a few. In addition, OEM installations exist worldwide (including Europe, Japan, Australia, South America, and Asia).

With over 7,000 installations worldwide, the company has earned a reputation for providing high-quality products and services. Its latest innovation – SCADAPack PLC/RTU – is based on industry-standard, non-proprietary protocols that ensure its compatibility with most distributed control systems, SCADA software, and any third-party programmable controllers. The ability of different system components to communicate successfully by using the same 'language' or protocol virtually eliminates any possibility of system attrition in the future.

Control Microsystems is active in many applications including municipal and waste water, cryogenic storage tank monitoring, gas and oil pipeline leak detection and control, irrigation control, and environmental monitoring markets. ●

FOR FURTHER INFORMATION:

To learn more about how Control Microsystems can help you with your SCADA projects, Tel: + 613 591 1943 Fax: + 613 591 1022, or visit the company's website at www.controlmicrosystems.com

Integrated systems for winning ways with water

Why the water industry turns to Schlumberger for revenue enhancement solutions

In today's competitive market-place, water utilities are becoming more and more aware of the importance of building revenue while decreasing operating expenses. It is imperative that both the quantity and quality of their resources be improved. To solve these issues utilities are looking to companies within the water industry that are experienced in these areas – literally in the trenches next to you day after day.

That's why, in the water industry, customers turn to Schlumberger. With over a hundred years' experience and the financial backing of a global parent, Schlumberger is positioned to be the total solutions provider utilities need. As the only meter manufacturer for all four primary resources – water, gas, electricity and heat – Schlumberger is well known within many water utilities the world over. But, it is its ability to provide integrated systems and services, in addition to metering, that makes Schlumberger the most reliable resource when difficult tasks arise.

As a decision-maker, you look for a company that listens to your needs and is willing to work *with* you to define and develop a solution tailor-made for you. From a strong foundation in metering, to advanced systems and systems integration, to third-party alliances and joint ventures, Schlumberger works with utilities of all sizes to find the perfect solution to meet your needs.

Unlike Schlumberger, most consultancy firms today make their profit by performing extensive reviews of your utility – leaving you with little more than a hefty binder of reports, spreadsheets and presentations telling you to downsize and cut back – then disappearing, never to be seen again. Schlumberger, on the other hand, views its customers in a different way. We are here to listen to our customers' needs, work with them to customise solution plans for their utility, be there working with them during integration of these solutions and, most importantly, we'll still be there afterwards for full support.

One of the newest and fastest-growing services Schlumberger has to offer is its Revenue Enhancement Solution (RES). This programme is a revolutionary way for utilities to evaluate revenue production of large meters. By simply providing Schlumberger with a database of meter type, service and age, we can conduct a statistical audit advising you how much revenue you are losing at each metering point. Based on thousands of real field evaluations, this new methodology has proved very accurate. We are so confident of this new service that we are willing to perform an audit on your system and evaluate how you can increase your revenue without any obligation on your part.

Through its RES programme, Schlumberger offers utilities around the world a consultative approach to total network solutions. It provides 'optimal solutions packaging' to reduce operating costs and increase revenue through efficient data collection and billing. When you search the market-place for a company that offers real-world, single-source solutions integration – whether it be needs analysis, products, systems or services – call Schlumberger. You will be rewarded through better business practices, increased revenue and decreased expenses. ●

Most consultancy firms today make their profit by performing extensive reviews of your utility – leaving you with little more than a hefty binder of reports, spreadsheets and presentations telling you to downsize and cut back – then disappearing, never to be seen again. Schlumberger, on the other hand, views its customers in a different way

Anybody can sell you meters to measure water flow.

Only Schlumberger offers total solutions to help you improve revenue flow.

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Prepayment meters make life easier

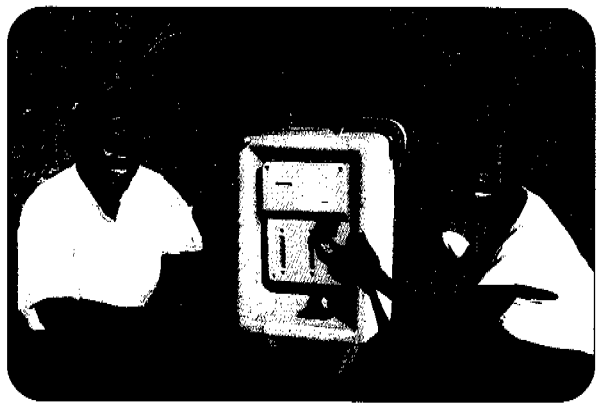
Represented in 45 countries around the world and with over half a million consumers using its products, Bambamanzi markets internationally patented prepayment water meters and management systems

'Bambamanzi' – meaning 'take hold of the water' in vernacular Zulu – is a division of Conlog (Pty) Limited, the largest manufacturer of prepayment electricity meters in the southern hemisphere with sales in excess of 1.4 million meters. Conlog in turn is a subsidiary of Logtek Holdings Limited, listed on the Johannesburg Stock Exchange. Bambamanzi is based in the province of KwaZulu-Natal and currently produces 4,000 prepayment meters per month. These meters form the backbone of a turnkey prepayment water management system that facilitates complete control of the water supply process from the pre-purchase of water credits and delivery of water, to the in-depth recording and analysis of consumer consumption and payment trends.

Three different types of prepayment meter are manufactured and marketed under the Bambamanzi name, namely the yard connection or individual household meter; the community standpipe meter; and the bulk industrial meter. The yard connection prepayment meter is designed for use at individual sites where the consumer inserts a smart token bearing a water credit. Upon inserting the token, the meter is credited with the total amount of water credit purchased by the consumer and allows water usage until this credit expires, whereupon supply is cut off until further credit is purchased.

The community standpipe prepayment meter is designed for use at communal water supply points where neighbouring consumers use encrypted smart tokens to draw the amount of water they require. When the token is put into the meter, the unit allows the flow of water, debiting the available credit on the token while crediting its consumption record. Water flow ceases when the token is withdrawn. The bulk prepayment meter has been developed more recently in response to specific requests from clients for heavier industrial applications.

Based on smart technology, the Bambamanzi system is tamper-proof and suitable for use in both rural and urban environments. Apart from guaranteed cost-recovery on capital expenditure, recent findings by an independent consultant have shown that, compared to conventional methods, the system offers savings of up to 75 per cent on administration and billing costs, as well as savings of up to 65 per cent on water consumption.



Area projects manager, Mandla Xulu (left), shows a happy resident of Ndwedwe near Durban how to use Bambamanzi's community standpipe prepayment meter

However, financial security and management efficiencies in supplier organisations are not the only benefits of the system. Its variable tariff scales, for example, allow poorer communities to access potable water at rates they can afford and in volumes laid down by official policy. Also, the system does not require electricity and can therefore be used in developing, as well as established, communities.

The management information system (MIS) is the nerve centre of the Bambamanzi system. It collects, processes and stores all information from the prepayment meters and vending units. The MIS comes complete with customised Bambamanzi software, compatible with all recognised operating systems. Each MIS is upgradeable and can handle literally millions of consumers. ●

FOR FURTHER INFORMATION:

Contact Peter Rodseth on Tel: + 27 31 7091547 Fax: + 27 31 701 3077. Alternatively, e-mail Bambamanzi on: bamba@sprintlink.co.za or, for further information, visit the company's website on http://www.kzonline.co.za/bamba

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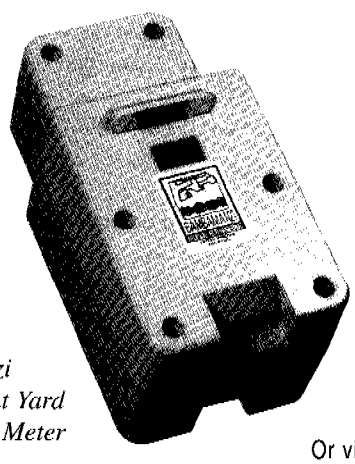
Suitable for use in all rural and urban communities, this advanced water management system offers the following benefits:

- Savings of up to 75% on administration & billing costs
- Guaranteed cost-recovery on capital expenditure
- Multiple tariff structure
- Automated meter reading
- 24-hour access to water
- Savings of up to 65% on water consumption
- Flexibility - consumer pays according to his / her needs
- No outstanding accounts
- No reconnection fees
- No electricity required

For further information circle (24)



Bambamanzi Pre-payment Yard Connection Meter

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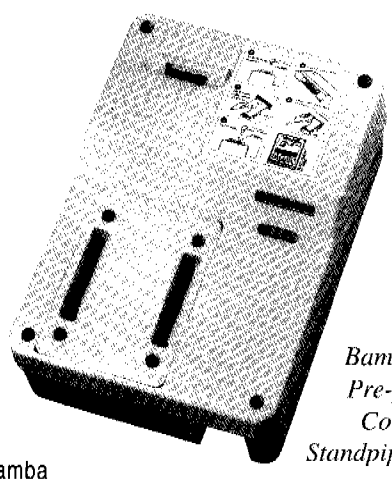


Bambamanzi Pre-payment Community Standpipe Meter

Materials selection demystified

WWS *reports on the newly updated publication from R A White,* Materials Selection for Petroleum Refineries and Gathering Facilities, *and reproduces an extract to highlight its applications in the pipe and pipeline industries*

Materials Selection for Petroleum Refineries and Gathering Facilities, by R A White* is a revised edition of *Materials Selection for Refineries and Associated Facilities*. The book is designed so that engineers with limited knowledge of materials selection can benefit from the information the author has gathered in his 40 years as a materials engineer with a corrosion and metallurgy background.

Since the first edition was published five years ago, a great deal has been learned about materials of construction for petroleum facilities. The new edition includes major changes in sections covering naphthenic acid corrosion, overhead corrosion, alkylation plants, amine units, sensitisation of austenitic stainless steels, hydroprocessing unit air cooler corrosion, wet hydrogen sulphide effects, corrosion in gas streams containing hydrogen sulphide/carbon dioxide mixtures and pitting of stainless steels (including super and duplex). New sections include flare tips, bending and de-aerator cracking.

WWS is pleased to present an extract of this valuable piece of work.

International corrosion of piping

High-strength line pipe is often used for transporting oil or natural gas, whereas lower-strength pipe is often used for water lines. ERW pipe is subject to grooving corrosion in the weld zone. This can be prevented by limiting the sulphur to 0.012 per cent maximum and by normalising at 900°C (1,659°F).

Corrosion in water lines is primarily a function of oxygen content in the 4 to 10 pH range. If oxygen is mechanically removed (by de-aeration) or chemically (by oxygen scavengers such as sodium sulphite), and if other corrosive gases (such as carbon dioxide and hydrogen sulphide) are not present, corrosion will not occur. Where oxygen or other corrosive gases are present, internal coatings, such as chemically cured epoxies, vinyls and cement linings, are normally used for corrosion protection. Organic coatings have a limited life because they contain pinholes and are subject to mechanical damage. Organic coatings require repair in 5 to 15 years, depending on the adequacy of the initial surface preparation and the specific type of coating. Internal cathodic protection[1] is usually impractical because the limitations of the anode throwing power require anodes at approximately every 10 diameters. Other problems with internal cathodic protection are maintenance of the system inside the pipe and ability to pass a pig through the line because the anodes' interfere with flow.

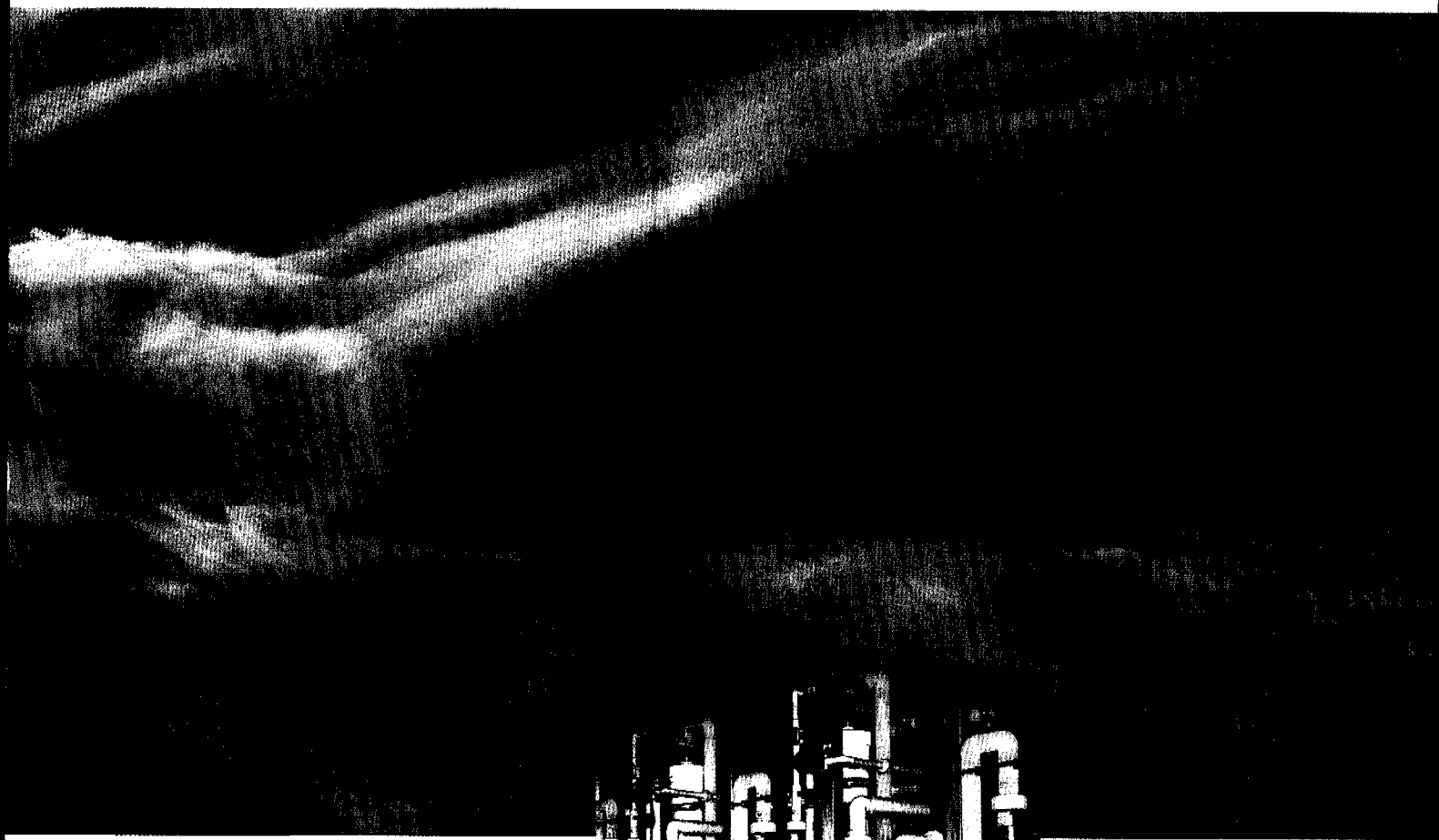
For cross-country gas lines, corrosive constituents, such as water, carbon dioxide, and hydrogen sulphide[2] are usually reduced to a very low level before the fluid enters the line. For oil lines, the water content is limited to 1 per cent maximum.[3] The lost efficiency required to pump the unwanted constituents and the extra wall thickness required for corrosion allowance cannot usually be economically justified. Even with clean-up systems, some water will get into pipelines. Efird and Jasinski have shown that the algebraic product of the total acid number is inversely proportional to the corrosion rate of steel in oil lines containing brine.[4]

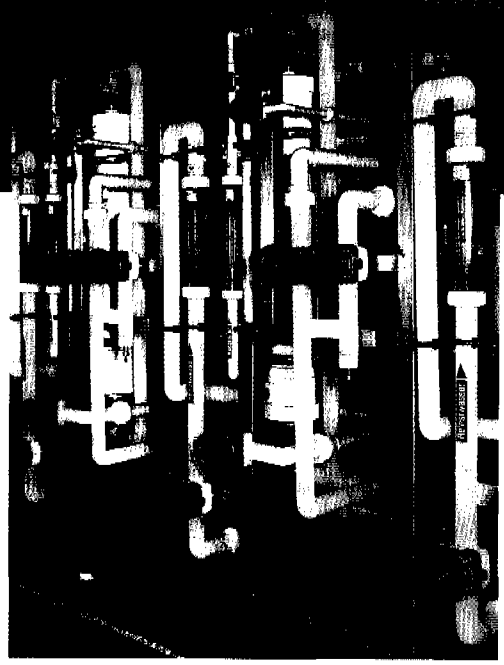
Corrosion inhibitors are usually added to oil lines when corrosion is anticipated by water settling in low spots, etc. Gas lines are usually dehydrated to 60 per cent of saturation to avoid corrosion from condensing water containing dissolved carbon dioxide. Molecular sieves that reduce water to 5 ppm have proved necessary in lines containing 100 per cent carbon dioxide.

Whether corrosive constituents are removed at the oil or gas well or just before they enter cross-country lines is a matter of economics (cost of the line, ease of replacement, etc). When dehydration or gas purification is not carried out at the wellhead, severe corrosion may occur. The severity of corrosion is a function of the $ppH_2S/ppCO_2$ ratio in wet (i.e. liquid water present) natural gas systems. When this ratio exceeds a certain value, corrosion is controlled by the iron sulphide film that forms on the metal surface. When an iron sulphide film forms on the surface (H_2S-dominated system), carbon steel with suitable corrosion inhibitors is adequate in lieu of corrosion-resistant alloys in most cases.

This ratio has been reported to be from 1/5,000 to 1/50. Therefore, experience should be checked to determine if carbon steel will be adequate if corrosion

Piping systems for all kinds of water





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inhibitors are used. In the absence of experience to the contrary, most users specify carbon steel in conjunction with inhibitors when the H_2S/CO_2 ratio exceeds 1/50.

An exception to the use of carbon steel with inhibitors when the H_2S/CO_2 ration exceeds 1/50 would be on an offshore system where the injection of inhibitors may be impractical due to the configuration of the piping, or where ultra high-reliability is desired for the line from the platform to the shore. Another exception would be where the mol per cent H_2S is in the order of 50 per cent; this is in the concentration range where elemental sulphur can form. In the latter case, corrosion is accelerated significantly because under-deposit corrosion occurs below the molten sulphur when the H_2S/CO_2 ratio is less than 1/50 (CO_2-dominated system).

The higher corrosion rates are based on the de Waard-Lotz equation, which is derived from laboratory tests.[5] De Waard and Lotz state that calculated rates are affected by the presence of oil, air, scale and the system pH. Corrosion is low when there is more than 14 per cent oil (defined as greater than 50 per cent by weight of C5+) and there is less than 20 per cent water. Under these conditions, the metal surfaces can be continuously wetted with an oil film, provided the velocity is greater than 1m/s (3.3ft/s). Corrosion can still occur in stagnant areas, such as low points, or if only light hydrocarbons are present.

Every precaution should be taken to exclude air because it will cause the formation of carboxylic acids, which accelerate corrosion significantly. The low corrosion rates are typical of those in systems with scale on the surface. The pH-dependent term that Markin has added to the de Waard-Lotz equation can be used to estimate whether or not a well is corrosive. In addition, Markin has dealt with the effect of mineral deposits such as calcium and iron carbonates.

In the temperature range where erosion-corrosion occurs in CO_2-dominated systems (above 70°C to 250°C (160°F to 480°F)) and in H_2S-dominated systems where inhibitors are used, annular flow conditions are preferred. The adequacy of corrosion inhibitors to prevent corrosion in CO_2-dominated systems is questionable, particularly where annular flow conditions do not exist. (Conditions to obtain annular flow conditions do not exist.)

Even when the system is designed for annular flow, long radius elbows and dead-leg tees should be used to minimise turbulence. When the system operates in the annular flow region, corrosion is low enough (because of the film on the wall) to permit the use of carbon steel. Although the velocities where annular flow exists must be calculated for each system, annular flow usually occurs at about 3.0m/s to 6.1m/s (10ft/s to 20ft/s). Below the annular flow range, where stratified, wavy, plug, or slug flow occurs, corrosion inhibitors are required if the partial pressure of carbon dioxide exceeds 28k Paa (4 psia). Three-phase corrosion inhibitors often prove practical in gas-oil-water systems. Regardless of the type of inhibitor selected, a monitoring system should be installed to check the effectiveness of the inhibitor.

SS is used when velocities exceed about 6.1m/s (20ft/s), or bubble or dispersed flow conditions exist. Martensitic SS has performed well, but austenitic SS – such as 304L (UNS S30403) – is required for complete immunity to metal loss unless oxygen is completely absent.

There is some indication that the presence of mercury in the system reduces the corrosion resistance of martensitic SS. In addition, this resistance is greatly reduced when tempering is done in the 400°C to 590°C (750°F to 1,100°F) range. Where the danger of pitting or stress corrosion cracking from chlorides makes austenitic SS – such as, 304L (UNS S30403) – a questionable choice, super SS such as UNS S32205 (duplex) and UNS S31254 can be used. The suitability of super SS for service is a function of pH, H_2S, chloride ion concentration and temperature. UNS S32205 is reported to be limited to a maximum hydrogen sulphide partial pressure of about 34.5k Paa (5 psia) at a sodium chloride concentration of one gram per litre at 80°C (176°F) and a pH of 2.7. So, suppliers of super SS should be consulted before selecting one of these materials. ●

* Materials Selection for Petroleum Refineries and Gathering Facilities, *by R A White is published by NACE (hardback, approximately 150 pages, including 89 figures) ISBN 1 57590 032 7 at US$127. To order, please Tel: + 1 281 228 6223 or Fax: + 1 281 228 6329*

Notes

1. The reduction of corrosion by shifting the electrochemical corrosion potential of the metal toward a less oxidising potential by applying an external electric current, i.e. by making it a cathode in an electrochemical circuit.
2. Typical maximums are as follows. Water: 112kg/million std m^3 (7lbs/million std ft^3); carbon dioxide: 2 per cent; and hydrogen sulphide: 4 ppm.
3. Corrosion in oil lines is considered water independent if the water is between 0.1 and 1 per cent. Limits on vapour pressure for oil pipelines are used to preclude the presence of corrosive gases.
4 & 5. Work by TWI indicates that, although 248 H 10 is required for the surface exposed to the corrodent, 275 H 10 is satisfactory for the side not exposed to the corrodent.

Pipe progress in Berlin

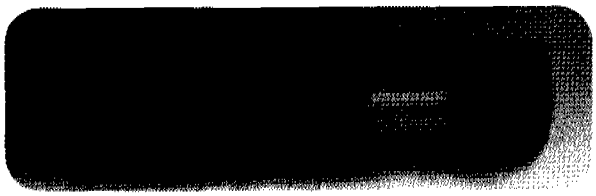
The past ten years have seen a number of developments in the Safety-Line Aluminium (SLA) pipe. Berliner Wasser Betriebe (BWB) describes this progression

Since the beginning of this century, a number of different materials (including lead, steel and plastic) have been used to supply water to service lines. At the beginning of the 1950s, the use of polyethylene for service lines became more common. In 1958, the Berliner Wasser Betriebe (BWB) also laid PE service lines on a trial basis. From 1987, there was a general shift to HDPE.

In the past, the positive properties of polyethylene pipes in terms of their corrosive and encrustation behaviour were accompanied by a number of serious defects; for example, the pipes were susceptible to damage during transportation and installation, and were not diffusion-impermeable with regard to halogenated hydrocarbons. The impaired taste of the water underlined the fact that plastic pipes without additional diffusion block for diffusion-impermeability cannot replace metal pipes which are absolutely diffusion-impermeable. By the mid-1970s, users agreed that polyethylene was a very useful material, especially with regard to installation. Hence, the manufacturers of plastic pipes were urged to improve the surface protection and diffusion-impermeability of the HDPE pipe.

In 1984, the Dutch discovered that the taste of their drinking water was impaired because HDPE pipes had been laid in contaminated ground. Egeplast solved this problem by introducing the Safety-Line Aluminium (SLA) pipe – an HDPE pipe with an aluminium barrier layer and a wear-resisting coating. At this particular time, the BWB was in the process of replacing steel pipes for service lines with plastic pipes. It was particularly important that the pipes were easy to lay and that damage during transportation, storage and installation could be reduced to a minimum. Because Egeplast's SLA pipe fulfilled all these criteria and was also diffusion-impermeable, the BWB decided to introduce this multi-layer pipe for the service line sector on a trial basis.

In the initial stages, Egeplast's SLA pipe was subjected to extreme mechanical stress. For example, the SLA pipe was used to replace lead and steel pipes for service lines without digging. In this case, the old service lines were pulled out of the ground after being disconnected from the public supply pipes and house installation pipes.



The water carrier: Egeplast's Safety-Line Aluminium (SLA) pipe

towards the house's cellar or in the direction of the public supply pipe. At the same time, a protective pipe was placed in the existing line into which the SLA was then drawn or pushed. Thanks to additional surface protection, which proved excellent in pulling tests through earth mixed with building rubble, the BWB decided to lay the SLA pipe, sometimes without the protective pipe.

Thanks to its positive qualities, the BWB finally decided exclusively to use Egeplast's SLA pipe for service lines from 1 September 1989. The material used by Egeplast for its pipes was subjected to further testing, especially in terms of damage to the pipe exterior. In 1995 the SLA pipe was awarded the official certification of the KIWA testing body for the transport of drinking water through contaminated ground.

After several years' experience with the pipe material HDPE, the BWB is convinced that it made the right decision in opting for Egeplast's multi-layer pipe (the SLA pipe). The pipe's advantages in terms of easy installation, optimum protection of exterior against mechanical damage during transportation, storage and installation and diffusion-impermeability were instrumental in the BWB's decision and it hopes that other public supply companies will share its philosophy in future. ●

Dr Ing Klaus Beyer, Berliner Wasser Betriebe (BWB)

FOR FURTHER INFORMATION:

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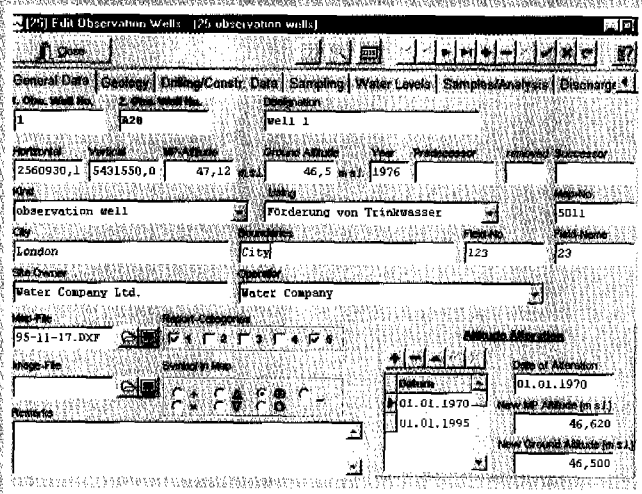

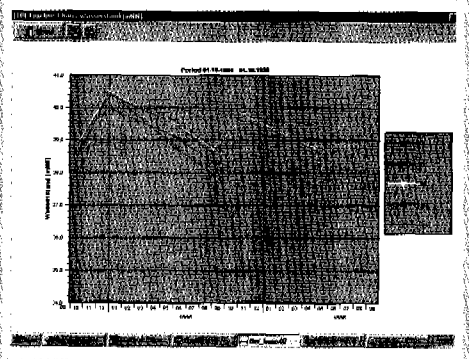

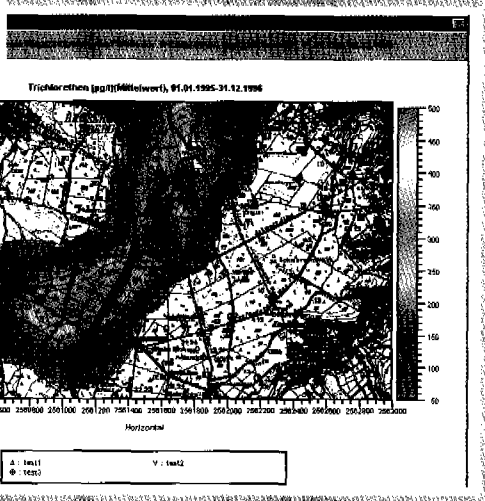

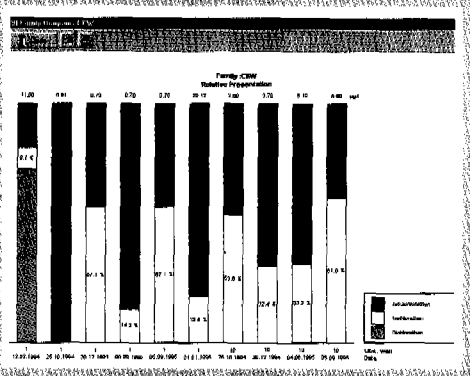

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The information provider

For a forward-looking groundwater resource guarantee and environmental management, the Rhein-Sieg Kreis (Germany) computer-supported communal Environmental Information System provides a solution

As information flows continue to grow, both the questions and the need for interpretation become more and more complex. The availability of personnel and finances is steadily decreasing and, at the same time, the need for high-quality fresh drinking water and the cost of its provision and disposal are increasing. Because of these changing requirements, modern environmental management should be supported by the establishment of an Environmental Information System. Communal environmental management should come from a modern service provider - from today's pure reaction to action in the future - and all-inclusive provision should be made using the necessary electronic tools.

The exchange of environmental data (and the quick retrieval of this data) has been, up until now, very demanding or simply impossible. Because of this, and the great volume of heterogeneous environmental data, a comprehensive interpretation of the environmental situation and, therefore, a recognition of contextual effect was not possible, and the environmental authorities were limited in their abilities to deal with problems and make decisions. In order to guarantee a high degree of acceptance and a quick deployment, the system presented here is constructed modularly and with uniform, practice-orientated, user interfaces. The development of the 'Groundwater and Soil, Dangerous Waste Residues and Dumps' modules was carried out using software from the Dr Richter-Berger-Kasper software company.

The Environmental Information System consists of 29 program modules in total. The main emphasis of the package (with a total of 20 modules) lies in the area of groundwater, waste water, dumps and dangerous waste residues. The System manages data about wells (construction data, position of screen sections, aquifers, geology), groundwater levels and water analyses.

On one hand, the pieces of information - even from minor investigation areas - run yearly into the thousands. On the other hand, requirements for the necessary evalutions and reports are continually increasing. This means that all of this information not only has to be collected, archived and edited, it also has to be made available to administrations, industry and the public in a prepared, evaluated and understandable form.

The Environmental Information System manages all kinds of data collected in a groundwater survey, whether it has to do with a water management district, groundwater damage, a clean-up or a dump. Investigative programs and measurement programs can be defined by the user, routine measurements overdue are displayed, water rights and resources can be managed. For presentation and data export various possibilities are available. With a simple click of the mouse the Environmental Information System lets you create spreadsheets, contour maps, time series charts and diagrams for all necessary tasks.

A target group-orientated, standardised report program enables users to define frequently recurring reports according to their scope and to produce them when they are due. The presentation of graphic objects (maps and so on) and their connection with each other in PC environmental workplaces takes place with the Siemens-Nixdorf GIS system SICAD-SD. In other environments other GIS systems can be used (Arc View, for example). Thus, extensive digital map catalogues are available to the user (contour maps, land registers and so on). International deployment is guaranteed by the availability of foreign-language modules.

The Environmental Information System was developed as a classic client-server database. All database-user programs are programmed independently in Delphi or Visual Basic, in order to leave the system open for using other database systems. Additionally, for use in standard tasks (such as editing text), the system can take advantage of office programs (such as text editing and spreadsheet calculations) via an OLE connection.

To summarise, environmental and groundwater resource management enables the maintenance, quick access and combination of large amounts of data, and forms the basis for comprehensive, fast and cost-reduced evaluation, information and decision-making. The various surveillance and planning tasks in communal, commercial and industrial areas will be optimised. ●

IT for a changing industry

Information technology is enabling dynamic business change and this revolution is as pertinent to the water industry as any other

The water industry is changing. There have been some major changes in the past - such as, in the UK, the formation of catchment-based water authorities in 1974. Now the water industry is being driven by increasing customer expectations and the apparent success of electricity and gas liberalisation.

Across the globe, increasing customer expectations resulting in the need for ever-improved (and competitive) customer service levels has been the priority for business strategies in the 1990s. As the leaders in the industry progress through these strategies, companies have also tended to consider core business functions and their cost base for the service delivered. (The 'cost of quality' debate on affordable service levels in the water industry is separate and likely to continue.)

Business strategies have changed emphasis in recent times. The public service company has become the customer service company. The latest transformation in some is into the asset management company. So, we see a variety of strategies depending on the state of the industry environment in the locality and on the international leadership of the company. Principal business strategies are based on the following factors.

- Excellent customer service - exceed customer and regulatory expectations to protect and grow revenue streams.
- Operational efficiency (while maintaining quality) - attains lower unit costs than comparative suppliers.
- Best use of technology - required for competitive advantage.

We will look at these factors in more detail below.

Excellent customer service

While managing a large customer base has always been a major concern for water utilities, higher customer expectations, fuelled by increasing levels of customer service in other industries and regulatory pressure, are driving utilities to focus more on this area. At the same time, there is a demand for greater financial efficiency, which places a strong need for reducing costs and improving productivity within the customer service operations. Many water utilities are facing significant challenges trying to balance these competing pressures.

In response, companies are transforming themselves into customer-focused utilities, and refining or establishing new business processes in order to be able to offer superior and cost-effective customer service. Information technology is the major enabler to effectively implement these new business processes. When efficiently implemented, customer service-related IT solutions will provide operational benefits and financial efficiency, while, at the same time, increasing customer service levels.

The successful customer service system will provide:

- feedback on operations needed for more effective management decisions
- the flexibility to react quickly to changes in the industry environment
- the capacity to incorporate advances in information technology to further reduce costs and improve operational efficiency.

This customer service system may broken down into two major components which facilitate daily operations: customer care and financial management.

The ability to effectively store and utilise data will enable management to make better decisions

Customer care

Customer care begins with a customer request to the utility (a visit, letter, telephone call, or, even e-mail). An efficient customer service system will allow the rapid and cost-effective response to such a request by providing its users with the following.

- Easy identification of the customer and access to any relevant operational and financial information. The aim is to give an immediate solution to the customer's request.
- Easy access to pertinent information allowing immediate action to be taken, for example access to field agent schedules in order to make an appointment.

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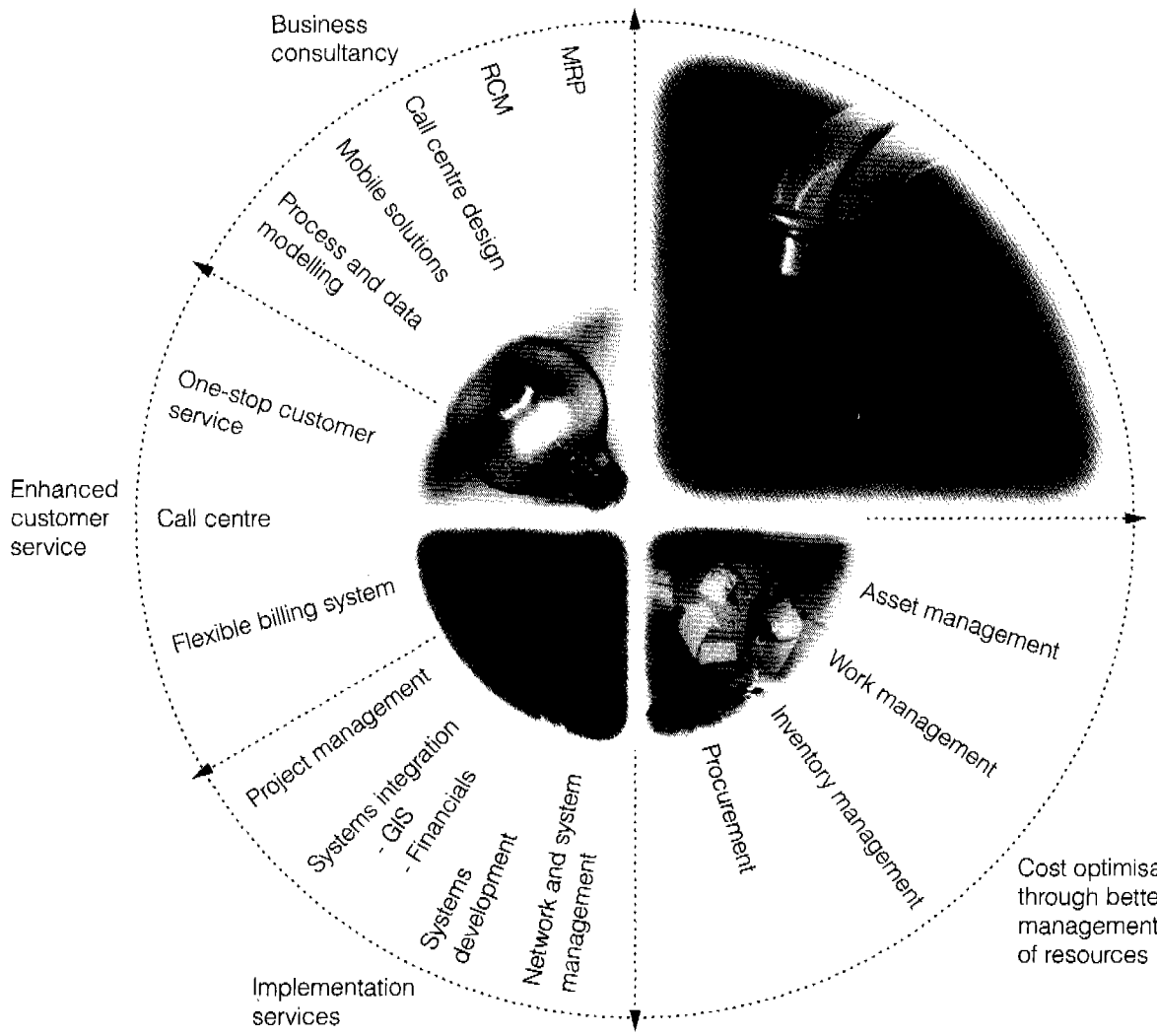

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- Contact management tools for storing or updating the status of requests, transmittal to another agent and confirmation by letter to the customer.
- Access to customer-base information for proactive contact with customers about any incident that might affect them.

Financial management

An effective customer service system will enable utilities to manage financial operations more efficiently at each step of the financial cycle: metering, billing, collection and debt recovery.

- The meter-reading function captures meter indices, calculates consumption and provides the ability to plan and organise the meter-reading process.
- The billing function simplifies the process of creating, managing and rapidly customising rates and tariffs, and allows billing for all metered and non-metered products and services.
- The collection function manages customer accounts with their account balance or by association of bill and corresponding payment. Numerous payment methods are managed, from cash to direct debit of bank account.
- The debt recovery function enables a set of actions towards the customer, such as management of various levels of reminder and payment plans.

Water utilities typically collect large amounts of data on customers through their customer service activities. The ability to effectively store and utilise this data, with business intelligence tools such as data warehousing and data mining, will enable management to make better decisions and improve business processes.

Operational efficiency

While customer service is the high-profile area of business improvement in many utilities, operational efficiency is the foundation upon which competitive companies thrive in the long term. Operational efficiency

Operational efficiency is the foundation upon which competitive companies thrive

is being addressed by a combination of business process transformation, organisational change (especially relating to supplier relationships) and supporting technologies, especially information technology.

As companies move to more process-orientated business models (rather than functional models) there is a change from 'activity management' to 'asset management'. This change reflects the issue in operational and engineering functions of many separate information systems, each with different data definitions. Supporting processes across so many systems has been inefficient and the systems have often prevented any real process control. Further, and more critically, the fragmentation has caused the operational cost base of the business to be hidden within the external financial reports.

Leaders in the industry are learning from other asset-intensive industries and looking at two critical aspects: maximum efficiency ('doing things right') and maximum effectiveness ('doing the right things'). IT has

Supporting processes across so many systems has been inefficient

long been used for efficiency improvements and there is still plenty of room for further support in this area. However, it is in improved effectiveness that IT is being combined with business practice improvements such as Reliability Centred Maintenance to deliver step-change improvements in the cost base. By using decision support tools on the newly consolidated and consistent data being collected by efficiency systems, managers are able to spot trends and exceptions. 'Drilling down' into the detail where necessary enables management to determine root causes and put in place policy changes in response. Such changes can have dramatic effects on operational costs – far more than incremental efficiency savings.

The process change to asset management is also creating a great need for integration across some of the major systems, especially those with asset data. Traditionally, companies have had many systems with asset data, each supporting a different function. These are now being consolidated and major corporate system definitions are appearing. These include Work Management, Asset Management, Geographic Information, Materials Management and performance systems such as Water Quality. Some of these are being grouped into Enterprise Resource Planning (ERP) or Enterprise Asset Management (EAM) system descriptions.

Whatever the particular system descriptions, it is clear that consistency for end-to-end process support and management analysis is becoming a critical requirement. Major system groups are appearing (ERP and EAM, for example) and interfaces between these groups will be critical. Interface technologies, middleware and standard 'packaged' interfaces are becoming of greater importance in the selection of systems and suppliers.

Two opposing strategies are being proposed by suppliers – integrated corporate systems based on one software platform and a 'best of breed' approach using integrating mechanisms to create a cohesive corporate whole. The jury is still out as to which will deliver best. Leading suppliers are competing to expand from either 'base' towards the other, to provide a balanced solution.

Another technology requirement that is gaining momentum is that of mobile access to systems and support for mobile functions. As the cost of mobile terminals reduces and the availability of wireless communications options increases, the benefits of real-time management of the field force become attractive. Integration of mobile terminals requires a mix of standard information technologies and communications technologies. Leading suppliers in this area have a hybrid set of skills together with knowledge of field-working processes.

Asset management requirements further encompass capital investment planning. There do not appear to be standardised solutions in this area today and integration with operational asset management is still a largely unsatisfied requirement. However, as the integration described above starts to appear, together with standardisation of other business data, then the capital investment planning system may emerge as a new form of decision-support tool.

Operational efficiency improvements must be a constant goal for all companies but especially so for the water industry. IT requirements are constantly increasing in response to ever more rapidly changing business requirements. Successful suppliers will polarise into integrators and niche providers.

The capital investment planning system may emerge as a new form of decision-support tool

Specialist systems

Water companies need specialist systems in addition to the business support systems described above. Two major examples are Geographic Information Systems (GIS) and Water Quality Systems (WQS).

GIS has been in existence for around two decades but may still be considered a 'specialist system' as it still requires relatively specialist platforms (hardware) and training. However, it is a key part of the overall information technology support, as it responds uniquely to the challenges of location referencing (maps) and spatial analysis. Increasingly, companies are aiming to optimise resources across wide areas of both geography and organisation.

GIS appears to hold the answer to this spatial optimisation if only it can be seamlessly integrated with the corporate operational efficiency systems. If this can be done and delivered to the average business user on the standard desktop, then challenges such as incident management, leakage analysis, network design or simple work order management can be made more cost-effective. In addition, customer service can be significantly improved through both the reduction of incident impact and the better co-ordination of resources.

Consistency for end-to-end process support and management analysis is becoming a critical requirement

WQS have also been around for a long time and are a more traditional technology than GIS, though they are often linked to laboratory information systems which are very specialised. These systems have been used to manage the legal requirements for a clean environment and potable water and, especially, to provide evidence to relevant authorities. The requirements on water companies – both for management and reporting – are increasing, while the costs are under pressure. WQS requirements are, therefore, becoming more sophisticated, especially in the areas of integration with real-time monitoring systems and with capital investment planning systems. Hence, managing both the near-term and long-term cost-effectiveness and service levels of the company is improved.

Conclusions

The strategic areas mentioned earlier are examples of technology enabling the business to change more dramatically than otherwise possible. IT is a key enabler of business strategy and, increasingly often, a source of competitive advantage. When combined with visionary management, IT is undoubtedly a powerful tool.

In this increasingly competitive industry the use of IT to enable business change and reduce costs is critical. What business is now demanding from IT providers is not just the technology but some industry vision as well. Suppliers need to provide leading-edge technology plus a vision of utility management gained from a worldwide perspective if they are to support the industry in this period of dynamic change. ●

Keeping leakage under control

Leakage problems affect water companies the world over. This report examines the latest developments in the field of leakage control and checks out the steps industry needs to take to solve this wasteful problem

Valerie Homer, Technical and Regulatory Director, **Water UK** (the UK water companies' association)

Those involved in the water industry in England and Wales spent three years researching and documenting best practice in leakage control. This resulted in the publication of the *Managing Leakage* report[1] in October 1994. The report covers all aspects of the subject including performance measurement, night flows, water use, pressure control, customers' leakage, training, technology and economics. Since that time, two further blocks of research have refined this information.

Measuring performance

The water industry in England and Wales is now privatised and regulated by the Office of Water Services (OFWAT). Each year, companies report to OFWAT data related to the amount of water produced and the breakdown of use. This data is published in *The Cost of Water Delivered and Sewage Collected Report* and more recently in the 1996/97 *Report on Leakage & Water Efficiency*,[2] and the information is used by many interested bodies to draw conclusions on the performance of companies. A major problem arises in finding a comparator that accurately conveys inter-company performance in an equitable manner and a number of scaling factors have been used in the past.

Metering remains unpopular and only a small percentage of domestic properties are charged this way

The most popular method in the past has been to express leakage as a percentage of distribution input, but this can be extremely misleading. For example, in a hot, dry year when demand is high, the leakage percentage will be lower than that for a wet year, even when the volume of leakage lost is the same. Another popular method in the past was to express leakage in terms of litres/property/hour or per hour/day. The problem with this scaling factor is that it favours urban areas and therefore sets impossible targets for rural areas. Conversely, litres/km mains/hour or per day (not popular in the UK) would favour rural areas.

The *Managing Leakage* report developed a further scaling factor - litres/km distribution system/day - which divides leakage by the total length of distribution system. This is the total length of mains plus the total length of communication pipes (the small-diameter pipe connecting the property to the main). In England and Wales, the average length of communication pipe is about 3 metres and adds around 25 per cent more to the length of mains. The communication pipes act as a proxy for the number of properties and hence we have a scaling factor which is suitable for both urban and rural areas.

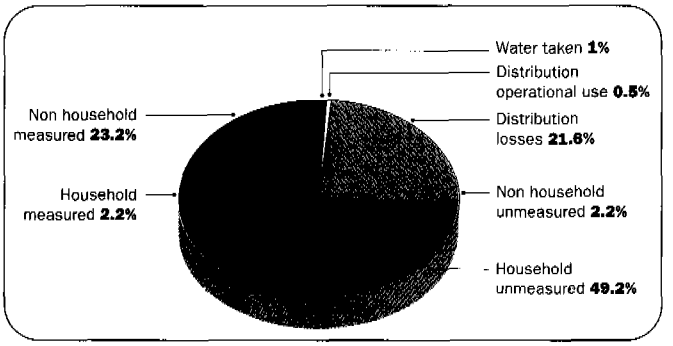
Water delivered

In much of England and Wales customers pay for water through a system based on 'rateable value'. This is calculated against the value of a property if it was to be rented on the open market. The system was abandoned by the rating authorities in 1990 but the water industry is allowed to continue charging in this way. Metering remains unpopular and only a small percentage of domestic properties are charged this way. This means that over half of the distribution input is estimated to be delivered, rather than measured.

This has a serious effect on the way in which leakage is reported as distribution losses can be calculated in two ways:

- by estimating water delivered and assuming residential as distribution loss
- by measuring night flows and assuming this, plus other minor losses, make up distribution losses - the remaining water is then considered to be water delivered.

In the 1996/97 *Report on Leakage & Water Efficiency*,[2] per capita water delivered figures ranged from 171.9 litres per person per day to 132 (with an average of 149.4). It is clear that, with such a range of data, the estimating errors for leakage levels will be high if leakage is derived as the residual of distribution input. Leakage control policy should not, therefore, be determined from per capita consumption.



Breakdown of water use (1996/97)

Night flows

The most popular method of estimating leakage is through night flow monitoring. Some companies employ waste metering which involves installing a turbine meter on the main serving a group 500 to 1,000 properties. It is important that, during a night flow test, all of the flow goes through that meter. At various times of the year, the meter is attached to a data logger and run overnight. Depending on the level of night flow recorded, a decision will be made to conduct a leakage survey. Waste metering can be manpower-intensive and leave long periods between leaks starting and their being discovered.

A more recent development is the use of district metering covering 1,000 to 5,000 properties. Here a turbine meter is connected to a telephone line. A computer at the company office will call the logger once a day and download the contents. If the night flow has risen, the computer alarms to the operator and a survey is conducted.

Many companies now have wide-scale continuous night flow monitoring and therefore are able to monitor the whole of their distribution system on a daily basis. It

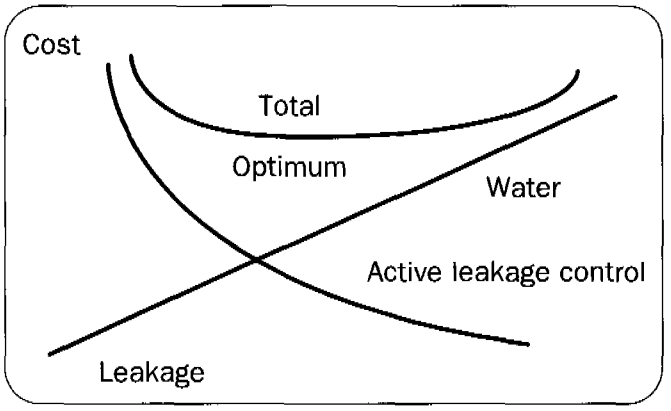


Fig. 4: The economic model

is therefore important to prioritise the efforts of the leak location team and, for this, spreadsheets are used. The *Managing Leakage* report contains a sample spreadsheet showing how it is possible to prioritise either against cost of water, volume lost, or any combination of the two.

Leak location

Having set up systems to monitor night flows and reduce pressures, it is vitally important that leaks are accurately located and quickly repaired. In the past, leaks would have been located by step testing or sounding surveys. Today, other techniques – such as correlation – are employed to improve efficiency.

Economics

Leakage control can be justified against a number of parameters: economics; customer service; water shortage; and environmental issues. For different countries, the order of priority may change but, in most countries, economics will retain first position. Whatever happens, however, it will never be practical or feasible to eliminate leakage completely and, in some companies, it may be most economical to do nothing at all. (Leakage control is an issue for many countries.)

The *Managing Leakage* report goes into great detail in the establishment of unit costs for water and the cost of leakage control. The two items are plotted one against the other and the optimum level is determined to be where the cost of leakage control equals the value of water lost. When the optimum level is examined against the current level of leakage, policies can be set for a reduction programme. This programme should include other water-saving initiatives, such as compulsory metering, rehabilitation, resource development and pressure control.

A bottom-up approach is advocated where targets, policies and investment programmes are set for each water supply zone before they are summed to give values for the whole company. This disaggregation allows local differences in water costs, resource availability and network characteristics to be recognised.

Some water companies have reported that, even with increased leakage activity, leakage levels are continuing to rise. This is due to the state of the distribution system and its propensity to burst. Therefore leakage control alone may be insufficient and a programme of mains renewal is required in order to maintain the supply/demand balance.

Conclusions

As water becomes more expensive and, in some areas, more scarce, leakage control is gaining in importance. At the same time, operating costs, especially labour, are rising and it is therefore important that leakage control is undertaken in a properly evaluated manner. Advances in technology are assisting with accurate detection and the ability to monitor flow has significantly improved. It is therefore feasible to make significant reductions in leakage in a cost-effective manner. In England and Wales, regulation, privatisation and customer pressures have significantly changed the operating regime. We cannot afford to ignore the changes taking place. ●

References

1. *Managing Leakage*, 1994. WRc plc/Water Services Association/Water Companies Association, 1 Queen Anne's Gate, London WC1.
2. *Report on the Cost of Water Delivered and Sewage Collected*, 1993/94 (ISBN 1 874234 14 X); *Report on Leakage and Water Efficiency*, 1996/97 (ISBN 1 874234 32 9). Office of Water Services, Centre City Tower, Birmingham B5 4UA.

About Water UK

Water UK is a new trade association for the water industry across the whole of the UK. It was formed on 1 April, 1998 and subsumed two former associations operating solely on behalf of water companies in England and Wales. The new organisation will represent both the private and public sectors of the water industry in the UK and will be able to represent UK interests in relation to European issues.

Viable pumping from Sweden

Vacon, specialists in control systems for pumping stations, reports that its customers make savings in terms of energy and chemical resources

The Swedish city of Grums in western Sweden has upgraded the control philosophy of one of its sewage networks and sewage treatment plants. Investment has been made in a SCADA system for five pumping stations. The SCADA system is unconventional since it does not include any remote terminal units.

Vadsbo Elektriska AB, an OEM customer of Vaasa Control Ltd (Vacon), specialising in control systems for pumping stations, has installed a SCADA system based on Vacon drives. The drives not only control the speed of the pumps but also all local automatic functions. Five pumping stations are controlled from a central PC and special SCADA software has been designed by Vadsbo Elektriska.

The main function of the installation is the variable speed control of the pumps in the pumping stations and the even flow of sewage water into the plant. Variable speed control makes it possible to save on energy costs, and the flow of sewage water itself minimises the use of chemicals in the treatment plant.

The flow of sewage water minimises the use of chemicals in the treatment plant

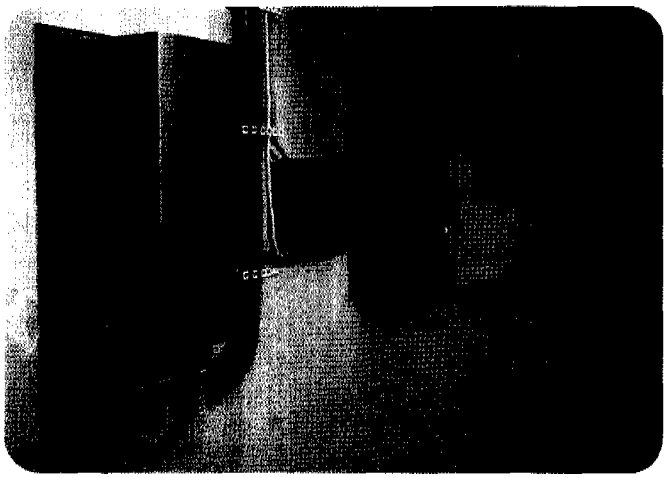
The system has now been up and running for more than six months. The results have been very encouraging and the goals exceeded, especially in terms of savings in the use of chemicals.

Vacon saves energy in pumping stations

The average energy saving, in five pumping stations over six months, is 31.1 per cent (kWh/m³) compared to the same period during the previous year. The maximum average saving is 51.12 per cent and the minimum 23.65 per cent during the first month of operation. The cost per pumped m³ sewage water is much more stable than before installation.

SCADA controls the flow

An even flow of water into the plant was one reason for installing the SCADA system. Before installation of the system the pump was started and stopped according to level switches in the pumping station. This resulted in an uneven flow of water which made the control of the functions in the plant difficult.



Vacon's SCADA System

Variable speed control is a feature of the installation

Five pumping stations can be controlled from a single PC

Money-saving, environmentally friendly

The control of treatable chemicals is more accurate and stable, and the amount of chemicals used decreases dramatically. From a level of 0.16kg/m³ in October 1996, the amount of chemicals used was reduced to 0.07 kg/m³ in October 1997. This resulted in reduction of 57 per cent in chemical effluent discharged into the environment. It also reduced the cost of running the plant; perhaps this is almost as important as protecting the environment and local Lake Vanern in particular - the ultimate destination of the discharge. ●

Events diary

A brief rundown of water industry-related international fairs and exhibitions due to take place in late 1998 and throughout 1999

AUSTRIA
● EUviron
Vienna, 12–14 October 1999
Environmental technology, industry and engineering
Organisers: Wiener Messen & Congress GmbH,
Tel: + 43 1 72720443

CHINA
● Water China
Beijing, 13–17 October 1998
International water expo
Organisers: Business & Industrial Trade Fairs Ltd,
Tel: + 852 2865 2633
● Irrigation China
Beijing, 14–17 September 1999
International exhibition and conference for irrigation technology and management
Organisers: China Council for the Promotion of International Trade,
Tel: + 1 301 4935500
● Pumps & Systems China
Shanghai, 8–9 July 1999
Pumps and systems exhibition
Organisers: HQ Link Pte Ltd,
Tel: + 65 534 3588

CYPRUS
● Watertech
Nicosia, 5–10 October 1999
Water technology exhibition
Organisers: Cyprus State Fairs Authority,
Tel: + 357 2 35 2918

CZECH REPUBLIC
● Hydro
Ostrava, October 1998
International exhibition for water and waste water treatment, technology and equipment
Organisers: Cerna Louka AS,
Tel: + 420 6116304
● International Water Economy Fair
Pilsen, 25–27 May 1999
Organisers: Vystaviste Plzen,
Tel: + 420 19 7221382

DENMARK
● Copenhagen Waste & Water
Copenhagen, 1–3 June 1999
International conference and trade fair on water and environment technology, waste management and recycling
Organisers: Bella Center AS,
Tel: + 45 32528811

GERMANY
● IFAT
Munich, 4–6 May 1999
International trade fair for environment, waste water and waste disposal, water, sewage, refuse and recycling
Organisers: Messe München,
Tel: + 49 89 94901

INDIA
● Water Asia
New Delhi, 19–21 January 1999
Technology exhibition
Organisers: Interads,
Tel: + 91 11 6283018

INDONESIA
● Pumps & Systems Indonesia
Jakarta, 11–14 October 1999
Pumps and systems exhibition
Organisers: HQ Link Pte Ltd,
Tel: + 65 5343588

Israel
● Water
Tel Aviv, 17–19 November 1998 and 30 November–2 December 1999
Exhibition of equipment and accessories for water management
Organisers: Keshet Events Ltd,
Tel: + 972 3 9516570

LEBANON
● World Water Technology
Beirut, 4–8 May 1999
International trade fair for water technology and equipment
Organisers: PromOrient Liban,
Tel: + 961 1 215814

MALAYSIA
● Enviromex/Watermex Malaysia
Kuala Lumpur, 13–16 July 1999
International environmental and water management technology, equipment and control systems exhibition
Organisers: Malaysian Exhibition Services,
Tel: + 60 3 4410311

THE NETHERLANDS
● Ecotech Europe
Utrecht, 13–15 April 1999
International environment trade fair
Organisers: Royal Dutch Jaarbeurs,
Tel: + 31 30 2955911
● Oman
Gulf Water Technology
Muscat, March 1999
International water control and management technologies exhibition
Organisers: Oman International Trade & Exhibitions, Tel: + 968 564268

PORTUGAL
● Expoambiente
Lisbon, 10–14 November 1999
International exhibition on environmental technology, waste management and water treatment
Organisers: Feira Internacional de Lisboa,
Tel: + 351 1 3601500

RUSSIA
● Aquaterra
St Petersburg, March 1999
Water technology exhibition
Organisers: Restec JSC,
Tel: + 7 812 2172047

SINGAPORE
● Watermex Asia
30 November–3 December 1999
International water management technology, equipment and control systems exhibition and conference
Organisers: Singapore Exhibition Services,
Tel: + 65 3384747

SLOVAK REPUBLIC
● Ekotechnika
Bratislava, June 1999
Environmental technologies trade fair
Organisers: INCHEBA,
Tel: + 421 7 801111

SOUTH AFRICA
● Afriwater
Johannesburg, 17–20 August 1999
International water, waste and environmental exhibition
Organisers:
TML Reed Exhibitions,
Tel: + 27 11 886 3734

SPAIN
● SAMA
Alicante, September 1999
Environment and water technology exhibition
Organisers: Institución Ferial Alicantina,
Tel: + 34 6 5682144

TURKEY
● Aqua-Tech
Istanbul, March 1999
International water technologies and equipment exhibition
Organisers: Royal Dutch Jaarbeurs,
Tel: + 90 212 2828808

UAE
● The 'Big 5' Show
Dubai, 17–21 October 1999
Five industry sectors, including water technology
Organisers: International Conferences & Exhibitions Ltd,
Tel: + 44 1442 878222

UK
● ET
Birmingham, October 1999
Environmental technology exhibition
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● IWEX
Birmingham, 19–21 October 1999
International water and effluent treatment exhibition
Organisers: Turret RAI plc, Tel: + 44 1895 454545
● WETShow
Harrogate, 11–12 November 1998
National water and waste water treatment exhibition
Organisers: Turret RAI plc, Tel: + 44 1895 454545

USA
● WEFTEC
Orlando, 3–7 October 1998
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Novi Sad, 14–18 September 1999
International exhibition for water treatment
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Tel: + 381 21 25155

Product Review

WORKING TODAY FOR A BETTER TOMORROW

In man's quest to prosper through industrialisation, pollutants have contaminated many of our waters and soils. Environmental Solutions, Inc (ESI) recognises the potential hazards of industrialisation and consistently provides enhanced processes, chemicals and equipment to the worldwide market of government and commercial agencies responsible for removing the toxic elements from our waste water and soil. ESI's point-of-source manufacturing, coupled with an open distribution network, allows it to distribute cutting edge technology competitively to these organisations.

Using an integration of innovative and traditional technologies and chemistries, ESI provides engineered process-flow systems that easily meet the most stringent waste water discharge regulations. All of ESI's systems are engineered with water recycling or zero discharge capabilities in mind.

Because ESI recognises the importance of educating its clients and providing the information necessary to understand its projects, it maintains a comprehensive website containing process-flow diagrams, chemical and equipment descriptions and sample project proposals. This, in turn, provides a single reference point for clients to obtain timely and accurate information about ESI's latest technologies. ●

ESI's engineered process-flow systems meet stringent waste water discharge regulations

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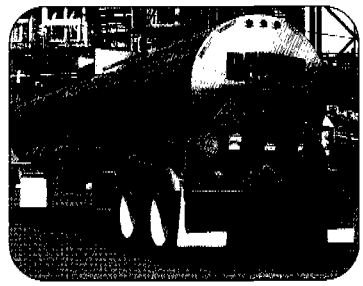
TANK TRAILERS FOR HIRE

Baker Tanks is an equipment hire company celebrating its 50th birthday without taking any time to eat its birthday cake! Baker Tanks' idea of celebrating is constantly looking for ways to better satisfy customers. 'We believe in the concept of continuous improvement,' states Jim Holmes, President and CEO of Baker Tanks. 'We not only look for new products and services to introduce, but we also look for ways to perfect our current services and products.'

New product introductions are Baker Tanks' idea of business as usual. Since 1993 it has added over 13 new products to its turn-key industrial equipment hire line. Baker Tanks' products include steel tanks, polyethylene tanks, secondary containment systems, mixing tanks, stainless steel tank trailers, solids-handling pumps, pipes, hose, ISO tank containers and intermodal box containers.

Baker Tanks hires out equipment to many industries. Examples include: refinery and petrochemical, electrical generation, construction, municipal, ship and barge cleaning, tank terminal and pipeline, mining, and environmental clean-up. Baker Tanks' customers include Shell, Chevron, Exxon, Dow, the US Government, Schlumberger, General Motors, Westinghouse, Boeing and thousands more. Its hire equipment is designed to supplement customers' existing fleets and to solve temporary on-site storage situations. By renting equipment on a daily, weekly and monthly basis, Baker Tanks is ready to serve any storage or pumping application. In fact, it will deliver equipment day or night, 365 days a year and can save its customers significant capital: 'Why spend your money on capital equipment for a temporary situation when you can hire?' says Jim Holmes. Why indeed ... ●



Baker Tanks hires out new tank trailers

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THE ECONOSTORE ADVANTAGE

An Econostore water storage system at Ramla, Israel

Many quality storage systems have been developed, including those made from concrete, pre-stressed concrete, bolted and welded steel. Working to meet primary criteria, an evolutionary process has created the latest innovative storage system from C W Neal Corporation; it's called 'Econostore'.

Weatherability, corrosion-resistance, maintenance and overall cost-efficiency are the major challenges facing every engineer and/or owner in selecting and specifying construction materials. Econostore successfully merges two proven storage systems to provide an efficient alternative for projects with large capacity requirements.

Glass-fused-to-steel technology has been continually upgraded by A O Smith Engineered Storage Products Co (beginning in the 1920s). With a firing temperature of 1500°F, a thickness of 6–11 mils on the interior and exterior, and a bond of over 5,000 PSI, the coating attains the mechanical and physical properties of porcelain enamel. This proven technology provides a tank shell that offers unmatched advantages over other steel coating systems.

Econostore combines this technology with the advantages of polypropylene high-performance reinforced flexible membrane lining (FML) to achieve maximum quality drinking water and waste water containment. Polypropylene FML is used for containment on the in-ground floor areas and glass-fused-to-steel tank walls contain the liquids above ground. Where covered storage is required, a floating cover made of reinforced polypropylene completely seals the contained liquid.

All major components of the Econostore storage system are prefabricated and shipped to the job site for rapid installation. If your containment needs are in the range of 2–45MG, please contact C W Neal Corporation for additional information. ●

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TAILOR-MADE WATER TREATMENT

Waste water for one can serve as process water for another

Groundwater levels are subsiding worldwide, with the result that the most important source of clean drinking water threatens to dry up. As a consequence, international authorities are getting ready to preserve drinking water for human consumption and exclude its use for industrial purposes. Intensive work is being carried out on new technologies to make the use of surface water more attractive for industrial use.

Modular testloop

KEMA Power Generation provides support in the area of water use and re-use through practical advice and innovation. Its modular test loop is a good example of this support. 'The modular test loop is for anyone that wants targeted-quality process water,' explains André Zeijseink of KEMA. 'When customers are looking for an alternative water source for process water preparation their first criterion is that it must have at least the same [high] quality as before. Introduction of problems such as corrosion and deposits of chemical compounds must be prevented. With the modular test loop we have a tool that can be used to preselect the optimum water-treatment techniques.

'Modules of different water-treatment techniques can be installed in a random sequence. The numbers and types of water treatment techniques and their sequence depends on the composition of the water to be purified. Then the chosen configuration is tested on location for several months and adapted as necessary. This provides the assurance that desired water quality will be achieved and the least expensive configuration is chosen with an operationally proven technology.

'In a broader context, the modular test loop can also be used as a tool for water management. A good example of this might be waste water recycling. What is waste water for one can serve as a basis for process water preparation for another. Here, the testloop is very useful in supporting feasibility studies.' ●

FOR FURTHER INFORMATION:

Please visit KEMA's website at:
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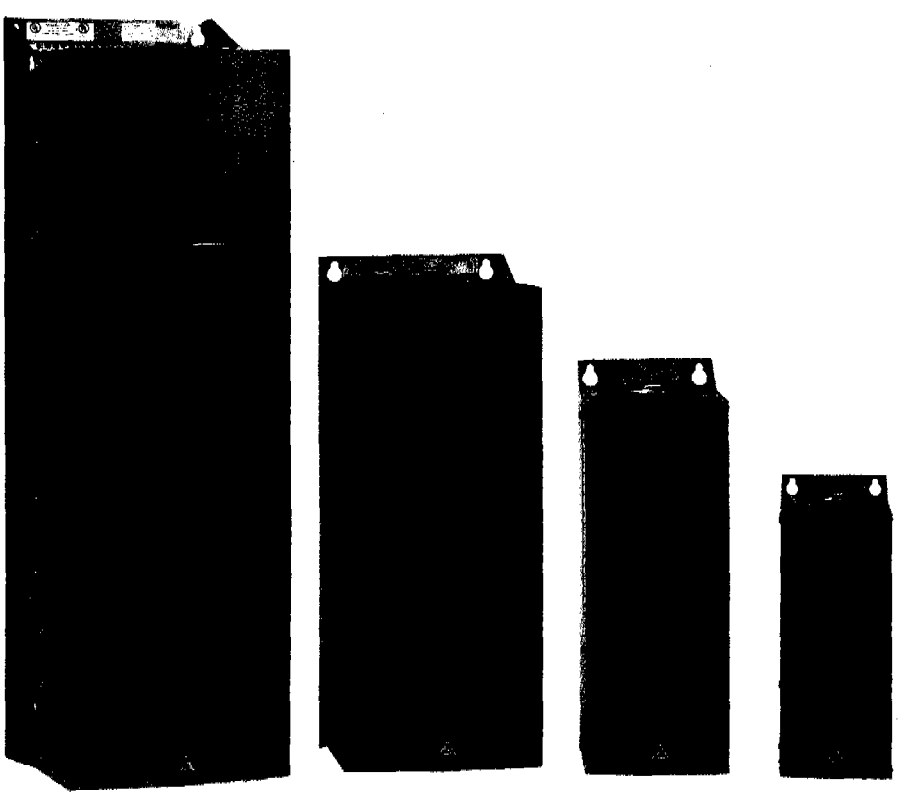

FOR SMOOTH CONTROL

vacon

For further information circle (2)