As more South African cities and towns feel the pinch of drought and excessive demand, alternative water sources, such as the sea are becoming increasingly attractive. Desalination, once considered an expensive, experimental technology is now being considered by many a municipality. *Lani van Vuuren* reports.

There is increasing evidence that desalination presents a viable option for drinking water supply from alternative water sources in South Africa to supplement the country's dwindling water resources. Both capital and operating costs of desalination plants have reduced significantly in the last two decades, mainly due to the improvements made in the membrane technology available, making it an increasingly attractive option.

To date, reliable information regarding desalination has been scattered among various sources. This, in addition to the fact that the South African desalination industry is still in its infancy in respect of drinking water supply, has made it difficult for water services providers to establish whether the use of desalination is an option, what the costs are and which technology to apply. Local authorities are specifically faced with the uncertainty where information regarding desalination is only supplied through suppliers, providing only a tariff per unit of water supplied, on which to base their decision.

Now the Faculty of Engineering at the University of Stellenbosch, in a project funded by the Department of Water Affairs & Forestry and managed by the Water Research Commission (WRC), has compiled a desalination guide to assist in this regard. Kobus du Plessis of the university acted as the project leader. "The recent severe drought in the Cape Town region stimulated the debate around the application of desalination to augment conventional water supplies," WRC research manager Dr Gerhard Offringa tells *the Water Wheel*. "Through this renewed interest in desalination the need for reliable information regarding the pros and cons of applying this technology in the South African context was identified."

The guide, which is in the final stages of preparation, will provide municipal decision makers with crucial information regarding the technologies that can be implemented in South Africa to treat saline water (seawater and brackish groundwater) to drinking water standards. It provides guidelines to identify the pre-treatment necessary and will assist with the decision-making process regarding the operational, maintenance, management and environmental aspects related to the selection and use of these technologies.

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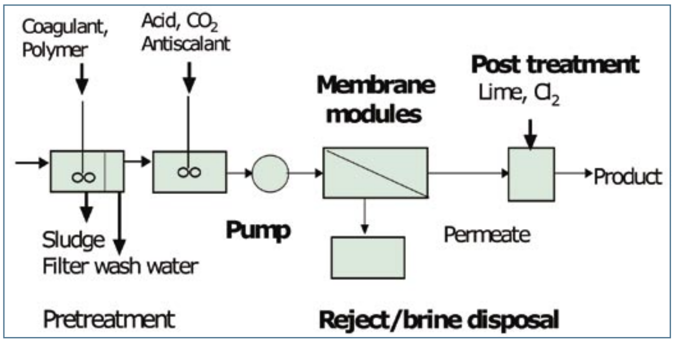
"Of particular importance for the South African application was to identify the level of skills required for daily operation of the desalination plants, the level of skills required to provide technical back-up and service, and to identify and advise on the competencies, training needs and capacity building required at operator and management levels," notes Chris Swartz of Chris Swartz Water Utilisation Engineers, who cooperated with the University of Stellenbosch in compiling the guide.

OPTIMUM TECHNOLOGY

While thermal distillation systems still account for the majority of the world's seawater desalination capacity, it is believed the membrane-based reverse osmosis (RO) systems, which are rapidly gaining ground, are more suited to South African conditions. Due to its substantially lower energy use, RO is expected to have a much lower lifecycle cost than thermal distillation and contributes much less to greenhouse gases. All existing desalination plants in South Africa use RO technology. The guide therefore also focuses exclusively on RO technology.

A typical membrane process



It explains that there are many aspects to consider when contemplating the use of desalination technology. For example, compared to conventional municipal water treatment, desalination processes are energy intensive. No assessment of a desalination process is thus complete without proper understanding of the energy requirements and the available sources and cost of energy. Interestingly cost comparison between conventional treatment and desalination for various sized plants are provided.

Another important aspect is the type of feed or raw water source. This will determine the type of technology required. South Africa has three seawater zones with different water qualities of which the West Coast water, roughly located between Cape Agulhas and the mouth of the Orange River, is believed to be the most expensive and difficult to treat. In turn, the quality of brackish inland water will need to be determined before an optimum treatment technology is selected. Groundwater exploitation potential maps as well as groundwater quality maps are included in the guide.

Also of importance is what to do with regards to the fouling of membranes. Fouling or the deposition of solid substances on the surface of the membrane can be one of the most crippling effects of desalination processes as it affects both the amount of water produced and the quality of the water. Pre-treatment is usually applied to reduce fouling of the membranes.

In certain areas in South Africa small-scale desalination plants have proved to be more cost-effective than transporting freshwater over long distances. One such a plant treating saline groundwater is situated at Bitterfontein, in the Western Cape.

As the technology becomes increasingly affordable water services authorities, especially those situated at the coast, have shown progressively more interest in augmenting their water resources through desalination.

ENVIRONMENTAL CONSIDERATIONS

During the desalination process, it is inevitable that waste streams are generated, which should be managed suitably. The treatment and disposal of these residuals may result in significant costs for the water services provider. The most important and largest waste stream from any desalination plant is the brine which contains high concentrations of salts and other concentrated impurities that may be found in the feed water, and which should be disposed of in a safe and acceptable way.

The most common brine disposal options are ocean disposal (in the case of seawater desalination), surface water discharge, sewer discharge, deep-well injection (not applied in South Africa at present), evaporation ponds, land application and co-disposal with wastewater treatment plant effluent or power plant cooling water. Swartz points out that when considering desalination as an alternative option to conventional water supply it is important to carefully take into account all the environmental costs associated with the development and operation of desalination plants.

SMOOTH OPERATION

Operating a desalination plant is not necessarily more difficult than operating a conventional water treatment plant, but a lack of adequate control measures during the operational phase can be very costly in terms of membrane life expectancy and therefore operational cost. The maintenance cost for desalination is normally also slightly higher than that of conventional treatment plants due to the higher pressure pumps and membrane cleaning processes required.

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"Perhaps the most important aspect of the operation of any desalination plant is the availability of accurate data on which decisions regarding the operational aspects can be based," reports Swartz. "If a specific plant is operated by an external company, then the water services authority must have access to all the relevant data."

TRAINED STAFF

With regards to human resources, the day-to-day operations of desalination plants do not require any special formal qualified staff. However, plant operators should be well trained and capable of acquiring the skills necessary to perform daily operations of the plant and to report any deviations from normal operating parameters. Certain maintenance tasks, such as chemical cleaning of membranes, need to be performed under the control and guidance of a knowledgeable supervisor or technician.

It is of utmost importance that sufficient funds and labour be made available to undertake preventative maintenance. In addition, technical support is necessary to ensure that any deviations from normal

Cost estimates for seawater reverse osmosis desalination plants (excluding distribution systems)

Plant & raw water type	Capacity (Mℓ/d)	Feed-water TDS (mg/ℓ)	Feed-water temp (ºC)	Order of magnitude capital cost (R/kℓ)	O&M costs (R/kℓ)	Capital redemption (R/kℓ)	Unit production cost (R/kℓ)
West Coast	5	36 000	9	63	4,00	4,40	8,40
	50	36 000	9	530	3,30	3,70	7,00
South Coast	5	36 000	16	46	3,30	3,20	6,50
	50	36 000	16	394	2,80	2,80	5,60
East Coast	5	36 000	21	40	3,00	2,80	5,80
	50	36 000	21	338	2,60	2,40	5,00

Note: These cost estimates should be used as a guideline for planning purposes only.

operating regimes are addressed rapidly and effectively so that service delivery (both volume and quality) is not compromised.

This is the first time in South Africa that a publication of this kind has been produced. It is believed that it will go a long way in assisting informed decisions regarding the technology.

DESALINATION IN THE WORLD

According to the International Desalination Association, there are more than 17 300 desalination units with a total capacity of about 37,75-million m³/day worldwide. Desalination is already used in 125 countries around the world.

At present, the largest desalination plant using reverse osmosis (RO), the technology favoured in South Africa, is located in Ashkelon, Israel. This seawater RO plant, which started production last year, holds 40 000 membrane elements in 32 RO treatment trains over four floors, and uses optimised, multi-stage RO and boron removal procedures. At full capacity, the plant will produce about 274 000 m³/day.

Construction of Umgeni RO Plant Imminent

Plans for the construction of a 1,5 Mℓ/day desalination plant at Zinkwazi, on the KwaZulu-Natal North Coast, are progressing steadily.

The small town of Zinkwazi, on the KwaZulu-Natal North Coast.

At the time of writing the award of the multimillion Rand main construction tender was imminent. The desalination plant is expected to bring welcome relief to the small tourist town once completed in 2007. Bulk water supplier Umgeni Water is funding the project. Costs will be recovered in the long run through the sale of the water to the Ilembe District Municipality.

Like other towns on the North Coast Zinkwazi has benefited from a recent property development boom. Apart from luxury housing the town has also seen the construction of a new hotel in recent months. However, the influx of people has brought a sharp rise in the demand for water. In addition to recent droughts, this has placed increased pressure on the town's water supplies, which are still dependent on groundwater resources.

Umgeni Water's Graham Metcalf, who is leading the desalination project, explains that the borehole pumps have a maximum capacity of 850 kℓ/day. This has proved inefficient especially during the hot, dry peak holiday season.

An investigation into augmenting Zinkwazi's water supplies ruled out the drilling of additional boreholes as this proved to be unsustainable in the long term. Metcalf told *the Water Wheel* that in this niche application the desalination option turned out to be more cost effective than extending Umgeni Water's existing bulk water pipeline which ends at KwaDukuza. "Desalinating seawater remains an alternative option, and we will certainly not be constructing membrane plants all over the place in the near future, but in this case the technology proved ideal."

Thorough investigations resulted in the selection of reverse osmosis as the preferred desalination technology. This process basically involves pushing the seawater through a membrane filter that traps the impurities on one side and allows clean water to be obtained from the other side. The most suitable pre-treatment technology is yet to be determined. The final product will be piped to the town's existing reservoir.

All environmental precautions have been taken and an environmental impact assessment has been undertaken. The compact plant will be located about 800 m from the nearest residence on Tongaat-Hulett property, and no remarkable environmental impact is foreseen. "All precautions have been taken to ensure that the natural surroundings are disturbed as little as possible," said Metcalf.

The most important environmental consideration has been the disposal of the brine or saline waste product from the desalination process. Metcalf reported that the brine will be returned to the sea. Investigations showed that the brine would dissipate within about 20 m² in calm seas.

This is not the only desalination plant planned for KwaZulu-Natal. Another facility to treat seawater for drinking water is in the pipeline for the Blythedale Coastal Resort, north of Ballito. It has been reported that this facility will provide up to 8 Mℓ/day for 4 000 resort homes.