

A desalination guide for South African municipal engineers

CD Swartz^{1*}, JA du Plessis², AJ Burger³ and G Offringa⁴

¹ Chris Swartz Water Utilisation Engineers, PO Box 745, Mossel Bay 6500, South Africa

² Department of Civil Engineering, Stellenbosch University, Private Bag X1, Matieland 7602, South Africa

³ Department of Process Engineering, Stellenbosch University, Private Bag X1, Matieland 7602, South Africa

⁴ Water Research Commission, Private Bag X03, Gezina, Pretoria, 0031, South Africa

Abstract

Municipalities need to develop Water Services Development Plans (WSDPs) as a first requirement in their budgetary process, and need to be made aware of the options that are available to provide more than basic services. While 25ℓ/person·d has been set as the minimum basic water supply and while many consumers receive far in excess of this amount, there are areas of the country where water of acceptable quality is not available for household use. However, in many areas adequate quantities of saline water may be, or are, readily available. This is especially the case for coastal cities and towns.

The cost of treating water is only part of the total cost of making drinking water available to the consumer. This together with the fact that membrane technology is becoming more affordable and that energy can be recovered, makes the desalination of water viable for domestic purposes.

A desk study, funded by the Department Water Affairs and Forestry and managed by the Water Research Commission, was undertaken to identify treatment options for desalinating seawater from both the Indian and Atlantic oceans or brackish water from boreholes. The specific objectives of the project were to compile a Guide on the technologies that can be implemented in South Africa to treat saline water to drinking water standards, to identify the pretreatment that is necessary, and to present guidelines on operational, maintenance, management and environmental aspects relevant to the selection and use of these technologies. An important aspect was also to quantify the capital and operating costs for planning purposes of the different components needed to successfully bring the water to the accepted standards for potable and domestic use.

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 advice, and to identify and advise on the competencies, training needs and capacity building required at operator and management levels. Lastly, the relevant local environmental legislations governing desalination were also identified.

Keywords: desalination, municipal water treatment, reverse osmosis, pretreatment, post-treatment, operation and maintenance, environmental aspects, residuals management

Desalination technologies appropriate for South African conditions

Thermal distillation systems account for the majority of the world's seawater desalination capacity, while membrane-based reverse osmosis systems (newer technology than distillation) are rapidly gaining ground. Distillation systems are more energy intensive (up to four times more) than reverse osmosis systems, but require less pretreatment of the water and are therefore generally considered to be more robust. However, most distillation plants are located in the Middle East where low-cost energy is available and where these plants run in combination with electrical power stations (using low-pressure steam, discharged from the turbines, as energy source).

In the South African context, thermal desalination processes would normally not be considered for desalination of brackish or seawater, unless sufficient waste heat or low cost fuels are available (e.g. in combination with nuclear power generation). Until recently, the upper capacity limit for reverse osmosis (RO) desalination of seawater was considered to be around 100 000 m³/d, while plants with larger capacities were always based on distillation. However, the Ashkelon desalination plant in Israel,

one of the most recent additions to large-scale seawater desalination plants, has a production capacity of 330 000 m³/d and is, despite its 'large' capacity, a RO plant. Therefore, considering the relatively low cost of electricity in South Africa and the typical capacity requirements of potential South African desalination plants, reverse osmosis (RO) would almost always be the process of choice. This statement is supported by the following facts:

- A detailed costing study by Namwater (Namibia) for a desalination plant at Swakopmund indicated that RO would be less expensive than thermal distillation
- After an in-depth assessment, Perth (Australia) is progressing with the design of a seawater RO plant
- Sydney (Australia) is considering RO as their method of choice for desalination
- The new, large (330 Mℓ/d) desalination plant in Ashkelon (Israel) utilises RO
- Several other RO plants with capacities of around or above 100 Mℓ/d have recently been constructed in the UAE, Singapore and elsewhere
- Existing seawater and brackish water desalination plants in South Africa and Botswana that provide water for municipal use are all RO plants.

This paper was originally presented at the 2006 Water Institute of South Africa (WISA) Biennial Conference, Durban, South Africa, 21-25 May 2006.

* To whom all correspondence should be addressed.

☎+2744 691-1242; fax:+2744 690-7960; e-mail: cswartz@mweb.co.za

Further, because of its substantially lower energy use, RO will have a much lower life-cycle cost than thermal desalination and contribute much less in terms of greenhouse gases than thermal distillation. Therefore, apart from describing the fundamental