DESALINATION AND WATER REUSE IN INDIA - AN OVERVIEW

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Summary

India, being a tropical country, receives abundant rains. However, this is not evenly distributed and many parts of the country are chronically water starved. Due to occasional failure of the monsoon, the water problem becomes quite acute in these areas. In coastal urban locations it is possible to augment water sources by adopting desalination and water reuse technology. This paper presents the current water availability and needs, historical developments and current status on desalination and salient features of various desalination processes. The aspects of cost reduction strategies adopted for future are also discussed.

1. Water Needs and Availability in India

India receives an average of about 100 cm of rain annually. It is not, however, evenly distributed throughout the country. Some parts get more than 300 cm, while others get around 50 to 60 cm and have chronic water shortages. The total rain water received in India is estimated to be roughly 4000 km^3. Three quarters of the rain is lost however, as run-off to the sea and only one quarter is stored as ground water and surface water resources. The net water availability is thus around 1000 km^3 and the total water consumption at present is approaching 700 km^3. The water availability and consumption figures (Patel and Pujara 1991) are reported in Table 1.

As can be seen from Table 1, if available water sources are harnessed appropriately, the water needs of the country can be adequately met. In water-scarce areas such as Rajasthan, coastal Gujarat and coastal Tamil Nadu there are plans to bring water long distances from the reservoirs constructed on a number of rivers. These schemes require huge financial outlays and are also subject to environmental concerns. Their implementation is consequently delayed, and the afore-mentioned regions remain water starved. Due to the failure of monsoons, the problems become quite acute in these areas and water is supplied by tankers and railway wagons. The cost of such water supply is reported to range from Rs 50 to 200 m^3 and the quality is not always assured. Some of these areas are witnessing rapid industrial growth, which need good quality water. Installation of large size seawater desalination plants based on MSF and RO as well as RO effluent treatment plants for water recovery and reuse are under active consideration in these areas. It appears that desalination and water reuse could contribute about 10-20 per cent of the water requirements in these areas.

S. No.	**Needs**	**1985**	**2000**	**2025**
1	Irrigation	470	630	770
2	Domestic	16.7	24.2	40
3	Industries	10	30	120
4	Power	4.3	5.8	15
5	Misc.	39	60	105
		540	750	1050
Total rainfall			4000 km^3	
Utilizable			1050 km^3	
i) Surface ground water			700 km^3	
ii) Ground water			350 km^3	

Table 1. Annual water consumption for various needs in India (km^3).

2. Historical Developments of R&D on Desalination in India

The research and development work on desalination in India started as early as 1960 at the Central Salt and Marine Chemical Research Institute, Bhavnagar, a laboratory under the Council of Scientific and Industrial Research of the Government of India, engaged primarily in the research work on developing technology for the production of salt and various marine chemicals from the sea. With the experience in various aspects of seawater application, this laboratory started work on solar desalination and later also set up a small unit based on the multistage flash (MSF) process for seawater desalination. Subsequently this institute took up work on electrodialysis (ED) and reverse osmosis (RO) technology for brackish water desalination and is still engaged in this field. The work on desalination at Bhabha Atomic Research Centre (BARC) started in the late 60s as part of a study on a Nuclear Powered Agro Industrial Complex (BARC 1970), wherein with the possibility of availability of large blocks of cheaper energy from nuclear power plants, it was proposed to set up a number of energy intensive processes such as production of elemental phosphorus, electrolytic hydrogen and seawater desalting based on thermal processes using steam from nuclear power plants. In late 70s, work on RO was also included in this programme. Pilot plants on both MSF and RO process were set up and demonstrated successfully at BARC for seawater and brackish water desalination respectively. At this time, work on desalination was also taken up at the Defence Laboratory, Jodhpur on electrodialysis process. The National Environmental Engineering Research Institute, Nagpur, took up R&D on membrane processes for effluent treatment. Basic studies on mass transfer in membrane processes were taken up by a number of academic institutes. Finally, a number of private companies dealing in the field of water treatment adopted RO technology as a supplement to the demineralization process for production of good quality water from raw water, containing moderate salinity of 1000-1500 ppm.

During the 80s, declared by UN as International Decade for Water Supply and Sanitation, the three laboratories which had developed reverse osmosis and electrodialysis technology set up a number of demonstration plants in the villages for supply of safe drinking water from the available underground brackish water sources. This experiment indicated the feasibility of setting up small size RO/ED plants for supplying drinking water to the villages affected by the brackishness problem.

The Government of India launched a Technology Mission (Govt. of India 1987) called Rajiv Gandhi National Drinking Water Mission in 1986 for providing good quality water for all the villages in the country suffering from chemical and biological contamination of water sources, such as excess fluoride and iron, brackishness and guinea worm. The above laboratories and a number of companies joined in this mission project. Hundreds of RO plants were set up in the villages affected by salinity problem and these are now providing drinking water to the inhabitants. The total quantity of water produced by these plants is around 3000 $m^3 d^{-1}$, meeting only the drinking water needs of 0.3 million persons at 10 lpcd. This experience led to wide scale appreciation of the membrane technology, particularly RO in the country. A number of companies became subsequently involved in desalination and water reuse technology.

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