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Reverse Osmosis As A Solution For Water Shortage In Iran

S. S. Madaeni [*(1)] and M. Ghanei [(2)]

(1) Chemical Engineering Dept., Razi University, Kermanshah, Iran, (2) Urban & Industrial Water Technology of Iran Co., Tehran, Iran

Abstract

Large increases in water demand with very little recharge have strained Iran's ground water resources resulting in serious decline in water level and quality. Both thermal and membrane desalination technologies have been used in Iran. Electrodialysis (ED) and reverse osmosis (RO) processes have been used to provide water for domestic and industrial purposes. Application included both brackish and sea water desalination with plant size ranging less than 100 m^3/day to 10000 m^3/day with total cumulative installed capacity exceeding 100 000 m^3/day.

The domestic and industrial wastewater may be used as resources for producing water. This is scientifically possible using appropriate technologies such as membrane processes in general and reverse osmosis in particular. The produced water is a great resource for industrial and agricultural applications. This strategy minimizes the water crisis.

The objective of this paper is to summarize the experience gained form operating reverse osmosis plants over a long period. To achieve this objective, design and operational data from some of these plants were analyzed. Difficulties have been reported in all plants development stages including design, installation, start up, production, fouling control, cleaning, etc. Some of these problems are minor. However if they are not addressed properly, their impact on plant performance can be significant.

Keywords: *reverse osmosis, desalination, membrane technology, brackish water*

** Corresponding author: smadaeni@yahoo.com*

Introduction

Reverse osmosis desalination has a relatively long history in Iran. The first RO plant in Iran was established in 1977 for make-up water of boilers in Sepahan industries group. The feed water was obtained from the nearby brackish wells with a capacity of 30 m^3/day. The hollow fibers Dupont membranes were used in the plant.

Considering that the industrial application of RO has been started in 1967, indicates that Iran is one of the leading countries that employed membranes for industrial applications [1].

Nowadays many plants with much higher capacity has been designed and constructed in Iran. The main applications for these plants are production of industrial and drinking water from surface, well and seawater. More industrial water is produced compare to drinking water. A large RO desalination plant with a capacity of 24,000 m^3 per day is under construction. The total capacity of water production with membrane technology in Iran is around 100,000 m^3 per day [2].

Installed RO desalination capacities and main users

Various industries are the main users of reverse osmosis technology in Iran. They use surface or ground water. In the south of Iran and southern islands that suffer from water shortage, seawater is used for production of drinking water. Water production based on RO technology in different sectors of industries in Iran is as follows [2-5]:

User	Capacity (m^3 /h)	Type of water
Petrochemical plants	1800	Rivers, wells
Refineries	300	Seawater
Off-shore	100	Wells
Power plants	250	Wells
Rubber and vehicle industries	300	Wells
Pharmaceutical and food industries	800	Wells
Inorganic and metal industries	300	Wells
Textile and pulp and paper	150	Wells
Drinking Water	500	Seawater
Total production	4500	

Problems associated with reverse osmosis process

The application of reverse osmosis technology has been met with both successes and problems resulting in marked reduction in the actual capacities to only a

small fraction on the installed ones. These problems are associated with design, installation, as well as operation and maintenance. Moreover they are both general and specific depending on size, geographical location and operation. These problems contributing to the adverse impacts on water costs and reinforcing the prevailing misconception that reverse osmosis is too complex and luxuriously expensive and therefore is inappropriate as a supplementary water supply source especially for domestic applications. This shows the importance of the knowledge in the field of problems associated with reverse osmosis technology and the procedures for solving the difficulties.

The main problems associated with the application of reverse osmosis in Iran are as follows:

1. Unavailability of sufficient data showing the quality of raw water especially quality variation during time (e.g. different seasons).
2. Lack of knowledge of end-users due to limited local experience.
3. Un-sufficient attention of users to the recommendations made by RO designers.
4. Cost minimization by contractors to win bids resulted in under specifying equipment and material, which performed poorly, and/or in shorter periods.
5. Severe operation and maintenance problems due to lack of experienced personnel, spare parts and materials resulting in lower capacities and higher costs.
6. The problems associated with the importation of membrane modules and other instrument from overseas.
7. Fouling of the membranes due to long time shut down in holidays without using protection chemicals.
8. Flux drop due to the deposition of materials on the membrane.
9. Un-sufficient attention to periodical cleaning of the membranes.

These problems are expected, as most of the plants are small and are operated by non-specialized end-users. However many large capacities plants have been operated and maintained successfully by exclusively local operators for years. Based on the encouraging experience, more plants are being constructed each year [2-5].

Future trends and challenges

The water supply situation in Iran is critical due to scarcity of water sources and the rapidly increasing demand by all sectors. A shortage started more than two decades ago with severe socio-economic and environmental consequence. As conventional water resources are being subjected to serious depletions and quality deterioration, immediate measures should be taken to face these shortage including water demand management and development of unconventional resources. At the moment, they are the only viable alternative to augmenting the conventional supplies.

As the costs of water production using reverse osmosis are decreased smoothly, this technology appears to be more competitive with traditional water resources for domestic and industrial water supply. This is quite likely as these resources are being exhausted beyond economically and environmentally sustainable limits. Reverse osmosis will thus play an ever-increasing role in the future of Iran's development and ensures the continuous supply of water to existing communications and industries and to the emerging water consumers. Moreover, reverse osmosis exhibits a special strategic role as a readily available alternative in the case of partial or total failure of the existing traditional water resources.

Conclusion and recommendations

Iran is country with limited conventional water supply resource and rapidly increasing water demand for municipal and industrial purposes. Water demand exceeds markedly the capacities of conventional water resources creating an urgent need for integrated water resource management with special focus on non-conventional water resources, i.e. desalination and water reuse. Based on the presented analysis of reverse osmosis technology in Iran the following conclusion and recommendation are made:

1. Reverse osmosis technology has been employed in Iran since 1977. Some problems have been associated with design, installation, operation and maintenance.
2. Reverse osmosis technology has been used to provide water mostly for municipal, industrial and power generation users.
3. Reverse osmosis plays a greater role in future due to water scarcity, rise in environmental awareness, tighter regulations and emerging economic advantages over traditional resources. This role is likely to be permanent making reverse osmosis a major element in the sustainable development of the country.
4. As the applications of reverse osmosis are developed locally and internationally, a special attention should be paid to this technology.
5. Collecting the real seasonal data for good design and training of operators and plant designer are necessitated.

References

Sepahan group document and contract, 1977. Urban and Industrial Water Technology Reports, 1977-2002.

Projects documents recorded in Urban and Industrial Water Technology, 1977-2002.

badan petrochemical plant contract, 1995. Urban and Industrial Water Technology Reports, 1995-2002.

Pars tier and rubber plant reports, 1994. Urban and Industrial Water Technology Reports, 1994-2002.

Kavir tier and rubber plant reports, 1995. Urban and Industrial Water Technology Reports, 1995-2002.