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Reuse as a Solution for Water Shortage in Iran

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Abstract

Water shortage is one of the main problems in Middle East. Iran with a large area (1,648,000 sq km) and high population (70 millions) suffers from lack of water resources. In southern provinces, drinking water with a TDS of 4000 to 5000 ppm is consumed. Even this low quality water is not available as much as the people need. In addition to drinking water, a high volume of water is used by other consumers including various industries.

All wastewaters may be treated and recycled using newly established processes such as membrane technology. The produced waters may be considered as resources for domestic, industrial and agricultural purposes. A huge amount of water is saved for drinking and secondary applications such as swimming water. Although the water obtained from wastewater treatment may also be used for drinking purposes with no hygienic risk, the social obstacle is the main barrier.

In this paper some of the case studies for water reuse in Iran are explained. This includes treatment of boiler's wastewater, treatment of discharged water from paint unit, treatment of wastewater in alcohol manufacturing plant and effluent treatment in dairy industry. Although not many of the industries are involved in this technique, it has been shown that this is a possible strategy with the ability of decreasing water crisis.

Keywords: water, wastewater, reuse, recycle, membrane

Introduction

The increasing demand for water supplies, increasing scarcity of water resources, community concerns over the impacts of the discharge of wastewater effluent streams on the environment has created a situation where water supply planners must look at new approaches to satisfying the demands of the future.

Water reuse is an important approach for finding new resources. This strategy focuses on wastewater treatment and water recycles. Membrane filtration is an appropriate technique for treatment of water and wastewater.

Membranes can be employed to remove various contaminants including turbidity, suspended solids, colour, metals, BOD, inorganics, organics, bacteria and viruses.

Conventional water treatment processes including screening; sand filtration and disinfection provide limited to zero removal of species such as colour, metals, nitrates

and organics. Membrane processes may be selected to remove any of these contaminants.

Most of the wastewaters from chemical industries in general and food industries in particular must be treated prior to discharge. The chemical processing industry discharges more than 18 billion gallons of wastewater daily and spends more than $3.4 billion each year to treat this wastewater [1].

In many industries membranes have been tested for water reuse. Miyaki et al [2] developed a water recycling system, utilizing nanofiltration for the reuse of water at a soft drink factory. The system was capable of COD removal more than 70%.

The treatment of bleach effluent was described by Cho et al [3]. A composite membrane showed the COD removal of 84%. Cowan et al [4] carried out effluent treatment trials at a number of red meat abattoirs using membranes. Ultrafiltration followed by reverse osmosis produced high quality reusable water. The technique has been lifted from the research phase into the small scale commercial application.

In many countries with limited water supply water reuse is an important solution for water scarcity. In this paper some of the case studies for water reuse in Iran using membrane filtration have been explained. These studies show the possibilities of employing this technique in developing countries.

Case Studies

Treatment of boiler's wastewater in Behshahr Industrial Company

The consuming water in Behshahr Industrial Plant contains the total dissolved solids of 350 ppm and the total hardness of 250 ppm. The plant wastewater, mainly from boilers, contains 1,500 ppm of total solids and 100 ppm of total hardness. The wastewater is one of the potential water resources for the plant. The reuse of the wastewater provides benefit in respect to the environmental limitations.

In Behshahr Industrial Company, reverse osmosis is used for wastewater treatment. The specification of the system is as follows. In the first stage, 80 cubic meters per hour of wastewater with the total solids of 1,500 ppm is processed to produce 60 cubic meters per hour of polished water with the total solid of 350 ppm and 20 cubic meters per hour of concentrated water with the total solid of 4500 ppm. In the second stage the concentrated wastewater (20 cubic meters per hour with the total solid of 4,500 ppm) is treated to produce 15 cubic meters per hour of polished water with the total solid of 350 ppm and 5 cubic meters per hour of concentrated water with the total solid of 18,760 ppm. This water is conducted to the evaporation unit. The dried solid of the concentrated water is discharged.

This technique results in the production of 75 cubic meters per hour of treated water from 80 cubic meters of wastewater per hour. The polished water is reused in the plant.

Treatment of discharged water from paint unit in Absal Company

In Absal Company, a manufacturer of air conditioning packages, the discharged water from paint unit is pretreated and processed using reverse osmosis. Around 5 cubic meters per hour of wastewater with the total solid of 2,620 ppm is treated. More than 80% of the water is recycled and reused in the plant. The water that is processed

by the reverse osmosis contains iron (0.2%), zinc (4.06%), manganese (0.5%) and nickel (0.35%). The low quality of the feed water results in high fouling tendency. For cleaning and regenerating the fouled membranes, more chemicals are needed. This means higher operating costs. The costs may be higher compare to the investment for processing surface water. However the shortage of water is the driving force for the process.

COD Removal from wastewater of Bidestan Company

Food processing wastewaters are very distinct from other industrial activities [5]. They are distinguished by their high BOD and COD concentrations, high level of dissolved and/ or suspended solids, nutrients (e.g. ammonia) and minerals (e.g. salts).

Bidestan is an alcohol manufacturing company which produces wastewater containing organic materials. The Chemical Oxygen Demand (COD) of the wastewater is high (around 40,000 ppm). The wastewater is treated using biological techniques. However the quality of the treated wastewater (COD around 1000 ppm) is not good enough for discharge to the environment. In a research carried out by the authors, the reverse osmosis process was employed for polishing of the biologically treated wastewater.

Totally eight polymeric (FT30, PVD, DSII, DS, BW30, 37100, 3750 and NF45) membranes were employed. The polyethylene terphetalate PVD membrane showed outstanding results with higher flux and complete COD removal (100%). Among the other reverse osmosis membranes tested the hydrophilic polysulfone 37100 membrane showed moderate performance (86% COD removal). This membrane decreased COD value to ideal amount (less than 200 ppm). Nanofiltration polyterphetalate NF45 membrane showed high ability for removal of organics (98%) due to loose structure. The COD of the wastewater was reduced to lower than 100 ppm. The treated water has a good quality to be used in the same plant.

These results indicate the ability of membranes in combination with other treatment processes to produce recycled water for reuse in the industrial plant.

General demand for higher water recovery

In recent years, most of the industrial plants demand higher water recovery (up to 95%) due to the water shortage. This required higher membrane area which means higher capital costs. In the other hand, membrane fouling is severe due to the higher concentration of dissolved solids. To clean and regenerate the fouled membranes, more chemicals are needed. This means higher operating costs and lower membrane life. However the demand for water treatment using membrane processes is not affected by these limitations due to the water crisis.

Dairy industry

The effluent of dairy industry may be treated with membranes. Turan et al [6] evaluated nanofiltration and reverse osmosis membranes for this purpose. The COD of the NF and RO feeds were reduced from 470 to 9 mg/l and from 10,500 to 80 mg/l respectively. Koyuncu et al [7] investigated the requirements for water reuse of dairy industry effluents. It was possible to recover approximately 90% of the treatment plant effluent for reuse with nanofiltration membranes. In the same research, reverse osmosis

membranes were applied to the raw wastewater of the dairy industry. Almost complete COD removal was achieved. In another work Bickers et al [8] showed that reverse osmosis can polish the effluent from dairy industry. The treatment results in a COD of 18 mg/l.

The whey obtained in cheese manufacturing plants causes many problems in Iran. Nowadays, more than 15 cheese manufacturing plants use ultrafiltration process for milk concentration. These factories produce less whey compare to the other cheese manufacturing plants. The authorities in Iran encourage these industries to treat the effluent and reuse the obtained water for industrial or agricultural purposes.

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