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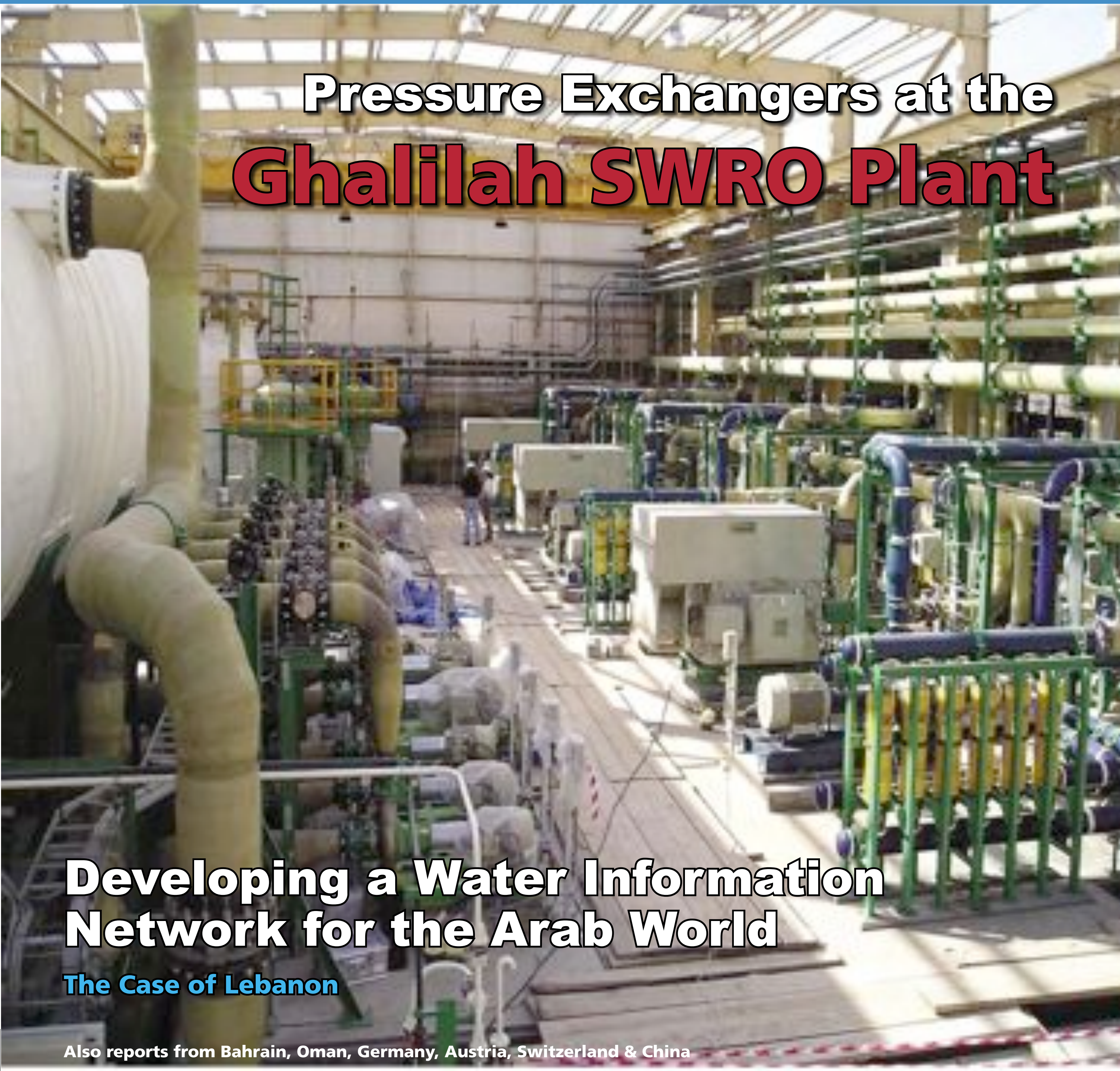

Pressure Exchangers at the Ghalilah SWRO Plant

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Pressure Exchangers at the Ghalilah SWRO Plant

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Ghalilah Plant Overview

The Federal Electricity and Water Authorities (FEWA) SWRO plant in Ghalilah, United Arab Emirates began operation in February 2005. Among the SWRO plants that use advanced energy recovery technology, this plant is the largest SWRO installation in the Arabian Gulf producing three MIGD (13,650 cubic meters) of potable water per day. The Ghalilah plant, designed and built by Fisia Italimpianti, employs ERI Pressure Exchanger technology to save energy and reduce power consumption. This paper describes the challenges and solutions associated with the design, commissioning and operation of the plant, particularly those aspects associated with energy efficiency and energy recovery. Actual performance is compared to predicted performance under various operating conditions.

Introduction

The new Federal Electricity and Water Authority's (FEWA's) 13,650 cubic meter per day SWRO plant in Ghalilah, Ras-Al-Khaimah, United Arab Emirates began operation in February 2005. The Ghalilah plant was designed and built by **Fisia Italimpianti**. Among plants that use ERI PX Pressure Exchangers, this is the largest SWRO plant in the Gulf.

Process Flow

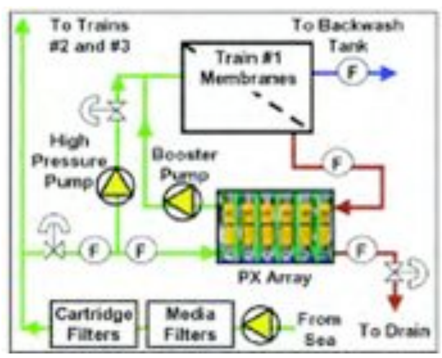
The Ghalilah plant takes feed water from a shared open sea intake. Pretreatment chemicals include chlorine, ferric chloride coagulant, sulfuric acid, sodium bisulfite, and anti-scalant. Seawater intake pumps deliver feed water through media and cartridge filters to three SWRO trains via a common feed header. Each SWRO train is designed to produce 191.5 m^3/hr of permeate.

Rejected brine is used to backwash media filters to save energy and reduce the load on the seawater intake pumps. The rejected brine, therefore, flows from the SWRO trains via a common header to the backwash tank and then to disposal in the sea. Permeate flows from each train via separate lines to the flush/suck-back tank and then to storage.

Post-treatment chemicals include slaked lime to adjust the pH of the product water to World Health Organization standards and chlorine for disinfection. A process diagram is shown in Figure 1. An overview of the plant is shown above.

Pressure Exchangers

The Ghalilah plant employs 18 ERI PX-220 Pressure Exchanger energy recovery devices (PXs) with six PXs per SWRO train. A PX transfers pressure from the high-pressure brine reject to a portion of feed water by putting them in direct, momentary contact in a rotor.



Ghalilah Unit 1 Process Flow Diagram

The rotor is fit into a ceramic sleeve between two endcovers that create an almost frictionless hydrodynamic bearing. The PX rotor contains no pistons or barriers. When the rotor is not spinning, flow passes directly through the device making PX operation during SWRO startup and shutdown almost automatic. Mixing between the brine and seawater

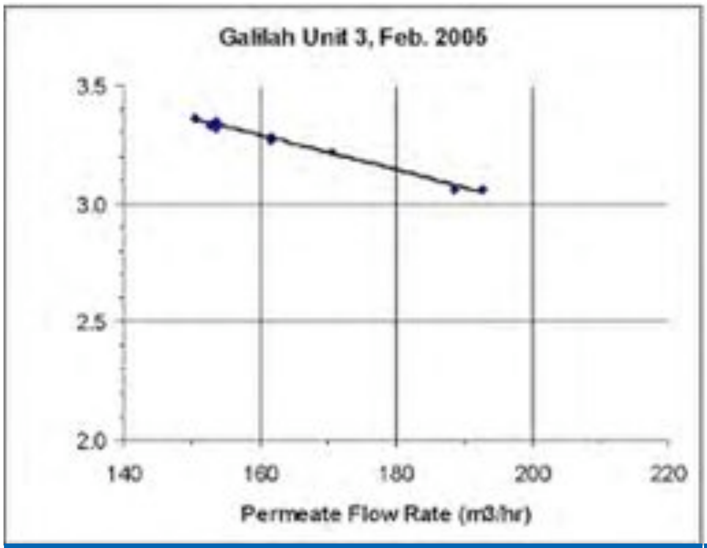


Figure2. Ghalilah Unit 3 Energy vs Flow

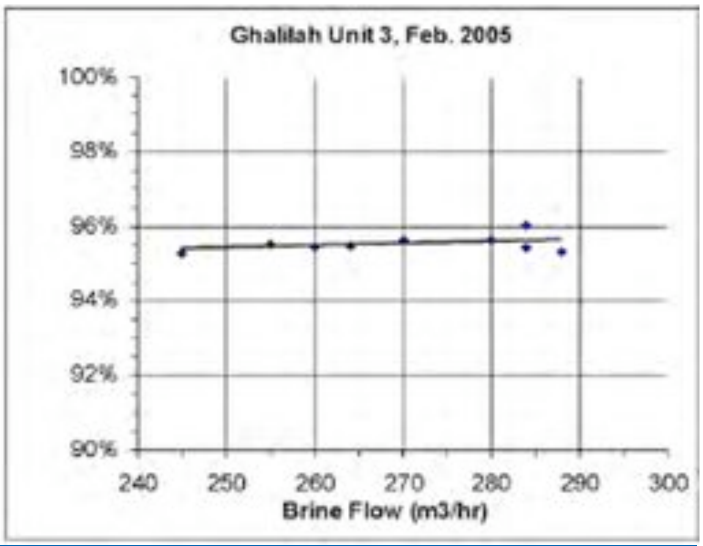


Figure3. PX Efficiency vs Flow

streams is limited because the interface between the brine and seawater in a rotor duct never reaches the end of the rotor before the duct is sealed.

PX Efficiency - The pressure-transfer efficiency of the PX can be calculated with Equation (1):

PX Efficiency =
(Pressure x Flow) out / (Pressure x Flow) in

The efficiency of a PX-220 is approximately 95%. In other words, the efficiency loss in the PX is approximately 5%. About 1% efficiency is lost to the compression of the seawater. Another 2% is lost to viscous friction through the PX. The remaining 2% goes to lubrication flow through the hydrodynamic bearing. This performance is approximately constant over the PX's operating range.

Multi-PX Arrays - The PX-220 has a capacity of 220 gpm or 50 m^3/hr. However, PXs can be manifolded to run in parallel such that unlimited capacity is possible. As has been demonstrated in many long-running multi-PX arrays, PXs perform as well on manifolds as they do individually with no vibration or resonance problems. The pressure drop through a PX (about 1 bar) is generally much greater than the pressure drop along the length of a PX manifold providing even flow distribution. PX arrays are similar to membrane arrays providing the operator with beneficial redundancy. In applications where several rotors are arrayed in parallel like at the Ghalilah plant, the loss of one rotor due to debris or damage has minimal impact on SWRO membrane performance and the plant can typically keep running until scheduled maintenance corrects the problem.

PX Mixing - The salinity of the high-pressure seawater from the PX is slightly higher than the salinity of the seawater feed as a result of contact between the brine and feed water in the PX devices.

At balanced flow when the high-pressure seawater flow from the PX equals the seawater feed to the PX, 6 percent of the brine is mixed into the seawater or a 3% salinity increase at the outlet of the PXs. This increase in salinity is negligible to many plant designers and operators, however, the mixing effect can be reduced or eliminated with excess seawater fed to the PXs.

PX Noise - The PX rotor runs with a hum of a frequency that corresponds with the rotation speed. The intensity of the sound is a function of the flow rate and the operating pressure. A PX-220 operating at 45 m^3/hr and 56 bar emits approximately up to 87 dB of noise measured at a distance of 1 meter. Because they do not emit heat, PXs can be fully enclosed for noise abatement.

Ghalilah Plant Performance

Performance data was collected during startup and commissioning in February 2005 at recovery rates from 35 to 41%.

The overall energy consumption of the plant is below 4 kWh/m^3 of permeate produced.

Throttling losses through the high-pressure pump control valve account for the relatively high rate of energy consumption: this because the pumps were specified with sufficient capacity to overcome membrane fouling or degradation that may occur in the years ahead.

Energy per cubic meter of permeate as a function of flow from the high-pressure pump for Unit #3, not including pre-treatment or auxiliary consumption, is illustrated in Figure 2. PX efficiency as a function of the high-pressure flow from the PXs of Unit 3 is illustrated in Figure 3.

This helps assure that day-to-day variations in plant operations will have little affect on production costs.

Noise, measured in the vicinity of the 6-PX arrays without sound enclosures, ranged from 90 to 91 dBa at 1 meter from center of the rack and 85-88 dBa at 2 meters from the PXs. The ambient noise in the vicinity of the PXs is approximately 84 dBa. The salinity increase at the outlet of the PXs is 3% relative to the incoming feed water.

Conclusion

The Ghalilah plant is running at its design production rate and producing water at less than 4 kWh/m^3 The PXs are running with low mixing, low noise and high efficiency as designed. ■

Source:
* **Energy Recovery, Inc.,** San Leandro CA, USA.

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