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Retro-fitting existing SWRO systems with a new energy recovery device

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Abstract

A new pressure exchanger (PX) device transfers the energy from the concentrate stream directly to the feed stream. This direct, positive displacement approach results in a net transfer efficiency of over 95%. This efficiency advantage makes it possible to dramatically improve the performance of existing SWRO plants by reducing their energy consumption by as much as 75% or by expanding their capacity as much as 300%. Detailed system designs, parameters, and recommendations are provided in this paper for several retro-fit configurations and will be accompanied with case data from operating plants that have been retro-fitted using these new devices. There has been a recent proliferation of commercially available energy recovery devices based on the positive displacement direct pressure exchange approach. This increased interest is driven by the fact that the technology can significantly reduce the energy consumption of new and existing SWRO systems. Since energy costs are rising and can consume, as much as 75% of the total operating costs of an SWRO plant, it is important that the technology be encouraged and disseminated throughout the industry. Although the author of this paper is directly associated with Energy Recovery, Inc., a leading supplier of pressure exchanger technology, the principles and theories presented in this paper will be applicable to all devices that are based on the positive displacement, isobaric chamber approach.

Keywords: Energy recovery; Retro-fit; SWRO system; Pressure exchanger; Cost savings; Reverse osmosis

1. Introduction

A new pressure exchanger (PX) device transfers the energy from the concentrate stream directly to the feed stream using a cylindrical rotor with longitudinal ducts. The rotor spins inside a sleeve between two end covers that divide the rotor into

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high and low pressure halves. This direct, positive displacement approach results in a net transfer efficiency of over 95%. This efficiency advantage makes it possible to dramatically improve the performance of existing SWRO plants by reducing their energy consumption by as much as 75% or by expanding their capacity as much as 300%. Detailed system designs, parameters, and recommendations will be provided for several retro-fit configurations and are accompanied with case data from operating plants that have been retro-fitted using these new devices.

2. Principle of operation

The PX unit utilizes the principle of positive displacement to transfer the energy in the reject stream directly to the incoming seawater feed stream. It is interesting to note that the reject stream is continuously and directly connected to the new seawater stream. This direct connection allows a real net transfer efficiency of energy from the reject stream to the feed stream of over 95%.

The rotor spins inside a sleeve between two end covers with port openings for low and high pressure. The low-pressure side of the rotor fills with seawater and ejects brine water while the high-pressure side fills with brine water and discharges seawater. The rotation simply facilitates the valving mechanism, which is to transport the ducts from one side to the other. By rotation the ducts are exposed to the low pressure feed water, which fills the duct and displaces the reject water. The rotor continues to rotate and is then exposed to the high-pressure concentrate, which fills the duct from the opposite direction, and displaces the seawater stream out at high pressure. This rotational action is similar to a Gatling machine gun firing high-pressure bullets and being refilled with new seawater cartridges. A virtual liquid piston moves back and forth inside each duct creating a barrier zone that inhibits mixing between the concentrated reject and new seawater streams. At 1500 rpm one revolution is completed every 1/25 s. Due to this short cycle time, membrane feed water concentrations typically increase only 1–2% (see Fig. 1). Although PX pressure exchanger technology is based on relatively simple mechanical concepts its application to existing systems can take on many forms.

3. General applications

The pressure exchanger makes it possible to significantly increase the capacity of existing systems by adding little or no additional power and/or reduce the power consumption of existing systems by as much as 75%. There are several

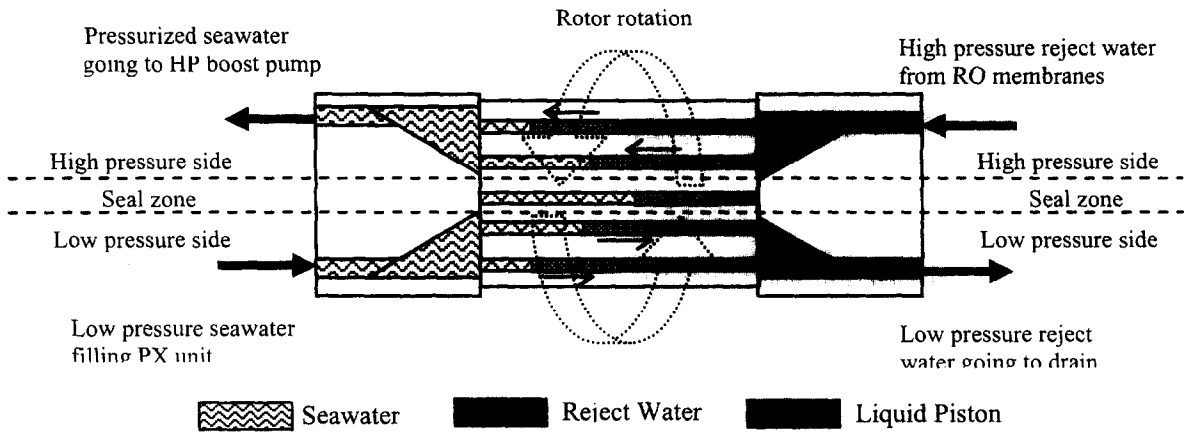

Fig. 1. Pressure exchanger flow path.