HOH USA & Carib Ltd.
Seawater Desalination

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THE DESALINATION STORY:

Seawater desalination plants have produced potable water for many years. However, until recently desalination had been used only in extreme circumstances because of the very high-energy consumption of the process.

Early desalination plants utilized various evaporation technologies. The most advanced seawater evaporation desalting plants using multiple stages have an energy consumption of over 9 kWh per cubic meter of potable water produced. For this reason large seawater desalting plants were initially constructed in locations with very low energy costs, such as the Middle East or next to process plants with available waste heat.

In the 1970s the seawater reverse osmosis process was developed which made potable water from seawater by forcing it under high pressure through a tight membrane thus filtering out salts and impurities. These salts and impurities are discharged from the SWRO device as a concentrated brine solution in a continuous stream, which contains a large amount of high-pressure energy. Most of this energy can be recovered with a suitable device. Many early SWRO plants built in the 1970s and early 1980s had an energy consumption of over 6.0 kWh per cubic meter of potable water produced, due to low membrane performance, pressure drop limitations and the absence of energy recovery devices.

The Search for Energy Savings:

In 1985 FilmTec (Dow Chemical Co.) developed the first commercial low pressure, single stage SWRO element. At the same time pump manufacturers were adapting existing technology such as reverse running turbines and Pelton wheel devices to SWRO plants in order to recover energy. The new membrane technologies and first generation energy recovery devices made possible seawater desalination with energy consumption of slightly less than 4.0kWh/m3. The rotating machinery of these first generation energy recovery devices were made of metal parts which often exhibited high corrosion, wear and maintenance problems when placed in a marine environment.

By 1990 a second generation of energy recovery devices came to market which used high alloy wear parts such as 904L stainless steel. At around this time the hydraulic turbo charger was also developed. These innovations improved reliability and reduced maintenance but still the limitation of recovering only 50 to 80 percent of the energy in the high-pressure brine stream from SWRO plants because of various inherent inefficiencies.

Over the past 20 years various inventors have attempted to develop advanced commercial energy recovery devices to overcome these efficiency limitations. These devices have used combinations of pistons, bladders, valves and timers, and some worked well initially but suffered high maintenance problems. Others were fitted with artificial intelligence programs only to suffer an early demise in an industry where the prevalence of unskilled operators demands simplicity.

In 1992 Energy Recovery, Inc. began the development of a relatively simple ducted rotor that could transfer the pressure energy directly from the SWRO brine to the incoming feed stream. Five years and several million dollars later, the idea evolved into a 4-inch diameter, patented commercial device, the Pressure Exchanger.

The PE devices were first sold commercially in 1997. The all-ceramic moving and mating parts of the PE have shown exceptionally low, and even zero wear in high-pressure SWRO brine applications and the material is not susceptible to the pitting and stress corrosion of steel and bronze components in similar applications. The slow rotating PE (1,500 RPM) has proven to be a low maintenance component in commercial desalination plants.

Since the PE transfers energy directly from the brine to the feed water without high-speed rotating shaft inefficiencies, the PE achieves actual efficiencies of 91 to 95 percent within a broad flow range.

Reduced energy and capital costs mean that for the first time ever it is possible to produce potable water from seawater at a cost below $1 per cubic meter in many locations worldwide.

Truly the greatest invention within SWRO desalination.

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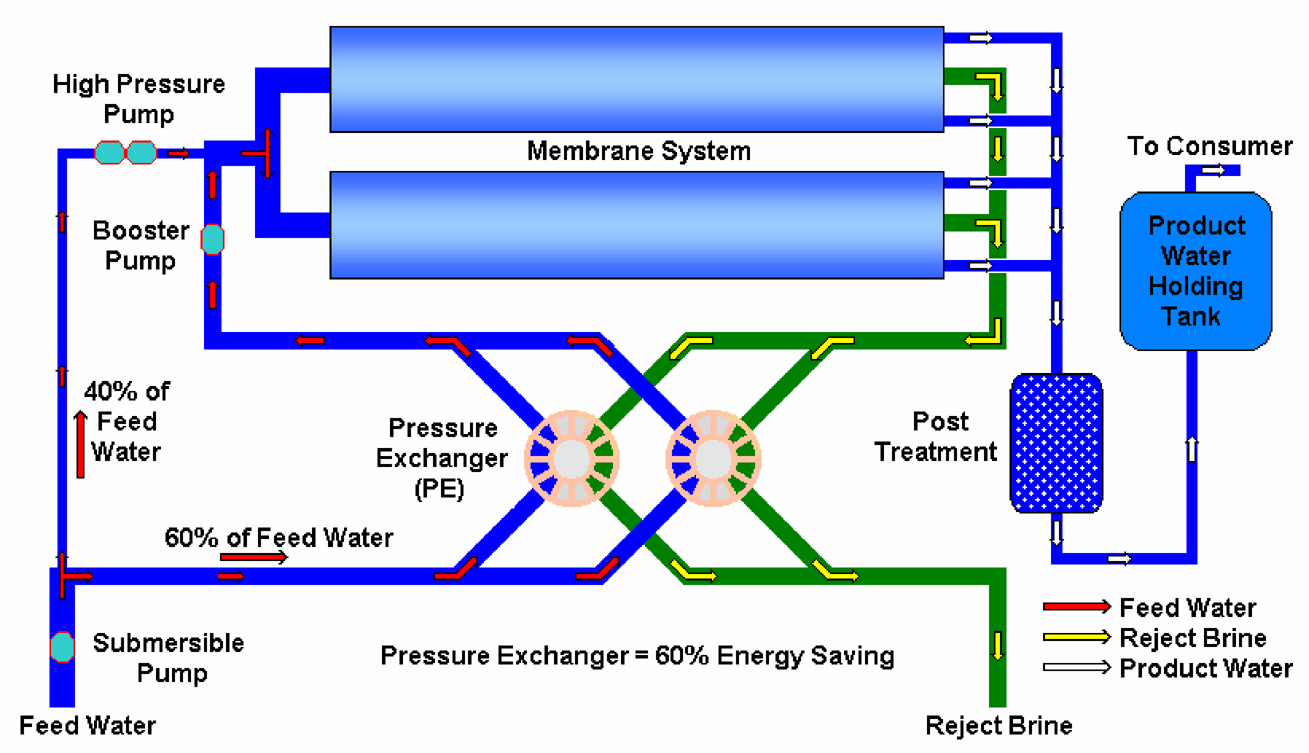
How the Pressure Exchanger works!



The Pressure Exchanger (PE) greatly increases the efficiency of the SWRO system by harnessing the energy of the reject brine. This efficiency can drive energy consumption under 2.8kWh/m³ of product water. By directly pressurizing a portion of the incoming seawater, the main high-pressure pump size can be reduced by up to 60%. This not only saves energy, it also cuts major capital costs.

Applying **(PE)** technology to SWRO is different from conventional recovery devise design, but in practice its quite simple. (See diagram). The reject brine from the SWRO membranes is passed through the **(PE)**, where its pressure energy is transferred directly to a portion of the incoming raw seawater at up to 94% efficiency. This seawater stream, nearly equal in volume to the reject stream, then passes through a small booster pump, which makes up for hydraulic losses through the SWRO system. This seawater stream now joins the seawater stream from the Main high-pressure pump; **it does not pass through the high-pressure pump.**

This is significant, because now **the main pump is sized to match the permeate flow, not the full flow.**

The main pump also makes up the small volume of brine lost through the **(PE's)** hydrostatic bearing. In a typical SWRO plant using the **(PE)** system, the main pump will provide 40% of the energy, the booster will provide 2% and the **(PE)** will provide the remaining 58%. Since **the (PE) uses no external power,** the total power saving is close to 60%, compared to a system with no recovery.

The **(PE's)** one moving part, a shaft less ceramic rotor with multiple ducts, is hydrostatically suspended within a ceramic sleeve. The rotor affects an exchange of pressure from brine to seawater through direct contact displacement, with negligible losses.

Unlike similar devises, the **(PE)** does not use separate valves or pistons. Due to the precision of the rotor and the short resistance time, mixing of the raw water and brine is avoided.