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Sealless Pumps for Reverse Osmosis Water Treatment

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Demand for effective water treatment points to reverse osmosis.

Water is an essential substance to sustain life and one of the most valuable resources a nation can possess. Most of what is available, however, is of little use in its natural state.

Water seems readily obtainable since it covers more than 70 percent of the Earth's surface, but clean, fresh drinking water comprises barely a fraction of all available water. In fact, 97.5 percent of the world's water is saline. Of the remaining 2.5 percent, 70 percent is locked up in the polar ice caps, and 30 percent resides in underground aquifers.

Demand for fresh water increases steadily, and researchers including Surendra N. Kulshreshtha of the University of Saskatchewan predict that half the world's population could face water vulnerability by 2025 [1]. It is no surprise that the United Nations devotes much attention to the issue of safe, fresh water, particularly in places that have been underserved in the past. The UN released a new report in March 2009, *Water in a Changing World*, which is the third in series.

Equally concerning is ensuring that harmful toxins and contaminants are removed from water that manufacturing processes release in the environment. Wastewater from factory production often has levels of chemicals, pharmaceutical byproducts and other pollutants that can pose a significant risk to human beings and other life.

Water and other liquids can be filtered and purified in many ways. One of the most effective methods is simple and straightforward: reverse osmosis (RO) filtration.

Depending on the pump model and configuration selected, sealless, high pressure pumps for reverse osmosis offer flow rates from 3 to 37 gpm with maximum discharge pressures ranging from 1,000 to 2,500 psi.

Design Principle

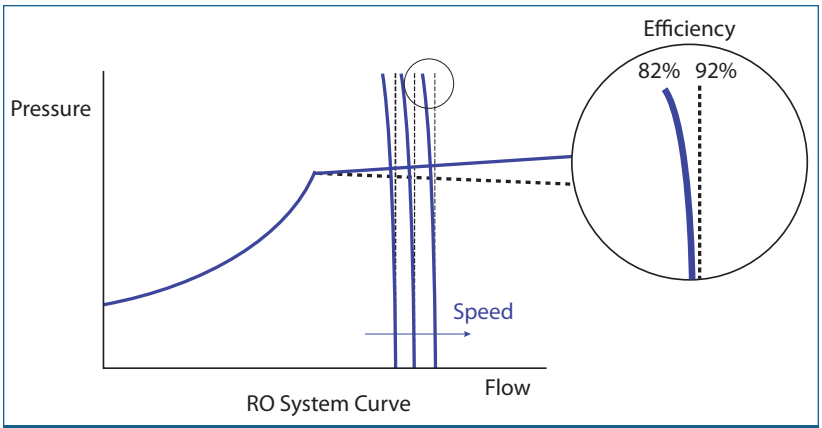
In RO filtration, liquid is forced through a semi-permeable membrane at high pressure, producing purified liquid. The contaminants are concentrated in a portion of the liquid that does not pass through the membrane and are discharged in a reject stream. Efficient RO systems employ positive displacement diaphragm pumps with a sealless design and high pressure capability to purify large volumes of water or liquid at a time. The sealless principle is appealing because of its design simplicity, low maintenance and operating efficiency.

Bill Wanner, CEO of Wanner Engineering, Inc. (Minneapolis, Minn.), explained how this design simplicity makes these pumps easy to operate and inexpensive to maintain.

A sealless design "removes the most maintenance intensive element compared to many other type pumps," he said. "This not only permits the pump to operate in severe environments

such as chemical treatment, but allows it to run dry indefinitely without damage, thereby avoiding a situation where operator error causes an equipment breakdown."

Wanner added that the relatively small footprint of these RO membrane pumps is a tremendous advantage in mobile water treatment systems, such as those used by emergency management teams, offshore oil platforms and even in submarines, where space is at a premium. Due to its unique design, the sealless, high pressure pump boasts a far more compact package than can be achieved with other pump technologies, such as multistage centrifugal pumps.



Since the flow of the pumps is proportional to the shaft speed (and independent from the pressure), it is easier to control permeate flow more accurately while matching it to the RO system curve for greater efficiency. Just a small change in flow and pressure can result in a large change in efficiency and operating costs.

Energy Consumption

Energy usage is a major factor in the operational cost of water purification systems, so companies and organizations that rely on water treatment are extremely conscious of efficiency. It is not only important to keep costs low, but electrical power is also extremely coveted in certain environments. Oil platforms, desert desalinization plants and mobile treatment facilities are prime examples of how remote locations rely on efficient energy usage.

Manufacturers are likewise under increasing pressure to find efficiencies in energy usage, not only from their accountants, but from the general public. Going "green" is not just sensible for the bottom line, but is also smart PR.

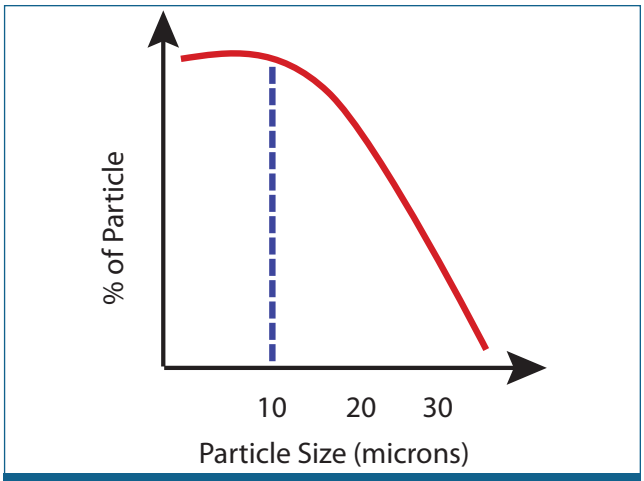
"We engineered [our pump] to operate so that a customer can use a smaller, lower wattage motor to acquire the same treatment capacity as other, less efficient types of pumps," said Wanner.

Wanner points to a number of case studies demonstrating energy savings. In one such example, a single 12 kW sealless PD pump replaced a pair of multistage centrifugal pumps totaling more than 18 kW, but with the same pumping capacity. The total energy savings was more than 50,000 kWh/year. Proportionate savings were shown in smaller applications, as well.

Since the sealless, high pressure pump for RO is a positive displacement system, the flow rate remains constant even as pressure increases. This reduces the cost-per-gallon of water, the critical measuring stick when gauging efficiency. To stretch efficiency further, many customers are now incorporating energy recovery devices as well.

Reliability and Longevity

Approximately 80 percent of typical pump maintenance, according to Wanner, involves the replacement of leaking seals and packing. A sealless design is an advantage in maintenance and downtime. In addition, these high pressure RO pumps feature a hydraulically-balanced diaphragm, so they are capable of handling virtually all particulates. According to Wanner, the pumps can handle solids of up to 500 microns, while other



RO pumps with a sealless design can handle particulates of up to 500 microns. There is no need for fine filtration and its associated costs, whereas axial piston pumps with dynamic seals may require filtration in RO applications to protect the seals and packing.

pump types may require the expense of a filter to prevent particulates larger than 10 microns from damaging the pump.

"We always tell our customers our Hydra-Cell positive displacement pumps handle the really miserable fluids and abrasives that destroy other pumps," he said. "Our design enables charged and dirty liquids to be processed without the need for fine filtration to protect the pump. This reduces maintenance and allows the pump to operate continuously at high pressure."

Wanner notes that most of these RO pumps can operate at any pressure from less than 40 psi up to at least 1,000 psi, with some models capable of operating at up to 2,500 psi. By comparison, rotodynamic pumps need to be started with 750 psi of pressure to avoid damaging the pump.

When compared to piston and plunger pumps, sealless RO pumps offer total separation of the pumped liquid from the lubricating oil, extending the life of the oil by a factor of

Brackish Water Reverse Osmosis (BWRO)	Pump(s)	Motor Size	RO PD Pump Energy Savings[2]	RO PD Pump Annual Savings[3]
11 TDS[1] 319 psi / 2.2 gpm	Multi-Stage Centrifugal	1.41 kW	7,280 kW hours	$655.20
	RO PD Pump	0.5 kW		
11 TDS 319 psi / 6.6 gpm	Multi-Stage Centrifugal	2.19 kW	5,520 kW hours	$496.80
	RO PD Pump	1.5 kW		
30 TDS 682 psi / 6.6 gpm	(2) Multi-Stage Centrifugal	6.11 kW (combined)	16,880 KW hours	$1,519.20
	RO PD Pump	4 kW		
25-30 TDS 624 psi / 18.5 gpm	(2) Multi-Stage Centrifugal	10.65 (combined)	34,000 kW hours	$3,060.00
	RO PD Pump	6.4 kW		
25-30 TDS 638 psi / 33.5 gpm	(2) Multi-Stage Centrifugal	18.44 kW (combined)	50,720 kW hours	$4,564.80
	RO PD Pump	12.1 kW		
25-30 TDS 653 psi / 66.0 gpm	(2) Multi-Stage Centrifugal	28.9 kW (combined)	34,400 kW hours	$3,096.00
	(2) RO PD Pump	24.6 kW (combined)		

[1] *Total Disolved Solids* [2] *Based on pump(s) running 8,000 hours a year* [3] *Based on USA average cost of 9 cents per kilowatt hour.*

Meeting the same performance criteria, but operating more efficiently with smaller motors, RO positive displacement pumps use significantly less energy than multistage centrifugal pumps. This saves the user hundreds, if not thousands per year in RO applications while allowing for a smaller, space-saving system footprint.

four and reducing breakdowns.

"Axial piston pumps internally driven by water need five microns of absolute fine filtration," Wanner added. "The filters typically cost around $500, and the elements, which should be changed every 15 days, cost about $180 each," he said. "Those maintenance costs add up quickly, and failure to maintain the filter means very costly breakdowns."

Maintenance cost is not the only concern. When one pump goes down for maintenance, it reduces the overall treatment capacity. This means that additional pumps are required in large treatment facilities for redundancy. In smaller applications, it means two pumps are required when one maintenance-free pump would have sufficed.

Application Flexibility

Although we tend to associate RO with water desalinization plants, it is also being used for innumerable applications in industries worldwide:

- Treatment of wastewater streams from food plants and industrial plants
- Treatment of waste solvent streams from chemical and pharmaceutical plants
- Treatment of recycled water for reuse
- Treatment of water used in boiler feed applications to prolong system life and efficiency
- Treatment of final rinse water in carwashes and in cleaning processes to aid drying and improve final result
- Disaster management water purification

Pharmaceutical processing facility.

Since pump seals deteriorate in the presence of corrosive chemicals, a sealless design is often considered a necessity in everything from normal to severe-duty applications.

The Tides of Need and Demand to Rise

As the need for fresh water continues to rise and more laws regulating the treatment of wastewater are enacted, the demand for economical, energy efficient water treatment will increase. Part of this trend, driven by the rising cost of fresh water is toward localized treatment plants and units. Given the significant advantages of reverse osmosis filtration, it is no surprise that Wanner predicts this market will grow by 68 percent during the next five years.

References

1. *A Global Outlook for Water Resources to the Year 2025*; ISSN0920-4741 (Print) 1573-1650 (Online)

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