Pump Fundamentals **[1]**

High-pressure pump selection is crucial for successful, long-term operation of an RO system. It is particularly important for seawater reverse osmosis (SWRO) due to severe duty requirements and a corrosive environment. Here are some factors to consider in pump selection:

Type of Feed Pump

- If the feed flow is greater than 10 m^3/hr, use a centrifugal pump. Otherwise, consider a positive displacement (PD) pump.
- Multistage pumps are typically used up to 400 m^3/hr. At higher flows, consider single-stage feed pumps due to lower cost and potentially higher efficiency.

Material of Construction

- For feed salinity below 37,000 ppm, the minimum material of construction is 316L (electropolished and passivated) or Duplex SS 2205. The pump should be flushed with permeate at shutdown.
- For feed salinity above 37,000 ppm, use Duplex SS for the material of construction. However, if feed water is from a well, there is likely no free oxygen. Thus, 316L could be used in higher TDS applications. In all cases, the pump should be flushed with permeate at shutdown.
- The gasket areas under the Victaulic® clamps are typically most prone to crevice corrosion. If available, specify these areas to be clad in a Super Duplex SS alloy.

Feed Pressure Controls

Feed pressure control is achieved by two methods:

1. Usage of a feed pump sized for the maximum expected membrane pressure requirement. Use a feed throttle valve to reduce pump discharge pressure as required by the membrane. Be sure to add the pressure loss through the throttle valve in the full open position to calculate the feed pump discharge pressure requirement.
2. Usage of a Variable Frequency Drive (VFD) to vary the frequency of the power to the feed pump motor. Varying pump speed allows the pump to vary discharge pressure with minimal energy loss. The VFD also allows a gradual increase in pressure (i.e. slow ramp-up) which minimizes electrical starting load and reduces stress on the instrumentation and membranes. However, typical VFDs are 97% efficient - thus a 3% loss of electrical energy should be included.

VFDs are suitable to 600 kW. At higher power levels, medium voltage equipment is generally used, rendering VFDs extremely expensive. Other means of feed pressure control are advisable, such as the HEMI™.

- In most cases, a VFD is preferred. However, if the expected feed pressure variation is less than 4-5 bar then a solid-state soft-start motor starter may be a more economical

solution.
- PD pumps provide feed pressure control and thus do not require a VFD or a feed throttle valve.

Efficiency

Higher efficiency suggests lower energy consumption. However, efficiency can vary depending on the points' conditions, such as:

- Cold water and fouled membranes (highest membrane pressure condition)
- Warm water and new/clean membranes (lowest membrane pressure condition)
- If a VFD is used, include the 3% loss of electrical energy in the VFD

Be sure to calculate the energy consumption (including the VFD, if used) at each duty point. The pump supplier can provide the energy consumption data. Also, determine at which duty point the pump will be operating at predominantly.

Maintenance and Reliability

- A single day of downtime can erase the benefits of a higher efficiency pump. Thus, consider pump reliability as preeminent importance, followed by efficiency and first-cost.
- Centrifugal pumps are generally much more reliable than PD pumps. PD pumps would be most appropriate for very small systems.
- Since RO systems are often operated in areas where little to no maintenance is available, select pumps with minimal maintenance requirements. Keep in mind that oil- or grease-lubricated bearings need regular maintenance. Pumps with water-lubricated bearings would typically be more reliable and require less maintenance.
- Several types of pumps are unusually sensitive to sand. In virtually any RO system using multi-media filters, small amounts of sand may reach the high pressure pump. Unless you are absolutely certain that sand or debris will never be present, use only pumps that can tolerate reasonable amounts of sand or other debris.

Life Cycle Cost

The LCC puts together all of the above considerations. The analysis considers many details, which are explained here [2]. In general, the feed pump with the lowest LCC will have:

- Efficiency in the upper range of centrifugal pumps
- Capital cost in the middle range
- Zero-maintenance bearings
- Long warranty
- Materials appropriate for the intended service

Contact [3] a FEDCO sales representative for further information.

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