PEI Technical Note Book

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Effects of Feed Stream Throttling on ERT Performance

Sea water reverse osmosis systems (SWRO) systems typically operate at applied pressures between 800 psig (55.2 barg) and 1200 psig (82.8 barg). For any given SWRO plant, over time, the pressure will range 100 to 200 psi (6.9 to 13.8 bar) or more. There are a number of reasons for this pressure range; seasonal variations in temperature and salinity require the membrane pressure to be altered accordingly. The magnitude of these adjustment pressures can be very significant. Other changes also effecting plant productivity and recovery are those associated with aging such as membrane compaction and bio fouling. To compensate for the decline in production operating pressure is increased to restore recovery. However, eventually a point is reached where even substatial increases in operating pressure cannot compensate for diminished production. It is here, at the maximum pressure capability of the feed pump, that new membranes are installed into the system. Before membrane replacement takes place there will be a considerable time span (years) when the plant is operated at pressures below the maximum. The lower pressures are achieved by throttling the feed stream pressure exiting the high pressure (HP) pump.

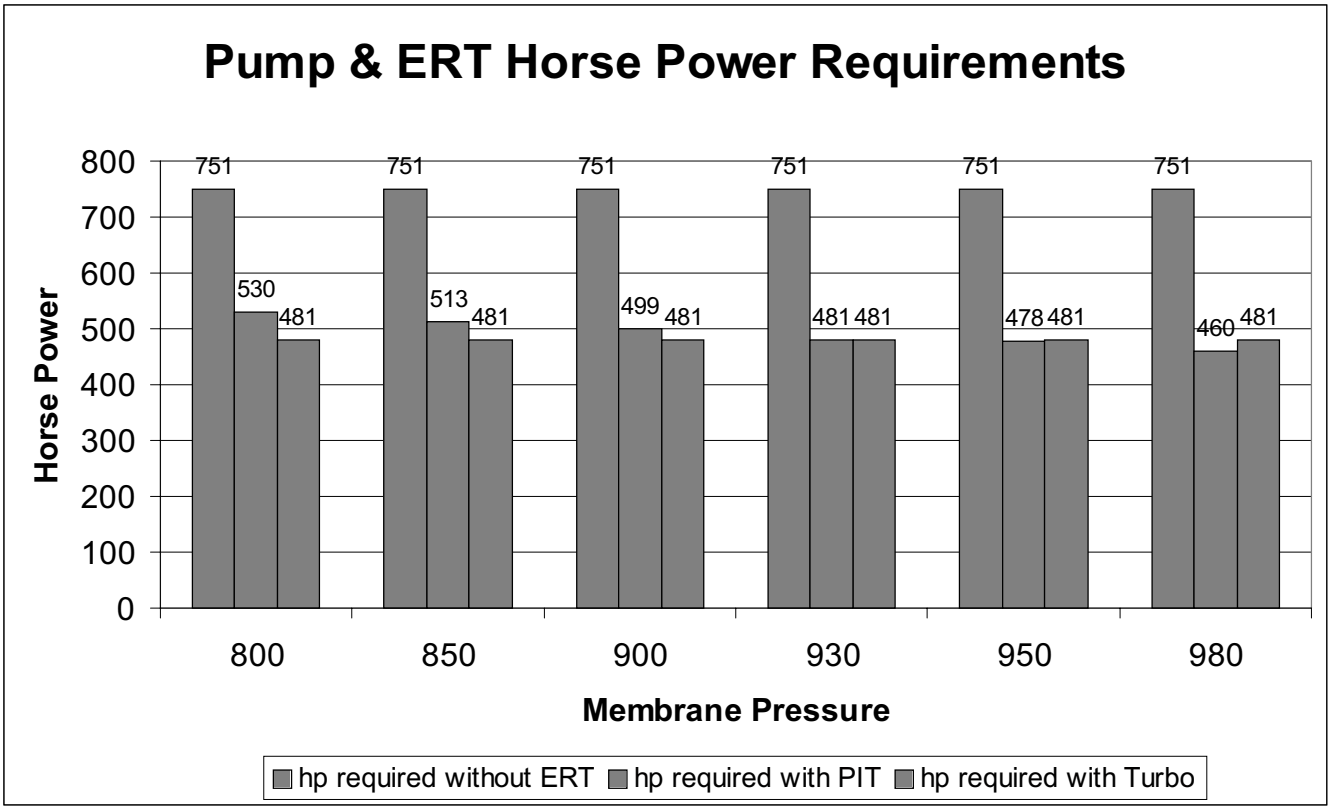
So what is happening to your energy consumption and the energy recovery turbine (ERT) under these varying pressure conditions? Let's examine a SWRO system utilizing a centrifugal pump for the high pressure feed service and two cases of energy recovery, a Pelton Impulse Turbine (PIT) and the Hydraulic TurobCharger™ (HTC™).

Assume the initial and three year membrane conditions are as follows:

	Initial	3 Year
Feed Flow	1000 gpm (227 m3/h)	1000 gpm (227 m3/h)
Membrane Pressure	825 psi (56.8 bar)	1000 psi (68.9 bar)
Concentrate Pressure	805 psi (55.5 bar)	980 psi (67.5 bar)
Concentrate Flow	600 gpm (136 m3/h)	600 gpm (136 m3/h)

In the case of the PIT, HP pump discharge pressure is 1000 psig (69 barg). In the case of the HTC, HP pump discharge pressure is 647 psi (44.6 barg). To obtain the required 1000 psig (69 barg)membrane pressure, the additional pressure boost of 353 psi (24.3 bar) is supplied by the intergral pump section of the HTC. Assuming a 76% HP pump efficiency for both cases, the PIT's pump needs 751 hp. The HTC's HP pump requires only 481 hp because it is deliver-

ing a lower pressure. The PIT will reduce the power supplied by the pumps driver to 460 hp at full membrane pressure. The bar graph below illustrates what happens when feed stream throttling takes place. The graph shows total pump horse power without energy recovery, net pump horse power when using a PIT, and net pump horse power when using the HTC.

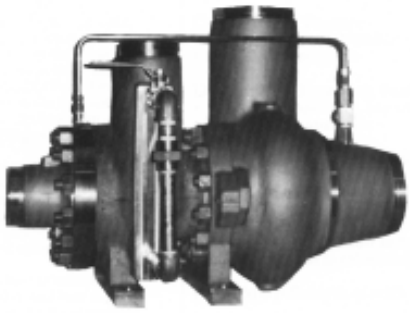


It is readily apparent that feed stream throttling has no effect on the HTCs HP pump power requirements. On the other hand, the PIT equipped system is constantly being robbed of potential recovered horsepower by feed stream throttling, so much so that even though the PIT has a slightly higher hydraulic transfer efficiency (64% vs 60%) than the HTC, at full membrane pressure, the actual amount of energy recovered over the years is less with the Pelton Impulse Turbine than the Hydraulic TurboCharger™. In our case cited above, assuming a constant rate of pressure change due to membrane aging, the HTC™ will save approximately 250,650 kw/hr more energy than the PIT over a three year period.

A reliable and accurate evaluation of an ERT for SWRO service must take into consideration the real world effects of feed stream throttling.

The Technical Note Book is a series of articles addressing pumping and energy recovery for the desalination industry.

Calculations Assume:
Feed pump efficiency at BEP of 76%.
Feed pump suction pressure - 20 psi.
PIT efficiency of 85% at full pressure.
Savings based on 8000 hours of operation per year.



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