PEI Technical Note Book

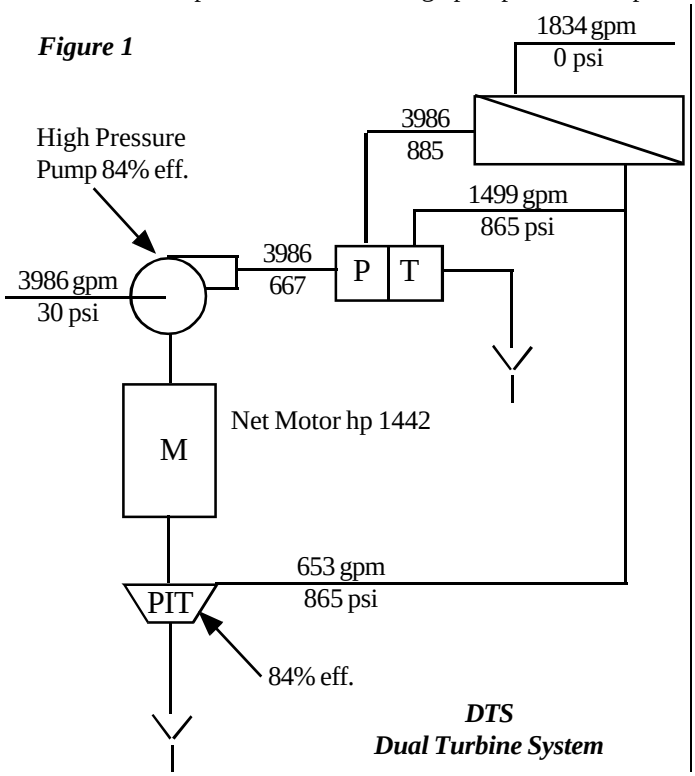
Pump Engineering, Inc. ***Issue 5*** ***March 2001***

10,000 m³/day Seawater RO Plant Achieves Maximum Energy Efficiency with PEI's Patented Dual Turbine System (DTS)

Our last Technical Note Book issued introduced the Dual Turbine Energy Recovery System (US Patent No. 6,139,740 international applications pending) for seawater Reverse Osmosis plants employing both single stage and two stage (brine staged) designs. The single stage example was a medium size train of 1,000gpm (227m³/hr). The example Dual Turbine System provided exceptional performance over the total operating pressure range of the RO plant.

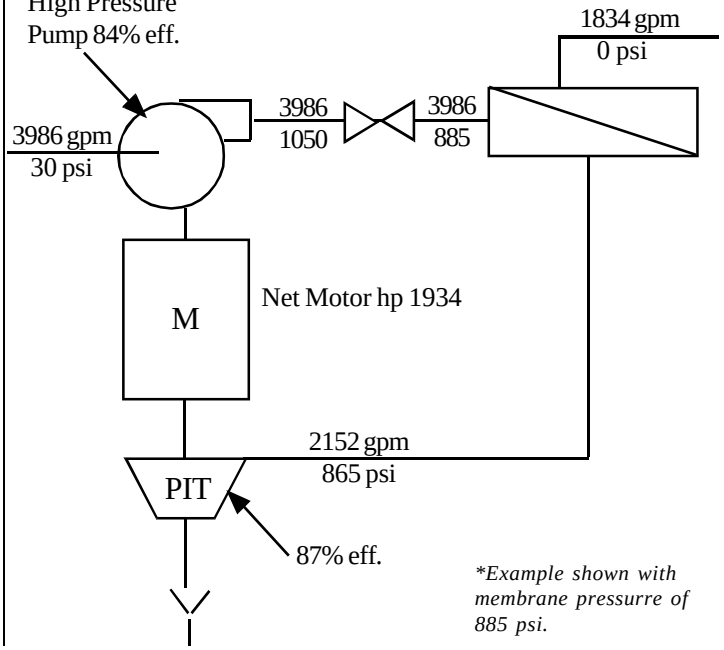
As pointed out in prior Technical Note Books, fixed speed pumping and energy recovery equipment has to be sized for the maximum operating pressure that is projected to occur over the life of the membrane. This maximum pressure is usually the 5-year end of life condition at the time of seasonal lowest feed water temperature or highest salinity. So, during those months or years of operation below the maximum pressure, the pump discharge pressure is reduced by a pump discharge throttle valve to the level of the membrane requirements. This throttling wastes a great deal of pump energy ahead of the membrane and reduces the pressure available to the ERT downstream of the membrane. The Dual Turbine System is meant to eliminate all feed pressure throttling. Let's refresh our memory of the single stage dual turbine concept by examining the flow schematic of fig. 1., which shows the Dual Turbine Concept and a standard design pump- Pelton Impulse Turbine (PIT) system (Figure 2).

Figure 1



DTS
Dual Turbine System

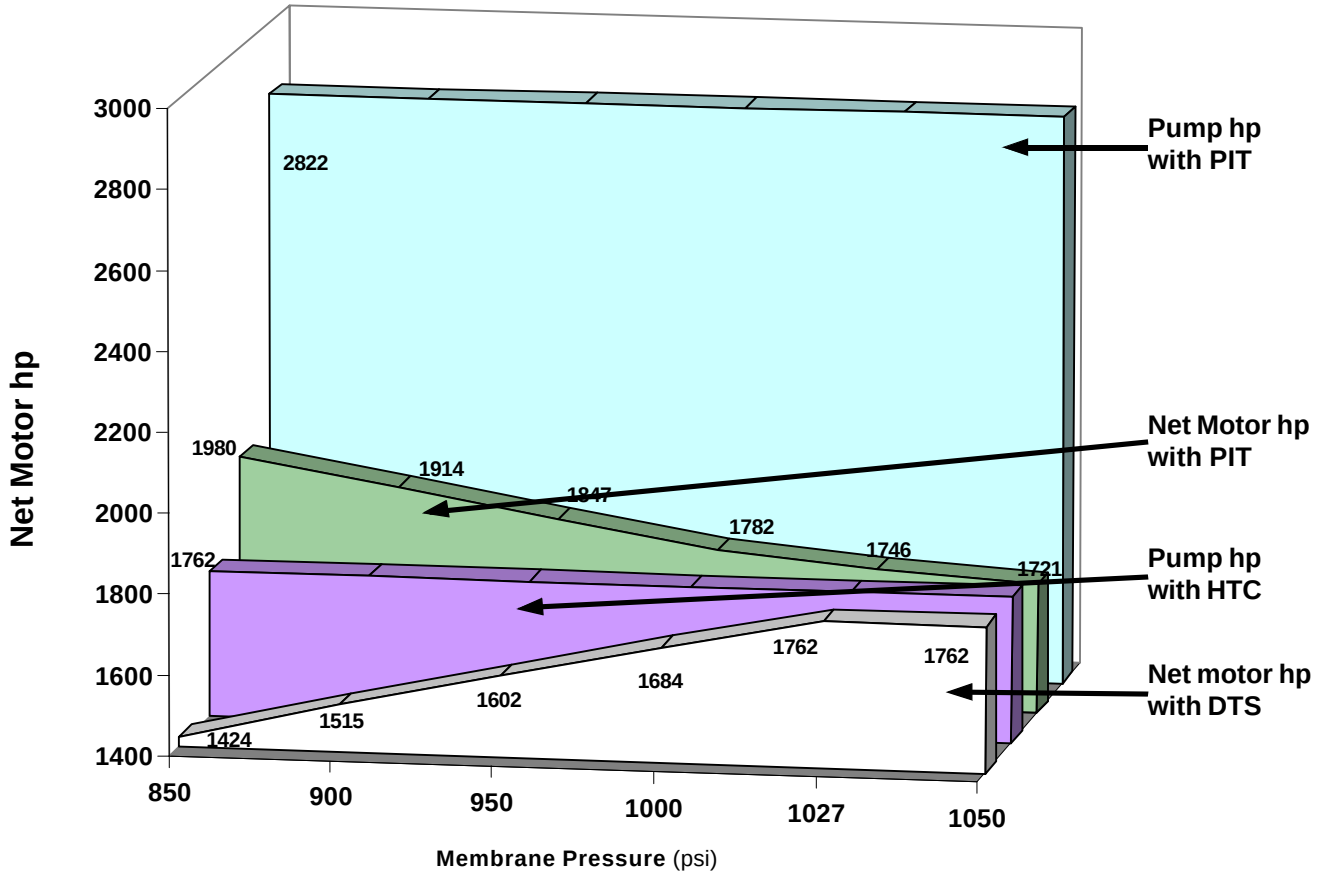
Figure 2



**Example shown with membrane pressurre of 885 psi.*

This example is based on a flow of 3986gpm (905m³/hr) and a recovery ratio of 46%. The pressure range for this membrane system will vary between 885psi (61bar) for 0 year 29° C condition and 1050psi (72.4bar) 5-year 14° C condition. We see from the flow schematic, the pump (typical axial split case multi stage pump performance of 84%) will provide the required flow of 3986 at a differential pressure of 637psi (43.86bar). A PEI HTC II 3600 is used as a pressure booster to achieve the maximum membrane pressure of 1050 (72.4bar). Attached to the double extended shaft high-pressure pump electric motor (2000hp) is a Pelton Impulse Turbine (PIT). This secondary turbine will recovery the energy in the brine flow that is not required by the HTC when feed pressure demands are below maximum. Basically, during the operation of the plant the HTC II 3600 will act as a variable speed and variable pressure pump. The variable speed operation is achieved by diverting the proper amount of brine flow ahead of the HTC to the PIT. With less brine flow to the HTC, less energy is available to the turbine section, hence less power, speed, and pressure generated by the HTC.

In our example, both pumps in both systems operate at constant conditions. In the HTC case the pump power is constant at 1,762 hp (3986gpm at 1453ft., 84% eff.). In the standard design example with the large PIT, the pump power is 2,822hp (3986gpm at 2353ft., 84% eff.). The graph below summarizes the net power requirements over the total pressure range for the two systems.



Comparison Chart of Savings in $/Year using the HTC or the Dual Turbine System (DTS)			
Estimated year of operation	Pm (psi)	$/year Saved w/ HTC	$/YEAR Saved w/ DTS
1	850	$ 129,624.66	$ 331,488.79
1.8	885	$ 102,222.63	$ 263,621.02
2.6	900	$ 90,324.99	$ 237,864.34
3.4	950	$ 50,680.85	$ 146,511.00
4.2	1000	$ 11,520.44	$ 58,168.62
5	1050	$ (24,671.61)	$ (24,316.86)

Energy Rate

885 psi - 1050 psi

DTS	PIT
2.55 - 3.14 kW/M^3	3.54 - 3.08 kW/M^3

Note, that although the standard design PIT system is more efficient at the maximum condition by about 3 points in Hydraulic Transfer Efficiency (see TNB issue No. 2 for definition of HTE), the overall advantage of the Dual Turbine Energy Recovery Concept in performance over the total pressure range is decisive. Additionally, because the Dual Turbine System eliminates all feed pressure throttling, it also eliminates the need for the very expensive 10 in. diameter pressure control valve.

***Assumptions for equipment comparisons.*
Both systems' feed pumps operate at 84% efficiency
The HTC II 3600 Hydraulic Transfer Efficiency is 70%
The DTS PIT mechanical efficiency is 84%
The standard design large PIT mechanical efficiency is 89%
No brine sump pump for PIT is assumed
Cost of electricity $0.10 per kwh.

For more information or a quote on the Dual Turbine System, please call, fax or e mail PE I at:

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