BRINE BLOWDOWN PUMP

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1.1. The Hydraulic Layout

The brine blowdown pump has the task of evacuating the concentrated brine from the desalination plant and at the same time controlling the level of the brine in the evaporator's last stage.

This control is, in general, achieved by throttling, although in some cases it is achieved by speed variation via hydraulic coupling.

Similarly to the brine re-circulation pump, the brine blowdown pump operates under severe available net positive suction head ($NPSH_{av}$) conditions, because its suction side is under heavy vacuum.

It is important, therefore, to take the maximum care in the arrangement and in the computation of the velocity on the suction side of the pump in order to avoid the formation of vortexes, and to further reduce the $NPSH_{av}$ due to the pressure losses.

For this reason, the brine blowdown pumps are often of the vertical type, despite the less easy maintenance, or are installed together with the brine re-circulation pumps in pits in order to increase the $NPSH_{av}$ at impeller level.

Due to the features of the circuit downstream, the brine blowdown pump, the density loss ($\Delta\rho$)in the pipework is very low, therefore, the pump head is usually very low (10-16 m). The maximum loss of the circuit is represented by the control valve, $\Delta\rho$, or by the orifices that need to be installed in order to prevent vacuum from entering the circuit.

Operating experience in many plants has shown very serious problems of cavitation erosion in the pipework immediately downstream of the brine blowdown pump caused by excessive power dissipated in the control valve.

For this reason orifices are often installed in the pump circuit in order to share the head loss at various points.

1.2. The Pump Rangeability

The brine blowdown flow rate is ruled by the overall desalination plant heat and mass balance:

$$Q_b = \frac{(Q_m \rho_m - Q_d \rho_d)}{\rho_b} (m^3\ h^{-1}) \qquad (1)$$

Where Q = flow rate; subscripts m, d and b = makeup, distillate and blowdown respectively; and ρ = density of the various flow rates.

It is obvious, therefore, that the maximum brine blowdown flow rate will be achieved when the makeup flow rate is maximum, and the distillate flow rate is minimum.

This condition is achieved for the highest top brine temperature (TBT) and at the highest seawater temperature.

The part load condition, achieved at minimum TBT, indicates on the other hand, the minimum flow requirement.

1.3. The Design Criteria

The required head for the brine blowdown pump is the combination of:

1. Geodetical head
2. Pressure head
3. Friction head

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Bibliography and Suggestions for further study

Edoardo Garibotti (2008), Energy savings and better performances through variable speed drive application in desalination plant brine blowdown pump service,Desalination 220 ,496–501

G. Crisp and M. Rhodes (2007), Perth Seawater Desalination Plant — Blazing a Sustainability Trail, Proceedings of the International. Desalination Association World Congress, Gran Canaria, Spain.

Gehrer, A., Benigni, H., Köstenberger, M.(2004), “Unsteady Simulation of the Flow Through a Horizontal-Shaft Bulb Turbine”, Proceedings of the 22nd IAHR Symposium on Hydraulic Maschines and Systems,Stockholm, .

Gehrer, A., Egger A., Riener J.(2002), “Numerical and Experimental Investigation of the draft tube flow downstream of a bulb turbine”, Proceedings of the 21st IAHR Symposium on Hydraulic Machines and Systems, Lausanne, September 9-12, .

Helmut Jaberg (2009), Centrifugal pumps for viscous and multi-phase fluids,Pumps and Compressors with Compressed Air and Vacuum Technology.

Iris Safrai, Alon Zask (2008),Reverse osmosis desalination plants — marine environmentalist regulator point of view,Desalination 220 , 72–84

John P. MacHarg (2002) Retro-fitting existing SWRO systems with a new energy recovery device,Desalination 153 ,253–264

Khawla AbdulMohsen Al-Shayji (1998), *Modeling, Simulation, And Optimization Of Large-Scale Commercial Desalination Plants* (PhD, thesis),Virginia Polytechnic Institute and State University

Lexicon KSB (1990) Aktiengesellschaft, Frankenthal Germany (eds K Holzenberger and K Jung), September.

Maihöfer, M., Heitle M., Helmrich, T. (2002), “Simulation of vortex rope in a turbine draft tube”, Proceedings of the 21st IAHR Symposium on Hydraulic Machines and Systems, Lausanne, September 9-12,

Penghui Gao, Lixi Zhang, Hefei Zhang (2008), Performance analysis of a new type desalination unit of heat pump with humidification and dehumidification,Desalination 220 , 531–537

Ralph Höfert (1999), Variable speed turbo couplings used as pump drive in desalination plants, Desalination 125, 181–189

Seawater and Brackish Water Desalination in the Middle East, North Africa and Central Asia A Review of Key issues and Experience in Six Countries Final Report 2004, This report was prepared by a consortium of consultants, consisting of DHV Water BV,Amersfoort, the Netherlands (leading partner), and BRL Ingénierie, Nîmes, France.For the World Bank with funding from the Bank-Netherlands Water Partnersh