COOLING WATER RECIRCULATION PUMP

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Contents

Summary

The cooling water recirculation pump has been recently installed in desalination plants in order to allow the operation of the plant in winter conditions where, due to the very low BBT, the vapor specific volume inside the evaporator can bring about excessive entrapment of the brine, and subsequently, pollution of the distillate.

The adoption of this pump is often not necessary and several installations in the Gulf area do not anticipate the adoption of this pump due to the quite high seasonal seawater temperature.

The duty of the cooling water recirculation pump, nevertheless, is discontinuous and for several months it has to be shut down in the installation in the Gulf area.

1. Cooling Water Recirculation Pump: The Duty on the Plant and the Rangeability

1.1. Hydraulic Layout and Control System

The temperature of the seawater during winter condition is often lower than 25°C, this temperature value is often specified in the desalination contracts as the minimum inlet temperature to the heat rejection section.

Lower seawater temperature at the inlet of the heat rejection section, would imply a decrease of the operating temperature in the stages (shell plus bundle) to values where the vapor specific volume is very high and consequently the velocity of its release and of its passage through the demisters is also very high.

Beside the erosion aspects which are involved in this phenomenon, the excessive vapor velocity can cause flooding problems inside the demisters as well as excessive dragging of droplets from the flashing brine which may cause the pollution of the distillate.

To this purpose, the temperature of the seawater at heat rejection section inlet is kept at values not lower than 25°C, in general, by recirculating part of the warmer drain routed to the culvert upstream of the heat rejection section.

For this reason the seawater request from the intake in the winter condition is very low causing the main seawater supply pumps to operate below the minimum operating flow.

Figure 1 shows schematically the circuit of the cooling water recirculation pump (also see Chapter Brine Recirculation Pump, Figure 1).

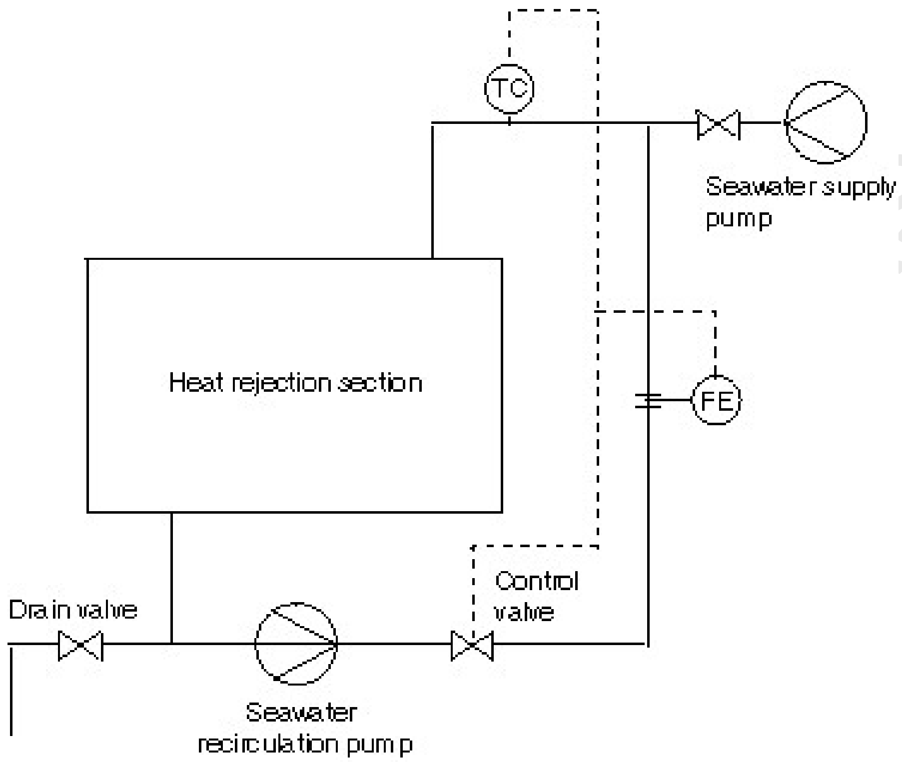

Figure 1. Cooling water recirculation pump schematic circuit.

The subject pump is also generally adopted for the circulation of the acid solutions during the various cleaning phases.

The pump flow rate is controlled by throttling the quantity of water recirculated using the temperature control loop, and by a flow control loop which, in general, is fitted on the line to prevent the pump from running below the minimum continuous operating flow.

In fact, during the season when the seawater temperature is very close to the set temperature of 25°C the variation from the day to the night imposes a very low flow rate of recirculation.

Due to this phenomenon the pump may be subject to several starts and stops in a short time, it is therefore very important that the logic controlling start up and stop of the pump is studied so as to avoid instabilities in the transition seasons.

To ensure that the optimum minimum flow rate passes through the cooling water recirculation pump regardless of the quantity of water flowing through the temperature control valve, the flow controller enables the flow control valve installed on the delivery header of the cooling water recirculation pump, to discharge to the culvert part of the recirculated water.

From the operation and maintenance point of view, it must be taken into account that the cooling water recirculation pump is operating, in the Middle East countries, for no more than three months per year, therefore the arrangement of the pipework and of the pump itself has to be designed with due regard to accessibility in order to make the draining and rinsing sequences easier.

Due to the fact that the costs of the manufacturing and installation of the pump are very high and the percentage of its utilization is very low, it is not advisable to design any stand-by for this pump.

Moreover in case of trip or malfunction of the cooling water recirculation pump, no immediate stop of the desalination process occurs, on the contrary, it is possible by a reduction of the flow rate to the heat reject section, to operate the plant keeping the same bottom brine temperature (BBT).

The tendency therefore of the design is aimed at eliminating wherever possible, this pump and specifying a wider range of operation for the evaporator.

The cooling water recirculation pump is a typical booster pump, whose duty is to compensate, through the pump manometric pressure, the pressure losses of the heat rejection section circuit, in order to recirculate, the heat reject section outlet, routed to the drain, to the inlet.

Moreover, contributions to the pump head are given by the losses in the control valves as well as the losses in the cooling water pipework which are by themself minor.

The range of the pump flow rate is set by the maximum flow rate value, which is necessary for recirculation, when the seawater temperature is minimum.

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Bibliography and Suggestions for further study

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.

Holzenberger K and Jung K (technical eds) (1994) KSB lexicon issue p. 83, 100, Frankenthal, Germany

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

M. Sanz and R. Stover (2007), Low Energy Consumption in the Perth Seawater Desalination Plant, Proceedings of the International Desalination Association World Congress, Gran Canaria, Spain.

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,

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

Richard L. Stover (2008) ,SWRO process simulator,Desalination 221 , 126–135

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