Masoneilan DRESSER

CONDENSATE PUMP RECIRCULATION

CONDENSATE SYSTEM

The power plant condenser receives exhaust steam from the low pressure turbine and condenses it to liquid for reuse. Condenser backpressures usually range from 1.0 to 4.5 in HG absolute (3.4 to 15.2 KPA) with higher pressures possible when the cooling water temperature is elevated by using an air-cooled steam condenser.

Condensate is collected in the bottom of the condenser in the hot well. From here the condensate feed pump supplies the subcooled water to the feedwater heaters.

PUMP RECIRCULATION VALVE APPLICATION

As with most centrifugal pumps, the condensate pump is subject to overheating and cavitation if used at a flow under a minimum value recommendation by the pump manufacturer. When the flow required by the deaerator level control loop falls below this minimum recommended value, additional flow is recirculated back to the condenser by opening a valve installed in a by-pass line thus maintaining the minimum flow through the pump at all times (Fig. 1).

Condensate Pump Recirculation

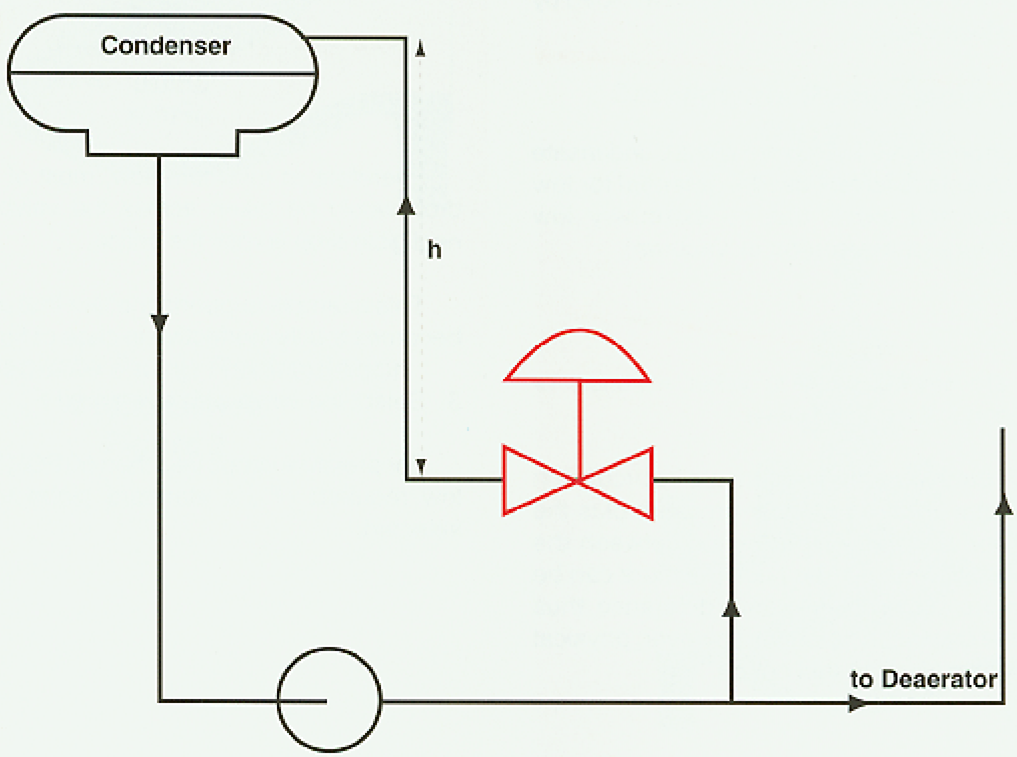


Figure 1

VALVE PROBLEMS

a) Shut-off

Tight shut-off is critical for two reasons. First of all, the valve is in a closed position most of the time under a relatively high differential pressure. Any leakage flow would result in a permanent loss of energy, expressed in terms of pump efficiency. Secondly, any leakage flow under a relatively high pressure drop would cause wire drawing, cavitation and subsequent increased erosion of the trim. The minimum Class V leakage rate is recommended with hard trim materials.

b) Trim Erosion

Even though hard trim material has been selected, the valve should not operate at low lifts. Limiting the valve opening to a minimum 20% lift through the control system would significantly enhance the trim life and sealing capability.

c) Body Erosion

Body erosion is a 3rd to 5th power function of fluid velocity. For increased life, the velocity must be limited by sometimes using an oversized body with a reduced trim. Impingement on the valve body walls can be avoided by using a flow to close design.

d) Cavitation

Although pressures associated with a Condensate Recirculation Valve are relatively low, the potential for low energy cavitation still exists due to extremely low condenser pressure (atmospheric or vacuum).

VALVE SELECTION

There are several ways to either minimize or eliminate cavitation in the control valve.

1. The back pressure of a condensate recirculation valve is the total of the condenser pressure plus the static head due to elevation difference between the valve and the condenser. The back pressure can be increased by increasing the elevation difference, thus minimizing the cavitation potential; however, physical constraints generally limit this option.

2. Increase the valve back pressure (P_2) by installing a static orifice downstream of the valve. A static orifice is a fixed flow device and the pressure drop across it is proportional to the flow rate. As the orifice is generally sized for the maximum recirculation flow, any reduction in the flow rate would reduce the pressure drop across it. This can be expressed, mathematically, as shown below.

The pressure drop across the orifice is given by the expressions:

$\Delta P = KQ^2$ where Q = recirculation flow

$\Delta P_{max} = KQ_{max}^2$ at maximum recirculation flow(Q_{max})

$\Delta P_{min} = KQ_{min}^2$ at minimum recirculation flow(Q_{min})

and $$\frac{\Delta P_{min}}{\Delta P_{max}} = \frac{Q_{min}^2}{Q_{max}^2}$$

Assuming $$\frac{Q_{min}}{Q_{max}} = 10\%$$

$$\frac{\Delta P_{min}}{\Delta P_{max}} = 1\%$$

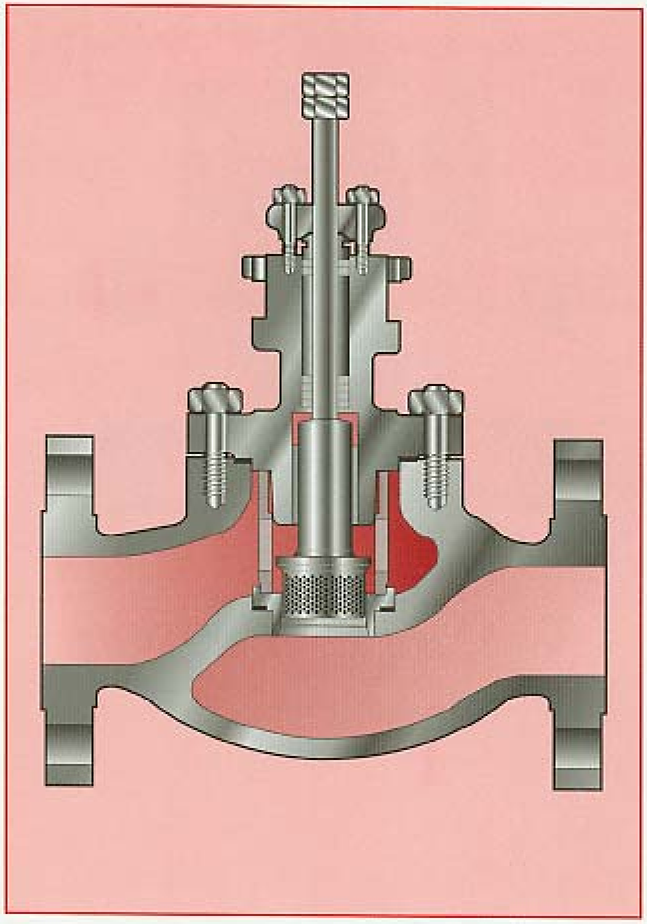
Therefore at minimum flow, most of the pressure drop would be taken across the valve with only a negligible drop across the orifice.

This example supports the fact that a static orifice becomes totally ineffective in case of flow variations.

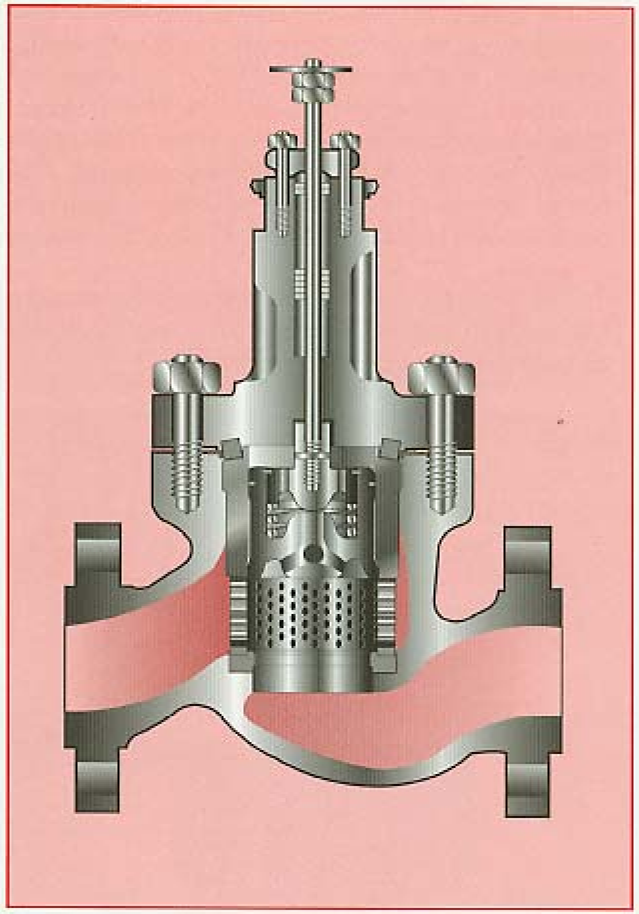
3. Select the valve with a required F_L.

For pressure drops less than 50 PSI (3.3 BAR) and low required F_L, a standard globe valve can be selected.

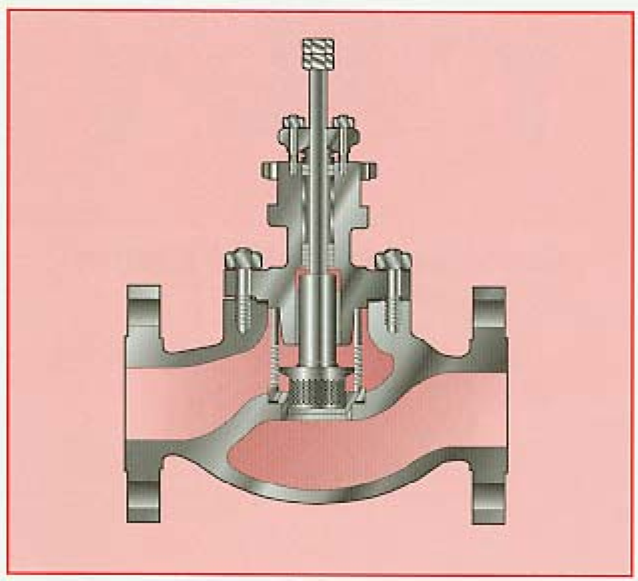
For pressure drops in the range of 50 to 250 PSI (3.3 to 17 BAR), cavitation control trim is recommended. Select a 21000 series valve with an oversized body and/or a 21200/21700 with flow to close (Fig. 2) or a 41412 (Fig. 3) for larger sizes. An oversized or alloy steel body is sometimes recommended to minimize erosion potential.



Condensate Pump Recirculation
21000 Series
Figure 2



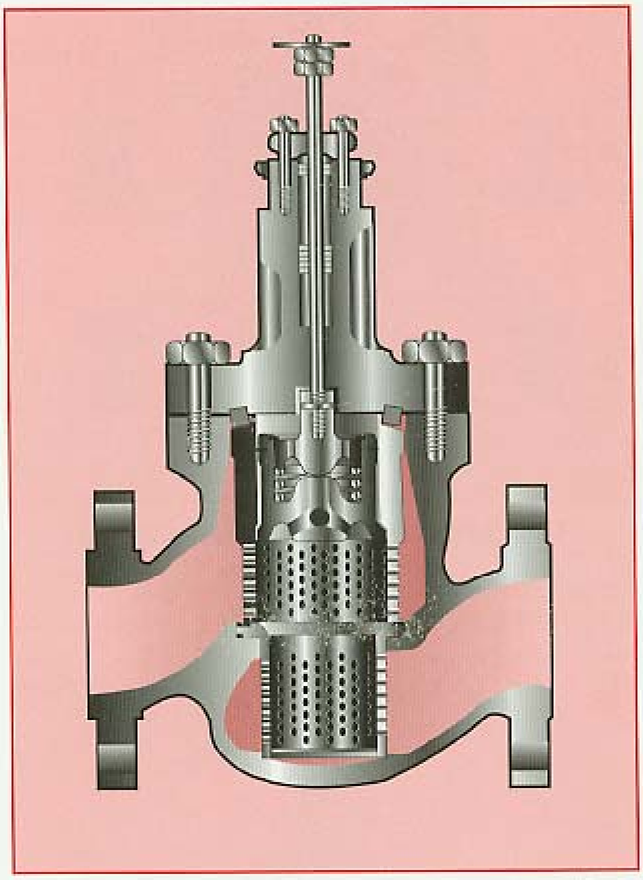
Condensate Pump Recirculation
41412 Design
Figure 3



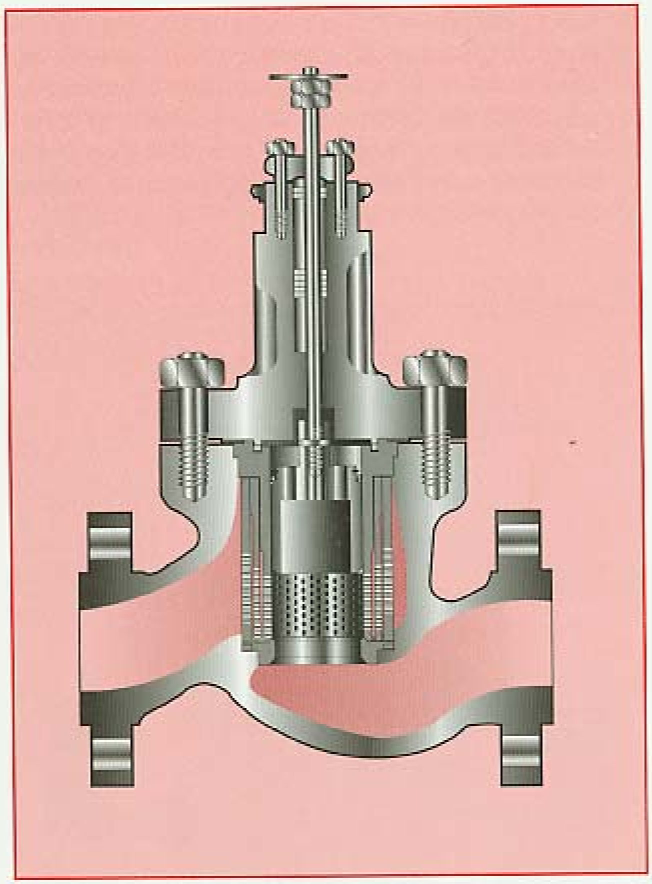
Condensate Pump Recirculation
21800 Two-stage Anti-cavitation Design
Figure 4

For pressure drops in excess of 250 PSI (17 BAR) or when high cavitation potential exists with a single stage trim, it is recommended that a two stage anti-cavitation 21800 valve (Fig. 4) for smaller sizes or a multi-hole cavitation protection trim with internal diffuser Model 41413 (Fig. 5) for larger sizes is selected. For a higher required F_L, multi-cage intermediate anti-cavitation trim Model 41318 (Fig. 6) could be selected.

The type of operation of the plant and the expected frequency of start-up are important criteria and must be considered in the selection process.



Condensate Pump Recirculation
41413 Design
Figure 5



Condensate Pump Recirculation
41318 Design
Figure 6