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Subject: **Overboard Dump Valves**

**Introduction**

Overboard dump valves, as the name suggests, are valves that are typically used to control the flow of seawater being dumped overboard on off-shore installations. Process conditions that would be innocuous on standard applications, become severe when applied to overboard dump valves.

Often users fail to realise the criticality of the application which results valves being incorrectly specified, ultimately leading to vibration, erosion and failure.

Fig 1. Typical Offshore Installation

**Severe Service Application**

Overboard dump valves are classed as severe service control valves due to the fact that there is a high potential for cavitation occurring on the valves. The potential for cavitation is caused by the relatively high inlet pressures and the low outlet pressures. Often the process engineers that specify the valve process conditions state that the valve outlet pressure is 1 BAR A, i.e. atmospheric, but in reality as the water is being dumped into the sea then there will be a vacuum in the outlet pipe. The discrepancy between the theoretical pressure and actual pressure often means that the valve is incorrectly sized, and with such low outlet pressures a difference of 1 BAR can mean that severe cavitation occurs.

**What is Cavitation?**

Cavitation is a phenomenon that can occur in control valves on liquid service duties. In its most severe form cavitation can destroy a control valve trim in a matter of hours. It is therefore important to control the level of cavitation when selecting a control valve.

Cavitation occurs in liquid systems when local pressure fluctuations near the liquids vapour pressure result in the sudden growth and collapse of vapour bubbles (cavities) within the liquid. Shown on the graph below, as the inlet pressure ($P_1$) passes through the valve, and exits the trim, then if the pressure drops below, and then rises above the vapour pressure ($P_V$) then these cavities are formed. The cavity collapse produces a localised shock wave and liquid microjets. If these impact on the metallic surface of the valve then severe pitting and erosion damage can occur.

Cavitation often produces high levels of noise and vibration across a broad range of frequencies. Excessive vibration can

loosen flange bolting, damage piping support structures, and destroy process equipment. The hazards of excessive noise can create dangerous conditions for people and their environment.

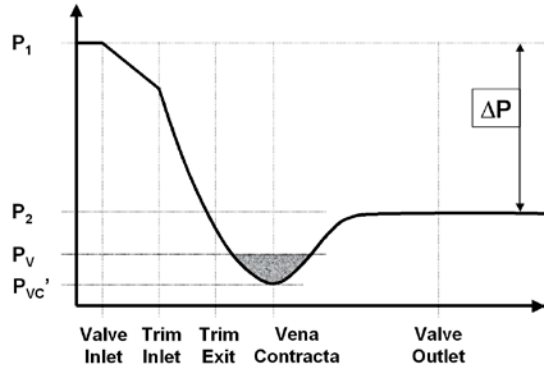


Fig 2. Pressure Drop Profile in a Single Stage Trim

**Pipework Solutions**

There are many solutions that can be employed to eliminate the occurrence of cavitation. The first thing that must be specified however, is the valve application, and accurate process conditions.

At the design stage, if the process engineer realises that the valve is going to be used on an overboard dump application, then the valve outlet pipework can be designed with either a vacuum breaker or an inverted 'U' shaped bend. These two solutions ensure that a positive pressure is maintained in the downstream pipe and therefore the more severe conditions are avoided.

*Vacuum Breakers* – are essentially two way valves that can be installed in the pipework. Once a vacuum forms in the pipe, the breaker opens to allow a positive pressure in the pipe.

*'U' shaped bend* – can be installed in the downstream pipe. The bend ensures a head of water in the pipe which in turn maintains a positive pressure at the outlet of the valve.

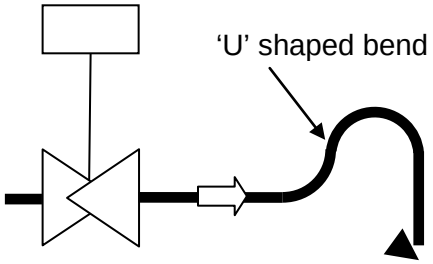


Fig 3. Installation of a Downstream Bend

**Valve Solutions**

If the correct process conditions are specified at the time of order, then the control valve can be selected to eliminate the cavitation that might occur.

If there is only one set of process conditions specified, then the simplest method of eliminating the potential for cavitation is to install a baffle plate at the valve outlet. The baffle plate generates a backpressure in the line thereby increasing the valve outlet pressure. As baffle plates have a fixed orifice size then they are only suitable one set of process conditions. Where the process conditions vary with the valve opening, then the solution should be made with the valve trim as this is a variable orifice.

The most effective valve solution is to install a low recovery or multi stage trim in the valve. Cage guided valves are typically valves with the low pressure recovery. The flow is broken down into a series of radial jets, and as the jets impinge together in the centre of the cage then pressure is controlled. Depending on the level of cavitation at the vena contracta then fitting

a low recovery trim will mean that the pressure at the vena contracta does not fall below the vapour pressure.

Where cavitation cannot be eliminated by a low recovery trim, then a multi stage trim can be employed. These are specifically designed to eliminate cavitation by the control of the pressure drop through each sleeve of the trim. The number of sleeves used in the cage depends on the level of cavitation. High levels of cavitation will require more sleeves so that the pressure at each stage of letdown is more gradually reduced. Each sleeve has a number of radial holes, with carefully calculated flow areas. The flow area is controlled to apportion the pressure drop across each stage of the trim. Thus, the small radial jets pass through a tortuous flow path resulting in frictional and impingment pressure losses.

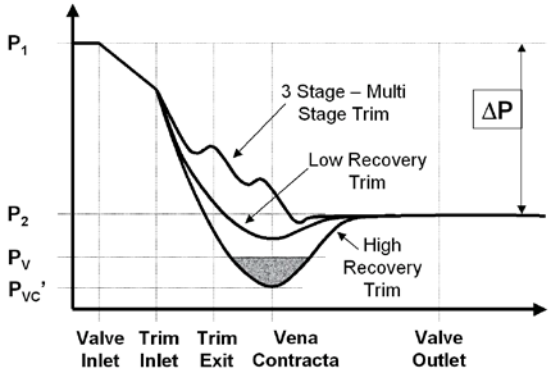


Fig 4. Treatment of Cavitation Using the Valve Trim

On overboard dump applications, the apportionment of the pressure drop can be made so that the largest pressure drops are taken over the initial trim stages, while at the final stage a minimal pressure drop is taken. This ensures control of the pressure at the vena contracta and therefore the elimination of cavitation.

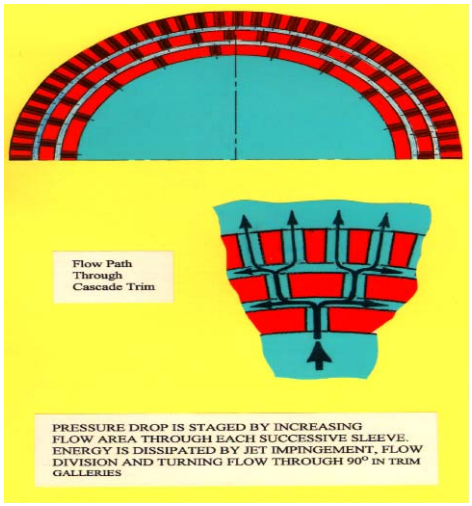


Fig 5. Flow path through a cascade trim