# Selecting a control valve

**Fluid velocity in a control valve is a key parameter that must be considered when sizing and selecting a control valve.**



HIGH FLUID VELOCITIES CAN LEAD TO EROSION DAMAGE, TRIM WEAR, TRIM component failure, vibration and high noise levels. Therefore, it is vital to design for valve velocities within acceptable limits so that these problems are avoided.

## Liquid applications

A maximum body inlet velocity of 25ft/s is recommended for a clean liquid flowing through a control valve constructed of carbon steel body material. The maximum body inlet velocity should be less than 15ft/s in order to reduce erosion damage if the liquid has entrained particles. A maximum body inlet velocity of 35ft/s for clean fluids and 20ft/s for dirty fluids is recommended for a control valve constructed of stainless steel or a higher alloy steel. Typical valve trim velocities can be much higher without causing damage, since trim components are usually made of much harder materials.

Some valve manufacturers limit the trim velocity to a maximum of 70ft/s the equivalent of a 75psig pressure drop. For many applications this trim velocity can be achieved only by using multistage trim. This is a very conservative approach that is not required in many applications and can also be very expensive. To validate the above argument, consider a clean water application where:

- Flow = 200gpm
- $P_1$ = 500psig
- $P_2$ = 200psig
- Temperature = 70°F

If we select a Masoneilan 2in 41000, cage guided, single-stage cavitation containment, Cv=25, the valve outlet velocity is approximately 20ft/s, the trim outlet velocity is approximately 155ft/s.

Both field experience and the sigma method for predicting cavitation damage indicate that the valve will not be damaged by cavitation in this application. Therefore, our valve selection is acceptable despite the fact that the trim velocity exceeds 70ft/s and the pressure drop across the trim exceeds 75psig. By applying field-proven velocity limit guidelines the user can avoid the high cost of overly conservative approaches.

## Steam and gas applications

It has been the practice in the valve industry to use the Mach number at the valve outlet to determine the velocity limitation in a compressible flow application. The fluid Mach number is defined as the ratio of fluid velocity over the velocity of sound in a given fluid.

A high outlet Mach number in control valves is an indication of high stream power and results in high noise level, induced vibration and erosion. The valve outlet Mach number should be limited to avoid these problems. These limitations also vary with the gas type, its cleanliness and the body material, duration and frequency of a given service condition and so on. For example, for saturated steam the recommended maximum outlet Mach number 0.3 for carbon steel body material and 0.4 for stainless steel or alloy body material. For superheated steam and clean gas the recommended maximum outlet Mach number is 0.4 for carbon steel body and 0.5 for stainless steel or higher alloy steel bodies. Of course, these limitations are overruled by noise performance specifications. A conservative approach with a saturated steam application is prudent, as thermodynamic properties must also be considered. A small decrease in steam temperature may lead to the formation of liquid droplets in the flow and can be very erosive at high velocities.

Reducing the high outlet Mach number can be achieved by increasing the valve size or by backing up the outlet pressure at the valve via a diffuser or silencer. Sometimes it is necessary to increase the size of the valve and provide a pressure back-up device downstream of the control valve in order to reduce its outlet Mach number and noise level to an acceptable limit.

The above velocity limitations in liquid and gas application represent guidelines for control valve selection. However, every application has its own peculiarities and engineering judgment should always be exercised.

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