ABOUT Cv (FLOW COEFFICIENTS)

Cv for FLUIDS

Cv for liquids is the volume of 68°F water in U.S. gallons per minute that passes through a valve at a pressure drop of 1 PSI. Flow for a given Cv is typically calculated from the following formula.

$$Q = Cv \times \sqrt{\frac{\Delta P \times 62.4}{D}}$$

Where:
- Q = Valve flow rate in gallons per minute (US GPM)
- ΔP = Difference between upstream and downstream pressure in pounds per square inch (PSI)
- 62.4 = Conversion factor for fluids computed in relation to water
- D = Density of fluids in pounds per cubic foot

The formula above utilizes a conversion factor of 62.4 which is the density of water in lbs/ft³. The following formula is often used using a fluid's specific gravity (G) where the relationship to water density is already considered.

$$Q = Cv \times \sqrt{\frac{\Delta P}{G}}$$

Likewise, Cv for particular flow characteristics can be determined from this formula:

$$Cv = Q \times \sqrt{\frac{G}{\Delta P}}$$

Similar formulas are available using metric units:

$$Q = Kv \times \sqrt{\frac{\Delta P \times 1000}{D}}$$

$$Kv = Q \times \sqrt{\frac{D}{1000 \times \Delta P}}$$

$$Q = Kv \times \sqrt{\frac{\Delta P}{G}}$$

$$Kv = Q \times \sqrt{\frac{G}{\Delta P}}$$

Where:
- Q = Valve flow rate in cubic meters per hour (m³/h)
- ΔP = Difference between upstream and downstream pressure in Bar
- 1000 = Conversion factor for fluids computed in relation to water
- D = Density of fluids in kilograms per cubic meter (kg/m³)
- G = Specific Gravity

Cv for GASES

The Cv formula for liquid flow can be modified for gas flow. However, since gases are compressible, they are affected by temperature. In addition, there are two flow conditions which must be considered, sub-critical flow, and critical (or choked) flow.

If the upstream pressure (P1) is less than two times the downstream pressure (P2), the formulas for sub-critical flow should be used.

$$Cv = \frac{Q_G}{962} \times \sqrt{\frac{(G \times T)}{(P1^2 - P2^2)}}$$

$$Q_G = 962 \times Cv \sqrt{\frac{(P1^2 - P2^2)}{(G \times T)}}$$

Where:
- Q_G = Gas flow rate in Standard Cubic Feet per Hour (SCFH)
- P1 = Upstream (inlet) pressure in PSIA (absolute pressure)
- P2 = Downstream (outlet) pressure in PSIA (absolute pressure)
- PSIA = Absolute pressure. This is PSIG (gauge pressure) plus 14.7 (atmospheric pressure)
- T = Absolute temperature in ºR (ºF + 460)
- G = Specific gravity of medium where air at 70ºF and 14.7 PSIA equals 1.0

If the upstream pressure (P1) equals or exceeds two times the downstream pressure (P2), the formulas for critical (choked) flow should be used.

$$Cv = Q_G \frac{\sqrt{(G \times T)}}{816 \times P1}$$

$$Q_G = Cv \frac{816 \times P1}{\sqrt{G \times T}}$$

NOTE: The formulas provided here are simplified for general use. There are many factors that can be considered when sizing valves for flow control including, temperature, pipe size, viscosity, flashing and cavitation conditions, turbulent flow, two-phase flow, and expansion factors to name a few. For critical flow control, control valve software or a systems engineer should be consulted.

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