Resistance Coefficient K, Equivalent Length L/D, And Flow Coefficient C_v — continued

The friction factors for clean commercial steel pipe with flow in the zone of complete turbulence (f_T), for nominal sizes from 1/2 to 24-inch, are tabulated at the beginning of the "K" Factor Table (page A-26) for convenience in converting the algebraic expressions of K to arithmetic quantities.

There are some resistances to flow in piping, such as sudden and gradual contractions and enlargements, and pipe entrances and exits, that have geometric similarity between sizes. The resistance coefficients (K) for these items are therefore independent of size, as indicated by the absence of a friction factor in their values given in the "K" Factor Table.

As previously stated, the resistance coefficient K is always associated with the diameter in which the velocity in the term $v^2/2g$ occurs. The values in the "K" Factor Table are associated with the internal diameter of the following pipe schedule numbers for the various ANSI Classes of valves and fittings.

Class 300 and lower	Schedule 40
Class 400 and 600	Schedule 80
Class 900	Schedule 120
Class 1500	Schedule 160
Class 2500 (sizes ½ to 6″)	XXS
Class 2500 (sizes 8″ and up)	Schedule 160

When the resistance coefficient K is used in flow equation 2-2, or any of its equivalent forms given in Chapter 3 as Equations 3-14, 3-16, 3-19 and 3-20, the velocity and internal diameter dimensions used in the equation must be based on the dimensions of these schedule numbers regardless of the pipe with which the valve may be installed.

An alternate procedure which yields identical results for Equation 2-2 is to adjust K in proportion to the fourth power of the diameter ratio, and to base values of velocity or diameter on the internal diameter of the connecting pipe.

$$K_a = K_b \left(\frac{d_a}{d_b}\right)^4 \qquad \textit{Equation 2-5}$$

Subscript "a" defines K and d with reference to the internal diameter of the connecting pipe.

Subscript "b" defines K and d with reference to the internal diameter of the pipe for which the values of K were established, as given in the foregoing list of pipe schedule numbers.

When a piping system contains more than one size of pipe, valves, or fittings, Equation 2-5 may be used to express all resistances in terms of one size. For this case, subscript "a" relates to the size with reference to which all resistances are to be expressed, and subscript "b" relates to any other size in the system. For sample problem, see Example 4-14.

It has been found convenient in some branches of the valve industry, particularly in connection with control valves, to express the valve capacity and the valve flow characteristics in terms of the flow coefficient C_v. The C_v coefficient of a valve is defined as the flow of water at 60 F, in gallons per minute, at a pressure drop of one pound per square inch across the valve.

By the substitution of appropriate equivalent units in the Darcy equation, it can be shown that,

$$C_V = \frac{29.9 d^2}{\sqrt{K}} \qquad \textit{Equation 2-6}$$

Also, the quantity in gallons per minute of liquids of low viscosity* that will flow through the valve can be determined from:

$$Q = C_V \sqrt{\Delta P \left(\frac{62.4}{\rho}\right)} \qquad \textit{Equation 2-7}$$

$$Q = 7.9\, C_V \sqrt{\frac{\Delta P}{\rho}}$$

and the pressure drop can be computed from the same formula arranged as follows:

$$\Delta P = \frac{\rho}{62.4} \left(\frac{Q}{C_V}\right)^2 \qquad \textit{Equation 2-7}$$

Since Equations 2-2 and 2-7 are simply other forms of the Darcy equation, the limitations regarding their use for compressible flow (explained on page 1-7) apply. Other convenient forms of Equations 2-2 and 2-7 in terms of commonly used units are presented on page 3-4.

*When handling highly viscous liquids determine flow rate or required valve C_V as described in the ISA Handbook of Control Valves.

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