GENERANT

Valves & BI-Lok Fittings

Flow Calculator Explanation

The K_d, or discharge coefficient, is a efficiency rating for flow through an orifice. It describes the percentage of maximum, unobstructed flow that an orifice allows due to geometry constraints. Even a straight edged orifice with no obstruction only allows 80% of maximum flow due to the formation of a *vena contracta* immediately after the orifice. When calculating flow traveling through a restriction, it is necessary to first determine the maximum flow through an unobstructed, straight pipe of a given orifice diameter and then apply a correction factor to account for flow restriction(s). This correction factor is called the discharge coefficient (Kd). The discharge coefficients published in Generant's product literature are derived from flow rates observed in actual testing. The following equations utilized by Generant's Flow Calculator are mathematically equivalent to the formulas and methods described in BS EN ISO 4126-1.

First, the calculator determines if the flow is choked or unchoked:

$$Critical\ Pressure\ Ratio = PR_{crit} = \left(\frac{2}{k+1}\right)^{\frac{k}{k-1}}$$

$$if\ PR_{crit} \geq \frac{P_o}{P_i}\ , flow\ is\ critical\ (choked)$$

$$if\ PR_{crit} < \frac{P_o}{P_i}\ , flow\ is\ subcritical\ (unchoked)$$

Then, the calculator uses the appropriate flow rate equation based on choked or unchoked flow:

For critical (choked) flow, the mass flow (m) is calculated by:

$$m = K_d * A * P_i \sqrt{\frac{k * g}{T * R} * (\frac{2}{k+1})^{\frac{k+1}{k-1}}}$$

For subcritical (unchoked) flow, the mass flow (m) is calculated by:

$$m = K_d * A * \rho * (\frac{P_o}{P_i})^{\frac{1}{k}} * \left(\frac{1}{144}\right) * \sqrt{2 * g * R * T * \frac{k}{k-1} * (1 - \left(\frac{P_o}{P_i}\right)^{\frac{k-1}{k}})}$$

Explanation of Variables:

$k = isentropic\ exponent\ of\ gas$

$P_i = valve\ inlet\ pressure\ (psia)$

$P_o = valve\ outlet\ pressure\ (psia)$

$A = Orifice\ Area\ (in^2)$

$K_d = Discharge\ Coefficient$

$g = gravitational\ constant\ (32.2\ ft\ lbm\ lb^{-1}\ s^{-2})$

$\rho = inlet\ gas\ density\ (lbm\ ft^{-3})$

$T = System\ Temperature\ (°R)$

$R = gas\ constant\ \ (ft\ lb\ lbm^{-1}\ °R^{-1})$

Notes: Constants within equations are for solving with units given above.
Calculator assumes that the media behaves as an ideal gas.

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