Flow Calculator Explanation

Flow rate can be calculated if the system pressure drop, flow passage dimensions, and fluid properties are known. 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 the flow restriction(s). This correction factor is called the coefficient of discharge (Kd) and it describes the percentage of maximum, unobstructed flow that the relief valve allows through. The discharge coefficients published in Generant's product literature are derived from measured experimental flow rates and calculated theoretical flow rates. Generant's flow calculator utilizes the formulas and method described in European Standard EN ISO 4126-1: 2004.

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

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

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

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

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

For critical (choked) flow, the discharge capacity (Q_m) is calculated by:

$$Q_m = P_o * C * A * K_{dr} * \sqrt{\frac{M}{Z * T_o}}$$

$$C = 3.948 * \sqrt{k * \left(\frac{2}{k+1}\right)^{\frac{k+1}{k-1}}}$$

For subcritical (unchoked) flow, the discharge capacity (Q_m) is calculated by:

$$Q_m = P_o * C * A * K_{dr} * K_b * \sqrt{\frac{M}{Z * T_o}}$$

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$$K_b = \sqrt{\frac{\frac{2*k}{k-1}\left(\left(\frac{P_b}{P_o}\right)^{\frac{2}{k}} - \left(\frac{P_b}{P_o}\right)^{\frac{k+1}{k}}\right.}{k*\left(\frac{2}{k+1}\right)^{\frac{k+1}{k-1}}}}$$

Explanation of Variables:

$k = isentropic\ exponent\ of\ gas$

$P_o = valve\ outlet\ pressure$

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$A = Orifice\ Area$

$K_{dr} = Discharge\ Coefficient$

$M = Molar\ Mass$

$Z = Gas\ Compressibility\ Factor$

$T_o = System\ Temperature$