PS 45 Orifice

A square-edges orifice is used to measure the flow rate of ammonia at 32 F and 60 lb_f/in^2 in a 12 in schedule-40S (stainless steel) pipe. The pipe has an internal diameter of 12.00 in and internal diameter of 0.7854 ft^2. The maximum ammonia flow is 6000 ft^3/min, and the maximum instrument pressure reading across the orifice is 127 in H2O. The square-edged orifice coefficient is 0.595. Ammonia has a viscosity of 2.205×10^{-4} lbm/(ft-sec) and a density of 0.0482 lb_m/ft^3. The ratio of specific heats is 1.3. What is the diameter of the orifice?

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- $v = \frac{q}{A} = \frac{\frac{6000}{60}}{0.7854} = 127.32 \frac{\text{ft}}{\text{s}}$
- $\text{Re} = \frac{vD\rho}{\mu} = \frac{(127.32)(1)(0.0482)}{2.205 \times 10^{-4}} = 27831$
- $\Delta p = (127 \text{ in}) \left(0.036092 \frac{\text{psi}}{\text{in}}\right) = 4.584 \text{ psi}$
- $p_2 = 60 - 4.58 = 55.42\ psi$

- $C_f = \frac{C_d}{\sqrt{1-\left(\frac{d_0}{d_1}\right)^4}} = \frac{0.595}{\sqrt{1-\beta^4}}; Y = 1 - \left(\frac{0.41+0.35\beta^4}{k}\right)\left(1 - \frac{p_2}{p_1}\right)$
- $= 1 - \left(\frac{0.41+0.35\beta^4}{1.3}\right)\left(1 - \frac{55.42}{60}\right)$
- $Q = \frac{\pi}{4} d_0^2 C_f Y \sqrt{\frac{2g_c \Delta p}{\rho}}$
- $d_0 = 5.73\ in.$