Calculating $C_d i$ from A_1, A_2, P_1, P_2

$\rightarrow$ *Calculate* P_0

$$P_0 = \left[\frac{\left(\frac{A_1}{A_2}\right)^2 \cdot (p_1)^{\frac{\gamma+1}{\gamma}} - (p_2)^{\frac{\gamma+1}{\gamma}}}{\left(\frac{A_1}{A_2}\right)^2 \cdot (p_1)^{\frac{2}{\gamma}} - (p_2)^{\frac{2}{\gamma}}}\right]^{\frac{\gamma}{\gamma-1}} = \left[\frac{\left(\frac{D_1}{D_2}\right)^4 \cdot (p_1)^{\frac{\gamma+1}{\gamma}} - (p_2)^{\frac{\gamma+1}{\gamma}}}{\left(\frac{D_1}{D_2}\right)^4 \cdot (p_1)^{\frac{2}{\gamma}} - (p_2)^{\frac{2}{\gamma}}}\right]^{\frac{\gamma}{\gamma-1}}$$

**** *Begin Iteration*

$\rightarrow$ *Calculate* $\dot{m}$, *Assume* C_{d0} *Value*

Compressible, Subcritical

$$\dot{m} = C_{d0} \cdot P_0 \cdot A_1 \sqrt{\frac{2\gamma}{(\gamma-1)(R_g \cdot T_0)}\left[\left(\frac{p_1}{P_0}\right)^{\frac{2}{\gamma}} - \left(\frac{p_1}{P_0}\right)^{\frac{\gamma+1}{\gamma}}\right]}$$

Compressible, Supercritical

$$\dot{m}_{outlet} = C_{d0} \cdot P_0 \cdot A_1 \cdot \sqrt{\frac{\gamma}{R_g \cdot T_0}\left(\frac{2}{\gamma+1}\right)^{\frac{\gamma+1}{\gamma-1}}}$$

$\rightarrow$ *Calculate Reynolds number*

$$\mathrm{R}_{\mathrm{e}_{D_1}} = \frac{\rho_1 \cdot V_1 \cdot D_1}{\mu_1} = \frac{\frac{\dot{m}}{A_1} \cdot D_1}{\mu_1} = \frac{\frac{\dot{m}}{\frac{\pi}{4} D_1^2} \cdot D_1}{\mu_1} = \frac{4 \cdot \dot{m}}{\pi \cdot D_1 \cdot \mu_1}$$

$\rightarrow$ *Calculate* $C_v i$ (*ASME MFC* $-14M-2001$)

Corner Tap : (*assume* $D_1, D_2 \text{ --> }$ *inches*)

$$C_v i = \left[0.5991 + \frac{0.0044}{D_1} + \left(0.3155 + \frac{0.0175}{D_1}\right) \cdot \left(\frac{D_2}{D_1}\right)^4 \left(1 + 2 \cdot \left(\frac{D_2}{D_1}\right)^{12}\right)\right] \cdot \sqrt{1 - \left(\frac{D_2}{D_1}\right)^4} +$$
$$\left[\frac{0.52}{D_1} - 0.192 + \left(16.48 - \frac{1.16}{D_1}\right) \cdot \left(\frac{D_2}{D_1}\right)^4 \left(1 + 4 \cdot \left(\frac{D_2}{D_1}\right)^{12}\right)\right] \cdot \sqrt{\left(1 - \left(\frac{D_2}{D_1}\right)^4\right)\frac{1}{\mathrm{R}_{\mathrm{e}_{D_1}}}}$$

Flange Tap :

$$C_v i = \left[0.598 + 0.468 \cdot \left(\frac{D_2}{D_1}\right)^4 \left(1 + 10 \cdot \left(\frac{D_2}{D_1}\right)^8\right)\right] \cdot \sqrt{1 - \left(\frac{D_2}{D_1}\right)^4} + \left(0.87 + 8.1 \cdot \left(\frac{D_2}{D_1}\right)^4\right) \cdot \sqrt{\left(1 - \left(\frac{D_2}{D_1}\right)^4\right)\frac{1}{\mathrm{R}_{\mathrm{e}_{D_1}}}}$$

$\rightarrow$ *Calculate* $C_d i \rightarrow \beta = \sqrt{1 - \left(\frac{D_2}{D_1}\right)^4}$

$$C_d i = \frac{C_v i}{\sqrt{1 - \left(\frac{D_2}{D_1}\right)^4}}$$

Return to ****, *Iterate Until* $\left|\frac{(C_d i)_{j+1} - (C_d i)_j}{(C_d i)_j}\right| < \varepsilon$