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Mechanical Engineering

1) $S.g = 0.8$

$\phi_{inlet} = 150mm = 0.15m \quad A = \frac{\pi d^2}{4} = 0.0172m^2$

$\phi_{throat} = 75mm = 0.075m \quad A = \frac{\pi d^2}{4} = 0.0044m^2$

$Z_2 - Z_1 = 150mm = 0.15m$

$Q = 40lit/sec = 0.04m^3/s$

$Cd = 0.96, \; W = -\rho g = 7848$

$$Q = Cd \frac{A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \times \sqrt{2gh}$$

$$0.04 = 0.96 \times \frac{0.0177 \times 0.0044}{\sqrt{0.0177^2 - 0.0044^2}} \times \sqrt{2 \times 9.81 \times h}$$

$$h = \left(\frac{0.04}{0.96 \times 0.00457 \times 4.429}\right)^2$$

$= 4.247m$

$$h = \left[\frac{P_1}{W} - \frac{P_2}{W}\right] + (Z_1 - Z_0)$$

$$4.247 = \frac{P_1 - P_2}{W} + 0.15$$

$P_1 - P_2 = 7848 \times (0.15 + 4.247)$

$= 34.51 \times 10^3 N/m^2$

2) $\phi_{inlet} = 300mm = 0.3m \quad A = \frac{\pi d^2}{4} = 0.07m^2$

$\phi_{throat} = 150mm = 0.15m \quad A = \frac{\pi d^2}{4} = 0.0177m^2$

$S.g_m = 13.6$

$S.L = 0.9, \; Z_1 - Z_2 = 300mm = 0.3m$

$y = 250mm = 0.25m, \; W = \rho g = 8.829$

$$h = \left[\frac{P_1}{W} - \frac{P_2}{W}\right] + (Z_1 - Z_0) = y \left[\frac{S_g}{S_1} - 1\right]$$

$$h = 0.25\left[\frac{13.6}{0.9} - 1\right] = 3.53m$$

(i) $$Q = Cd \cdot \frac{A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \times \sqrt{2gh}$$

$$= \frac{0.98 \times 0.07 \times 0.0177}{\sqrt{0.07^2 - 0.0177^2}} \times \sqrt{2 \times 9.81 \times 3.53}$$

$$= 0.1489 m^3/s$$

(ii) $$\frac{P_1 - P_2}{w} = \left(\frac{v_2^2 - v_1^2}{2g}\right) + (z_2 - z_1)$$

$$\frac{P_1 - P_2}{w} = 3.53 - 0.3$$

$$\frac{P_1 - P_2}{w} = 3.83$$

$$P_1 - P_2 = 3.83 \times w = 3.38 \times 10^3 N/m^2$$