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MECHATRONICS
18/ENG06/037
ENG 214

1) Specific G = 0.8

$D_1 = 160mm \simeq 0.15m$

$D_0 = 75mm \simeq 0.075m$

$Z_2 - Z_1 = 150mm \simeq 0.15m$

$Q = 40l/s = 0.04 m^3/s$

$Cd = 0.96$

$A_1 = \frac{\pi D_1^2}{4} = \frac{\pi \times 0.15^2}{4} = 0.01767 m^2$

$A_0 = \frac{\pi D_0^2}{4} = \frac{\pi \times 0.075^2}{4} = 0.00442 m^2$

$$Q = \frac{Cd \times A_1 A_2 \times \sqrt{2gh}}{\sqrt{A_1^2 - A_0^2}}$$

$$0.04 = \frac{0.96 \times 0.01767 \times 0.00442 \times \sqrt{2 \times 9.81 \times h}}{\sqrt{0.01767^2 - 0.00442^2}}$$

$$0.04 = 0.96 \times 0.004565 \times 4.429\sqrt{h}$$

$$h = \left(\frac{0.04}{0.96 \times 0.004565 \times 4.429}\right)^2 = 4.247m$$

$$h = \left(\frac{P_1}{w} + Z_1\right) - \left(\frac{P_2}{w} + Z_2\right)$$

$$h = \left(\frac{P_1}{w} - \frac{P_2}{w}\right) + (Z_1 - Z_2)$$

$$4.247 = \left(\frac{P_1 - P_2}{P_g}\right) - 0.15$$

$$(4.247+0.15) = \frac{P_1 - P_2}{\rho g}$$

$$(4.247+0.15)\rho g = P_1 - P_2$$

$$P_1 - P_2 = (0.8 \times 1000 \times 9.81)(4.247 + 0.15)$$

$$P_1 - P_2 = 34.511\ kN/m^2$$

$= 34.51 \text{ kN/m}$

2) Diameter of inlet $D_1 = 300\text{mm} \simeq 0.3\text{m}$

Area of inlet $A_1 = \frac{\pi \times D_1^2}{4} = \frac{\pi \times 0.3^2}{4} = 0.09\text{m}^2$

Diameter of throat D_2

$= 150\text{mm} \simeq 0.15\text{m}$

Area $(A_2) = \frac{\pi \times D_2^2}{4} = \frac{\pi \times 0.15^2}{4} = 0.07767\text{m}^2$

S.G of mercury $= 13.6$

S.G of oil $= 0.9$

Differential manometer reading $(y) = 250\text{mm} \simeq 0.25\text{m}$

$$h = \left(\frac{P_1}{w} + Z_1\right) - \left(\frac{P_2}{w} + Z_2\right)$$

$$= y\left(\frac{S.G\,Hg}{S.G\,oil} - 1\right) = 0.25\left(\frac{13.6}{0.9} - 1\right) = 3.53\text{m of oil}$$

a) Discharge of oil Q

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

$$Q = \frac{0.98 \times 0.09 \times 0.07767 \times \sqrt{2 \times 9.81 \times 3.53}}{\sqrt{0.09^2 - 0.07767^2}}$$

$$Q = 0.1489\ m^3/s$$

b) Pressure difference between entrance section and throat section $(P_1 - P_2)$

Given that:

$$h = \left(\frac{P_1}{w} + Z_1\right) - \left(\frac{P_2}{w} + Z_2\right) = 3.53$$

$$h = \left(\frac{P_1}{w} - \frac{P_2}{w}\right) - (Z_1 - Z_2) = 3.53$$

$$Z_2 - Z_1 = 300mm \simeq 0.3m$$

$$\left(\frac{P_1 - P_2}{w}\right) - 0.3 = 3.53$$

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

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

$$P_1 - P_2 = 3.83 \times w$$

$$P_1 - P_2 = 3.83 \times 9.81 \times 0.9$$

$$P_1 - P_2 = 33.8\ KN/m^2$$