EGBUHE KELVIN UZAMIDE
18/ENG04/025
Elect-Elect
ENG 214
Fluid Mechanics

i) Diameter of inlet, $d_1 = 300mm = \frac{300}{1000} = 0.3m$

Area of inlet, $A_1 = \frac{\pi (d_1)^2}{4} = \frac{\pi \times 0.3^2}{4} = 0.0707m^2$

Diameter of throat, $d_2 = 150mm = \frac{150}{1000} = 0.15m$

Area of throat, $A_2 = \frac{\pi (d_2)^2}{4} = \frac{\pi \times 0.15^2}{4} = 0.0177m^2$

Coefficient of discharge, $C_d = 0.98$, ~~$Z_1 = 0m$~~, $Z_2 =$
Specific gravity of mercury $(S_{Hg}) = 13.6$, $Z_2 - Z_1 = 300mm = \frac{300}{1000} = 0.3m$
Specific gravity of oil $(S_o) = 0.9$
Reading of differential manometer, $y = 250mm = \frac{250}{1000} = 0.25m$

Differential head, $h = \left(\frac{P_1}{w} + Z_1\right) - \left(\frac{P_2}{w} + Z_2\right) = y\left(\frac{S_{Hg}}{S_o} - 1\right)$

$h = 0.25\left(\frac{13.6}{0.9} - 1\right)$

$h = 0.25(15.11 - 1)$

$h = 0.25(14.11)$

$h = 3.5275m$

ii) Discharge of oil, $Q = \frac{C_d \times A_1 A_2 \times \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}}$

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$$Q = \frac{0.98 \times 0.0707 \times 0.0177 \times \sqrt{2 \times 9.81 \times 3.5275}}{\sqrt{0.0707^2 - 0.0177^2}}$$

$$Q = \frac{0.0102}{0.0684}$$

$$Q = 0.1491 m^3/s$$

ii) Pressure difference between the entrance and the throat.

$$Z_2 - Z_1 = 300mm = \frac{300}{1000} = 0.3m$$

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

$$h = \frac{P_1}{W} + Z_1 - \frac{P_2}{W} + Z_2$$

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

$$h - (Z_1 - Z_2) = \frac{P_1}{W} - \frac{P_2}{W}$$

$$3.5275 - (-0.3) = \frac{P_1 - P_2}{W}$$

$$3.5275 + 0.3 = \frac{P_1 - P_2}{W}$$

$$3.8275 = \frac{P_1 - P_2}{W}$$

$$P_1 - P_2 = 3.8275 \times W$$

$W = \rho_0 \times g$

ρ_0 = Specific gravity $\times$ ρ_{water}

$\rho_0 = 0.9 \times 1000$

$\rho_0 = 900 \, kg/m^3$

$P_1 - P_2 = 3.8275 \times 900 \times 9.81$

$P_1 - P_2 = 33792.9975\ N/m^2$

2) Relative density = 0.8

Inlet diameter, $d_1 = 150mm = \frac{150}{1000} = 0.15m$

Area of inlet, $A_1 = \frac{\pi (d_1)^2}{4} = \frac{\pi \times 0.15^2}{4} = 0.0177m^3$

Throat diameter, $d_2 = 75mm = \frac{75}{1000} = 0.075m$

Area of throat, $A_2 = \frac{\pi (d_2)^3}{4} = \frac{\pi \times 0.075^3}{4} = 0.0044m^2$

$Z_2 - Z_1 = 150mm = \frac{150}{1000} = 0.15m$

$Q = 40\ lit/sec = \frac{40}{1000} = 0.04m^3/s.$

$Cd = 0.96$

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

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

$0.04 = \frac{3.3117 \times 10^{-4} \times \sqrt{h}}{0.0171}$

$3.3117 \times 10^{-4} \times \sqrt{h} = 0.04 \times 0.0171$

$\sqrt{h} = \frac{0.04 \times 0.0171}{3.3117 \times 10^{-4}}$

$\sqrt{h} = \frac{6.84 \times 10^{-4}}{3.3117 \times 10^{-4}}$

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$\sqrt{h} = 2.0654$

$h = (2.0654)^2$

$h = 4.2659\,m$

$h = \left(\frac{P_1}{w} + z_1\right) - \left(\frac{P_2}{w} + z_2\right)$

$h = \frac{P_1}{w} + z_1 - \frac{P_2}{w} + z_2$

$h = \frac{P_1}{w} - \frac{P_2}{w} + z_1 - z_2$

$4.2659 = \frac{P_1}{w} - \frac{P_2}{w} - 0.15$

$\frac{P_1}{w} - \frac{P_2}{w} = 4.2659 + 0.15$

$\frac{P_1}{w} - \frac{P_2}{w} = 4.4159$

$\frac{P_1 - P_2}{w} = 4.4159$

$P_1 - P_2 = 4.4159 \times W$

$W = \rho_o g$

$\rho_o = \text{Specific gravity} \times \rho_{water}$

$\rho_o = 0.8 \times 1000$

$\rho_o = 800\,kg/m^3$

$P_1 - P_2 = 4.4159 \times 800 \times 9.81$

$P_1 - P_2 = 34655.9832\,N/m^2$

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