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BIOMEDICAL ENGINEERING
18/ENG07/108 7
ENG214 ASSIGNMENT

① $\omega = 0.8$

$d_1 = 150mm = 0.15m$

$d_2 = 75m = 0.075m$

$Q = 40 l/s = 4 \times 10^{-2} m^3/s$

$C_d = 0.96$

$A_1 = \frac{\pi \times 0.15^2}{4} = 1.767 \times 10^{-2} m^2$

$A_2 = \pi \times \frac{0.075^2}{4} = 4.418 \times 10^{-3} m^2$

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

$4.0 \times 10^{-2} = 0.96 \times 1.767 \times 10^{-2} \times 4.418 \times 10^{-3} \times \frac{\sqrt{2 \times 9.81 \times h}}{\sqrt{(1.767 \times 10^{-2})^2 - (4.418 \times 10^{-3})^2}}$

$4.0 \times 10^{-2} = \frac{0.96 \times 7.806 \times 10^{-5} \times \sqrt{2 \times 9.81 \times h}}{\sqrt{(1.767 \times 10^{-2})^2 - (4.418 \times 10^{-3})^2}}$

$4.0 \times 10^{-2} = 0.96 \times 4.563 \times 10^{-3} \times \sqrt{19.62h}$

$4.0 \times 10^{-2} = 0.96 \times 4.563 \times 10^{-3} \times 4.429 \sqrt{h}$

$\sqrt{h} = \frac{4.0 \times 10^{-2}}{4.38 \times 10^{-3} \times 4.429}$

$h = \left[\frac{4.0 \times 10^{-2}}{4.38 \times 10^{-3} \times 4.429}\right]^2$

$h = 4.25m$

Recall,

$h = \frac{V_2^2}{2g} - \frac{V_1^2}{2g} = \frac{P_1}{\omega} - \frac{P_2}{\omega} + Z_1 - Z_2$

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

$4.25 = \left(\frac{P_1 - P_2}{\omega}\right) + (0 - 0.15)$

$4.25 + 0.15 = \frac{P_1 - P_2}{\omega}$

$P_1 - P_2 = 4.4 \times 0.8 = 3.52$

$4.4 \times 0.8 \times 1000 \times 9.81 = 34.531 kN/m^2$

② $d_1 = 300mm = 0.3m$

$d_2 = 150mm = 0.15m$

guage reading $= 250mm = 0.25m$

$Z_2 = 300mm = 0.3m$, $Z_1 = 0$

$A_1 = \pi \times \frac{0.3^2}{4} = 0.07m^2$, $A_2 = \pi \times \frac{0.15^2}{4} = 0.0176m^2$

Differential guage reading $= \frac{SG \text{ manometric fluid} - SG \text{ oil}}{SG \text{ oil}} \times$ guage reading

$= \frac{13.6 - 0.9}{0.9} \times 0.25 = 3.53$

$h = 3.53$

Finding discharge, Q

$Q = \frac{C_d \times A_1 A_2 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}} = \frac{0.98 \times 0.07 \times 0.0176 \times \sqrt{2 \times 9.81 \times 3.53}}{\sqrt{0.07^2 - 0.0176^2}}$

$Q = 0.1489 m^3/s$

b). Finding the pressure diff.

Recall that $h = (P_1/\omega + Z_1) - (P_2/\omega + Z_2)$

$3.53 = (P_1/\omega - P_2/\omega) + (Z_1 - Z_2)$

$3.53 = (P_1/\omega - P_2/\omega) - 0.3$

$3.53 + 0.3 = \frac{P_1 - P_2}{\omega}$, $P_1 - P_2 = 33.8 kN/m^2$