***OBI-OBUOHA ABIAMAMELA***

***18/ENG05/040***

***MECHATRONICS ENGINEERING***

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① $D_1 = 150mm \ (0.15m)$

$A_1 = \frac{\pi D_1^2}{4} = \frac{\pi \times 0.15^2}{4} = 0.0177\ m^2$

$D_2 = 75mm \ (0.075m)$

$A_2 = \frac{\pi D_2^2}{4} = \frac{\pi \times 0.075^2}{4} = 0.0044 m^2$

$Q = 40 Litres/sec = 0.4 m^3/s$

$Cd = 0.96$

$\rho = 0.8$

$Z_2 - Z_1 = 150mm = 0.15m$

$$Q_{act} = (Cd \times A_1 A_2 \times \sqrt{2gh}) \Big/ \sqrt{A_1^2 - A_2^2}$$

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

$$0.04 = \frac{7.47648 \times 10^{-5} \times \sqrt{19.62h}}{\sqrt{2.9393 \times 10^{-4}}}$$

$$0.04 \times 0.017 = 7.47648 \times 10^{-5} \times \sqrt{19.62h}$$

$$6.8 \times 10^{-4} = 7.476 \times 10^{-5} \times \sqrt{19.62h}$$

$\sqrt{19.62h} = 6.8 \times 10^{-4}$ | $7.47648 \times 10^{-5}$

$\sqrt{19.62h} = 9.095$

$19.62h = 9.095^2$

$\frac{19.62h}{19.62} = \frac{82.72}{19.62}$

$h = 4.216$ m of liquid.

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

$4.216 = \left(\frac{P_1}{w} - \frac{P_2}{w}\right) - (0.15)$

$\frac{P_1}{\rho g} - \frac{P_2}{\rho g} = 4.216 + 0.15 = 4.366$

Therefore: $\frac{P_1 - P_2}{\rho g} = 4.366$

$P_1 - P_2 = 4.366 \times \rho g$

$= 4.366 \times 0.8 \times 9810$

$= 34264.368 \text{ N/m}^2$

$\simeq 34.26 \text{ kN/m}^2$

∴ Pressure difference $= 34.26 \text{ kN/m}^2$ /

(2) $D_1 = 300\,mm\ (0.3\,m)$

$A_1 = \frac{\pi D_1^2}{4} = \frac{\pi \times 0.3^2}{4} = 0.07\,m^2$

$7 = 250\,mm\ (0.25\,m)$

$D_2 = 150\,mm\ (0.15\,m)$

$A_2 = \frac{\pi D_2^2}{4} = \frac{\pi \times 0.15^2}{4} = 0.0177\,m^2$

$h = \frac{P_1 - P_2}{w} \Rightarrow h = 7\left(\frac{S_1}{S_0} - 1\right) = 0.25\left(\frac{13.6}{0.9} - 1\right)$

$= 0.25\ (15.1 - 1)$

$= 0.25\ (14.1)$

$= 3.525\,m$

$\approx 3.5\,m$ of oil

$C_d = 0.98$

(i) Discharge

$$Q_{act} = C_d \times A_1 A_2 \times \sqrt{2gh} \Big/ \sqrt{A_1^2 - A_2^2}$$

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

$$Q_{act} = \frac{0.0101}{0.0677} = 0.149\,m^2/s$$

$$Q_{act} = 0.149\,m^2/s$$

(11) Pressure Difference

$$\frac{P_1 - P_2}{w} + (z_2 - z_1) = 3.53$$

$z_2 - z_1 = 300\,mm\ (0.3\,m)$

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

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

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

$P_1 - P_2 = 3.83 \times 9810 \times 0.9$

$= 33,815.07\ N/m^2$

$\therefore P_1 - P_2 = 33.8\ kN/m^2$