NAME:

SUNDAY WINNER CHIGOZIRIM

COURSE:

ENG 214 (FLUID MECHANICS)

MATRIC:

18/ENG05/057

DEPT:

MECHATRONICS ENGINEERING

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SOLUTION:

(1) Specific gravity = 0.8

D_1 = Inlet diameter = 150mm = 0.15m

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

D_2 = Throat diameter = 75mm = 0.075m

$A_2 = \frac{\pi}{4} \times D_2^2 = \frac{\pi}{4} \times (0.075)^2 = 0.00442 m^2$

$Q = 40 litres/sec = 0.04 m^3/sec$

$C_d = 0.96$

$P_1 - P_2 = ?$; $z_2 - z_1 = 150mm = 0.15m$

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

$0.04 = 0.96 \times \frac{0.0177 \times 0.00442}{\sqrt{(0.0177)^2 - (0.00442)^2}} \times \sqrt{2 \times 9.8 \times h}$

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

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

$h = 4.247 m$ //

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

$4.247 = \left(\frac{P_1 - P_2}{w} \right) + (z_1 - z_2)$

$4.247 = \frac{P_1 - P_2}{0.8 \times 1000 \times 9.81} + 0.15$

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

$P_1 - P_2 = 34507.656 N/m^2$

(2) D_1 = Diameter at inlet = 300mm = 0.3m

A_1 = Area of inlet = $\frac{\pi}{4} \times D_1^2 = \frac{\pi}{4} \times 0.3^2 = 0.071 m^2$

D_2 = Diameter of throat = 150mm = 0.15m

A_2 = Area of throat = $\frac{\pi}{4} \times D_2^2 = \frac{\pi}{4} \times 0.15^2 = 0.01767 m^2$

$h = y\left[\frac{S_{hl}}{S_p} - 1\right]$; $S_{hl} = 13.6$ $\quad Cd = 0.98$

$S_g = 0.9$

$y = 250mm = 0.25m$

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

(i) Discharge of oil;

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

$$Q = 0.98 \times \frac{0.071 \times 0.01767}{\sqrt{(0.071)^2 - (0.01767)^2}} \times \sqrt{2 \times 9.81 \times 3.53}$$

$Q = 0.1489 m^3/s$

(ii) Pressure difference;

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

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

$P_1 - P_2$ ~~= 300mm~~ $\quad z_2 - z_1 = 300mm = 0.3m$

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

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

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

$$P_1 - P_2 = 33.81 KN/m^2$$