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COURSE: ENG 214 (FLUID MECHANICS)

MATRIC: 16/ENG06/029

DEPT: MECHANICAL ENGINEERING

ASSIGNMENT ENG 214 SOLUTION:

(1) length = 2.0m

$V_1 = 5m/s$ ; $V_2 = 2m/s$

$\frac{P_1}{w} = 2.5m$ of liquid

loss of head, $h_L = \frac{0.35(V_1 - V_2)^2}{2g} = \frac{0.35(5-2)^2}{2 \times 9.81} = 0.161m$

Applying Bernoulli's equation at ends (1) and (2)

$\frac{P_1}{w} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{w} + \frac{V_2^2}{2g} + z_2 + h_f$

$2.5 + \frac{25}{2 \times 9.81} + 2 = \frac{P_2}{w} + \frac{4}{2 \times 9.81} + 0 + 0.161$

$\frac{P_2}{w} = 5.77 - 0.204 = 5.6m - 0.161 = 5.4m$

Pressure head at lower end i.e larger end is 5.4m

$P_2 = 5.4 \times 9810 \times 10^{-5} = 0.53$ bar

(2) Inlet diameter $(D_1) = 20cm = 0.2m$

Inlet Area $(A_1) = \frac{\pi \times 0.2^2}{4} = 0.0314m^2$

Throat diameter $(D_2) = 10cm = 0.1m$

throat Area $(A_2) = \frac{\pi \times 0.1^2}{4} = 0.0079m^2$

$P_1 = 17.658 N/cm^2 = 176580 N/m^2 = 176.580 kPa$

Pressure head $= \frac{P_1}{w} = \frac{176.580}{9.81} = 18m$

throat pressure head $= \frac{P_2}{w} = -30cm$ of mercury

$= -0.3 \times 13.6 = -4.08m$

$h = \frac{P_1}{w} - \frac{P_2}{w} = 18 - (-4.08) = 22.08m$

$C_d = 0.98$

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

$Q = 0.98 \times \frac{0.0314 \times 0.0079}{\sqrt{(0.0314)^2 - (0.0079)^2}} \times \sqrt{2 \times 9.81 \times 22.08}$

$Q = 0.166\ m^3/s$ //

(3) Orifice diameter = 15cm = 0.15 m = $D_o$

Area of Orifice = $\frac{\pi \times 0.15^2}{4} = 0.0176 m^2 = A_o$

Pipe diameter = 30cm = 0.30 m = $D_1$

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

Manometer reading = 50cm of mercury = 0.5m of mercury

$C_d = 0.64$

~~sp. gravity~~ Sp. gravity of oil = 0.9

$h = y\left[\frac{S_{hl}}{S_o} - 1\right]$

$h = 0.5\left(\frac{13.6}{0.9} - 1\right)$; $h = 7.06$ m of oil

$Q = C_d \frac{A_o \cdot A_1}{\sqrt{A_1^2 - A_o^2}} \times \sqrt{2gh}$

~~$Q = 0.64 \times \frac{0.0176 \times 0.071}{\sqrt{0.0176^2 - 0.071^2}} \times \sqrt{2 \times 9.81 \times 7.06}$~~

$Q = 0.64 \times \frac{0.0176 \times 0.071}{\sqrt{0.071^2 - 0.0176^2}} \times \sqrt{2 \times 9.81 \times 7.06}$

$Q = 0.137\ m^3/s$

(4) axis = 15m below surface

$y = 170mm = 0.17m$ of mercury

Sp. gravity of Hg = 13.6

Sp. gravity of water = 1.026

$$h = y\left(\frac{S_H}{S_L} - 1\right) = 0.17\left(\frac{13.6}{1.026} - 1\right)$$

$$h = 2.08m$$

Speed of sub-marine $= \sqrt{2gh}$

$= \sqrt{2 \times 9.81 \times 2.08}$

$= 6.38 m/s$

(5) Rate of pump delivery $= 0.05 m^3/min = 8.33 \times 10^{-4} m^3/s$

Pressure change = 15 bar $= 15 \times 10^5 N/m^2$

speed of rotation = 1700 rev/min = 28.33 rev/sec

normal displacement $= 10 cm^3/rev = 1 \times 10^{-5} m^3/rev$

Torque input = 15Nm

(i) volumetric efficiency $= \frac{\text{Actual flow rate}}{\text{Ideal flow rate}} \times 100$

Ideal flow rate = normal displacement × speed

$= 1 \times 10^{-5} \times 28.33$

$= 2.833 \times 10^{-4} m^3/s$

volumetric efficiency $= \frac{8.33 \times 10^{-4}}{2.833 \times 10^{-4}} \times 100$

$= 294.03\%$

(ii) Fluid power = Actual flow rate × pressure

$= 8.33 \times 10^{-4} \times 15 \times 10^5$

$= 1249.5\ W$

$= 1.2495\ kW$

(iii) Shaft power = Torque input × angular speed

Torque input = 15 Nm

Angular speed = $\omega = \frac{2\pi N}{60} = 2 \times \frac{22}{7} \times 28.33$

$= 178.07\ W$

(iv) Overall efficiency $= \frac{\text{Fluid power}}{\text{Shaft power}} \times 100$

$= \frac{1249.5}{178.07} \times 100$

$= 702\%$ //