ENG 214 ASSIGNMENT

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18/MHS01/272
BIOMEDICAL ENGINEERING

1 $l = 2.0m$

$v_1 = 5 m/s$

$v_2 = 2 m/s$

$P_1 = 2.5 m$

Loss of head $= h_l = \frac{0.35(v_1 - v_2)^2}{2g}$

$= \frac{0.35(5-2)^2}{2g} = \frac{0.3(3)^2}{2 \times 9.81} = \frac{0.35 \times 9}{2 \times 9.81}$

$= 0.16m$

Pressure head $\frac{P_2}{\rho g} = ?(x)$, applying Bernoulli's equation

$$\frac{P_1}{\rho g} + \frac{v_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + z_2 + h_l$$

$z_2 = 0 ; z_1 = 2$

$$2.5 + \frac{5^2}{2 \times 9.81} + 2.0 = \frac{P_2}{\rho g} + \frac{2^2}{2 \times 9.81} + 0.16$$

$$2.5 + 1.27 + 2.0 = \frac{P_2}{\rho g} + 0.203 + 0.16$$

$$\frac{P_2}{\rho g} = (2.5 + 1.27 + 2.0) - (0.203 + 0.16)$$

$= 5.77 - 0.363 = 5.402 = 5.4 m$

2 Inlet Diameter $(d_1) = 20cm = 0.2m$

Throat Diameter $(d_2) = 10cm = 0.1m$

Area of inlet $A_1 = \frac{3.14 \times (0.2)^2}{4}$

$= 0.0314 m^2$

Area of throat $A_2 = \frac{3.142 \times (0.1)^2}{4}$

$= 0.007854 m^2$

$Cd = 0.98$, Pressure $(p_1) = 17.685 \times 10^4 Nm^2$, $P = 10000 kg/m^3$

$\frac{P_1}{P_4} \rho g = \frac{17.653 \times 10^4}{9.81 \times 1000} = 18m$

$P_2/P_4 g = 30cm$ of mercury $= 0.3 \times 13.6 = -4$

differential head

$h = \frac{P_1}{P_4} - \frac{P_2}{P_4} = 18 - (-4)$

$= 22.08 m$ water

$Q = \frac{Cd \times a_1 a_2 \sqrt{2gh}}{\sqrt{(a_1)^2 - (a_2)^2}}$

$= \frac{0.98 \times 314.16 \times 0.007854 \times \sqrt{2 \times 9.81 \times 22.08m}}{\sqrt{(314.16)^2 - (0.001854)^2}}$

$= \frac{50328837.21 \times 16.5555}{304} = 0.165m$

$= 165.56$ lit/s

3 orifice Diameter = 15cm

pipe Diameter = 30cm

Coefficient of discharge of the meter is = 0.64

flow of oil of specific gravity = 0.9

$A_o = \frac{3.142 \times (15)^2}{4} = 176.714 cm^2$ (Area of the orifice)

$A_p = P_n (30)^2 = 706.858 cm^2$ (Area of the pipe)

$H = \left[\frac{13.6}{0.9} - 1\right] \times 50cm$ of oil

$= \left[15.1 - 1\right] \times 50cm = 14.1 \times 50$

$= 705.56$

$$Q_1 = \frac{C_d A_o A_p \sqrt{2gh}}{\sqrt{(A_p^2) - (A_o)^2}}$$

$$Q = \frac{(0.64 \times 176.71 \times 706.86 \times \sqrt{2 \times 9.81 \times 7.05 \times 100}}{\sqrt{(706.85)^2 - (176.74)^2}}$$

$$= \frac{0.64 \times 176.71 \times 706.85 \times \sqrt{2 \times 9.81 \times 705 \times 100}}{\sqrt{(706.858)^2 - (176.74)^2}} \ cm^3/sec$$

$Q = 137414.25 \ cm^3/sec$

litres $= 137.41425$ lit/sec

Rate of flow of oil $= 137.414$ lit/sec

4 Diff of mercury level, $x = 170mm = 0.17m$

Specific gravity of mercury $= 13.6$

Specific gravity (sp) $= 1.026$

Soln

$$H = x\left[\frac{S_g}{S_o} - 1\right] = 0.17\left[\frac{13.6}{1.026} - 1\right]$$

$$= 2.0834m$$

$$v = \sqrt{2gh}$$

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

$$= 6.39 m/s$$

$$= \frac{6.39 \times 60 \times 60}{1000}$$

$$= \frac{23004}{1000} = 23.004$$

Speed of submarine $= 23.004$ km/hr

$= 23.004$ km/hr

5 Actual flowrate, $Q = 0.05\,m^3/min$

$= \frac{0.00005}{60} = 8.33 \times 10^{-5}\,m^3/sec$

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

Speed $= 1700 rev/min$

$\frac{1700}{60} = 28.33 rev/sec = 28.33 rps$

Normal displacement $= 10cm^3/rev$

$= 1 \times 10^{-5}\,m/rev$

Torque input $= 15Nm$

Ideal flowrate = Normal displacement × speed

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

$= 2.83 \times 10^{-4}\,m^3/sec$

i Volumetric efficiency $= \frac{\text{Actual flowrate}}{\text{ideal flowrate}} \times 100\%$

$= \frac{8.33 \times 10^{-5}}{2.83 \times 10^{-4}} \times 100\%$

$= 0.294 \times 100\%$

$= 29.4\%$

ii Fluid power $P_F = Q \cdot \delta p$

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

$= 124.95$ watts

iii Shaft power $= T \cdot w$

$w = 2\pi N$

$= 2 \times \frac{22}{7} \times 28.33$

$= 178.0$

Shaft power $= 15 \times 178.0$

= 2670 watts

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

$= \frac{124.95}{2670} \times 100\%$

~~[illegible]~~

$= 4.68\%$