TAIWO DAMILOLA
MECHATRONICS
18/ENG 05/058

FLUID MECHANICS ASSIGNMENT

1) $V_1 = 5ms^{-1}$, $U_2 = 2ms^{-1}$

$P_{T_1} = 2.5m$

$P_{T_2} = ?$

$$P_{T_1} - P_{T_2} = \frac{0.35(V_1 - V_2)}{2g}$$

$$= \frac{0.35 \times 3^{\circ}}{2 \times 9.81} = 0.161$$

$\therefore PT_1 - PT_2 = 0.161$

$2.5 - P_{T_2} = 0.161$

$P_{T_2} = 2.5 + 0.161$

$PT_2 = 2.67m$

2) D = 20 cm = 0.2m

Inlet $A_1 = \frac{\pi d^2}{4} = \frac{\pi (0.20)^2}{4} = 0.0314m^2$

$P_1 = 17.658 N/cm^2 = \frac{17.658}{10^{-6}}$ 176.580 kPa

Throat diameter D_2 = 10cm = 0.1m

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

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

Throat Pressure head $= \frac{P_2}{w} = -30cm$ of Mercury

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

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

$= 22.08m$

Cd = 0.98

②

① $Q = Cd \frac{A_1 \times A_2}{\sqrt{A_1^2 - A_2^2}} \times \sqrt{2gh}$

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

$Q = 0.166 m^3/s$

3) Oriface diameter D_0 = 15cm = 0.15m

Area of Oriface $A_0 = \frac{\pi \times 0.15^2}{4} = 0.0176 m^2$

Pipe Diameter D_1 = 30cm = 0.30m

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

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

Cd = 0.64

Specific gravity of oil = 0.9

$h = y\left[\frac{S_{Hg}}{S_0} - 1\right]$

$h = 0.5\left(\frac{13.6}{0.9} - 1\right)$

h = 7.06m

$Q = Cd \frac{A_0 \cdot A_1}{\sqrt{A_1^2 - A_0^2}} \times \sqrt{2gh}$

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

$Q = 0.137 m^3/s$

4) Area = 15m below surface

y = 170mm = 0.17m of mercury

Sp. gravity of Hg = 13.6

5)

i)

ii)

(4)

Sp gravity of water = 1.026

$h = y\left[\frac{S_m}{S_l} - 1\right] = 0.17\left[\frac{13.6}{1.026} - 1\right]$

$h = 2.08m$

Speed of submarine $= \sqrt{2gh}$

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

$= 6.38 m/s$

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

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 flowrate = normal displacement × speed

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

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

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

$= 294.03\%$

ii) Fluid power = Actual flow rate × Pressure

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

$= 1249.5 W$

$= 1.2495 kW$

5 (iii) Shaft power = Torque input × angular speed

Torque input = 15 Nm

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

$= 178.07 W$

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

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

$= 702\%$