18/ENG04/054
Electrical/Electronic 5
Fluid Mechanics Assignment

Number 1

Data: Length = 2.0
V at smaller end is 5m/s
V at lower end is 2m/s
P at smaller end is 2.5m

$$\text{Loss of head} = \frac{0.35(5-2)^2}{2\times 9.81} = 0.16$$

Bernoulli's eqn

$$\frac{P_1}{\omega} + \frac{V^2}{2g} + Z_1 = \frac{P_2}{\omega} + \frac{V_2^2}{2g} + Z_2 + h_f$$

$$\frac{P_2}{\omega} - \frac{P_1}{\omega} + \frac{V_1^2 - V_2^2}{2g} + Z_1 - Z_2 - h_f = \frac{P_2}{\omega}$$

$$2.5 + \frac{(5^2-2^2)}{2\times 9.81} + 2.0 - 0.16 = \frac{P_2}{\omega}$$

$$(2.5 + 1.07 + 2.0) - 0.16 = \frac{P_2}{\omega}$$

$$5.41 \text{ bar} = \frac{P_2}{\omega}$$

Number 2

inlet diameter $(d_1) = 20cm = 0.2m$

$$\therefore A_1 = \frac{\pi d_1^2}{4} = \frac{\pi(0.2)^2}{4} = 0.314m^2$$

throat diameter $(d_2) = 10cm = 0.1m$

$$\therefore A_2 = \frac{\pi d_2^2}{4} = \frac{\pi(0.1)^2}{4} = 7.85\times10^{-3}m^2$$

Pressure at inlet = 17.658 N/cm²
Vacuum pressure at throat = 30cm of mercury

Take $C_d = 0.98$

$$Q = C_d \times \frac{A_1A_2}{\sqrt{A_1^2 - A_2^2}} \times \sqrt{2gh}$$

$$Q = \frac{0.98\times0.0314\times7.86\times10^{-3}}{\sqrt{(0.0314)^2 - (7.85\times10^{-3})^2}} \times \sqrt{2\times9.81\times18.03}$$

$$Q = 0.149m^3/s$$

Number 3

Given
Diameter of orifice $d_0 = 15cm$

$$\therefore \text{Area}_0 = \frac{\pi(15)^2}{4} = 176.7cm^2$$

Diameter of pipe $d_1 = 30cm$

$$\therefore \text{Area}_1 = \frac{\pi(30)^2}{4} = 706.85cm^2$$

Sp.gr. of oil, $S_0 = 0.9$
Reading of diff. manometer, $x = 50cm$ of mercury
Differential head

$$h = x\left[\frac{S_g}{S_0} - 1\right] = 50\left[\frac{13.6}{0.9} - 1\right]$$

$$= 50\times14.11 = 705.5cm \text{ of oil}$$

$C_d = 0.64$

$$Q = C_d \cdot \frac{A_0A_1}{\sqrt{A_1^2 - A_0^2}} \times \sqrt{2gh}$$

$$= 0.64\times\frac{176.7\times706.85}{\sqrt{(706.85)^2 - (176.7)^2}} \times \sqrt{2\times9.81\times705.5}$$

$$= \frac{9404617.78}{684.4} = 13741.25cm^3/s$$

or
137.414 Litres/s

18/ENG04/054
Elect/Elect

Number 4

Reading of the differential manometer = 0.17m
Specific gravity of mercury = 13.6
Specific gravity of Sea water = 1.025

$$\text{head} = 0.17\left[\frac{S.g\,Hg}{S.g\,w} - 1\right]$$
$$= 0.17\left[\frac{13.6}{1.025} - 1\right]$$
$$= 2.09$$

Velocity of submarine $= \sqrt{2gh} = \sqrt{2 \times 9.81 \times 2.09}$
$= 6.403 m/s$

Number 5

Pump delivers at rate of $0.05 m^3/min = 0.00083 m^3/s$
Pressure change = 15 bar
Speed of rotation = 1700 rev/min = 1700
displacement = $100 cm^3/rev$
Torque Input = 15 Nm

i) Volumetric efficiency (η_p) =
$\eta_p = \frac{Q_A}{Q_T} = \frac{0.00083}{1700} =$ where 4.9×10^{-8}

ii) Shaft power
$$\frac{2\pi NT}{60} = \frac{2\pi \times 1700 \times 15}{60}$$
$$= 2670.4 Nm$$

iii) Fluid power = Flow rate x Change in pressure
$= 0.00083 \times 15 \times 10$
$= 1245$ watts

iv) Overall efficiency (η) $= \frac{\text{Fluid Power}}{\text{Shaft Power}} = \frac{1245}{2670.4} = 46.6\%$