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18/ENG02/042
Computer Engineering
ENG 214 (Fluid Mechanics)

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

PH at smaller end = 2·5m

$h_f = \frac{(0.35 (V_1 - V_2)^2)}{2g}$

$L = 2.0m$, $L = Z_1 - Z_2$

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

$$\frac{P_2}{w} = \frac{P_1}{w} + \frac{1}{2g}(V_1^2 - V_2^2) + (Z_1 - Z_2) h_f$$

$$= 2.5 + \frac{5^2 - 2^2}{2 \times 9.81} + 2 - \frac{0.35 (5-2)^2}{2 \times 9.81}$$

$= 2.5 + 1.07 + 2 - 0.16055$

$P_2 = 5.409$ Bar ∴ The pressure at lower end = 5·409 bar

inlet diameter = 20cm

throat diameter = 10cm

$P_1 = 17.658 N/cm^2 = 1.7658 N/m^2$

$J = 0.3m$, $Cd = 0.98$

$$A_1 = \frac{\pi d^2}{4} = \frac{3.14 \times 0.2^2}{4} = 0.0314m^2$$

$$A_2 = \frac{\pi d^2}{4} = \frac{3.14 \times 0.1^2}{4} = 7.85 \times 10^{-3} m^2$$

$$\frac{P_1}{w} = \frac{1.7658 \times 10^{-3}}{9.81} = 1.8 \times 10^{-4} m$$

$\frac{P_2}{w} = 0.3 \times 13.6 = -4.08$ of H_2O

$h = \frac{P_1}{w} - \frac{P_2}{w} = 1.8 \times 10^{-4} - (-4.08) = 4.08018 m$

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

$$= 0.98 \times \frac{0.0314 \times 7.85 \times 10^{-3}}{\sqrt{(0.0314)^2 - (7.85 \times 10^{-3})^2}} \times \sqrt{2 \times 9.81 \times 4.08018}$$

$$Q = \frac{0.000241}{0.0304} \times 8.997$$

$Q = 0.0709 m^3/s$

3) Diameter of Orifice $d_0 = 15 cm$

∵ Area $a_0 = \frac{\pi}{4}(15)^2 = 176.7 cm^2$

Diameter of pipe $d_1 = 30 cm$

∵ Area $a_1 = \frac{\pi}{4}(30)^2 = 706.85 cm^2$

Sp. gr of oil $S_0 = 0.9$

Reading of diff. manometer, $x = 50 cm$ of mercury

∵ Differential head $h = x\left[\frac{S_g}{S_0} - 1\right] = 50\left[\frac{13.6}{0.9} - 1\right]$ cm of oil

$= 50 \times 14.11 = 705.5 cm$ of oil

$Cd = 0.64$

∵ The rate of the flow, Q is given

$$Q = Cd \times \frac{a_0 a_1}{\sqrt{a_1^2 - a_0^2}} \times \sqrt{2gh}$$

$$= 0.64 \times \frac{176.7 \times 706.85}{\sqrt{(706.85)^2 - (176.7)^2}} \times \sqrt{2 \times 9.81 \times 705.5}$$

$= \frac{94046317.78}{684.4} = 137414.25\ cm^3/s = 137.414$ litres/s.

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

5) Pump delivers at rate of ~~0.005~~ $0.05 m^3/min$ $= 0.00083 m^3/s$
Pressure change = 15 bar
Speed of rotation = 1700 rev/min = 17000
Displacement = $10 cm^3/rev$
Torque input = 15 Nm

i) Volumetric efficiency $(\eta_p) = \frac{QA}{QT} = \frac{0.00083}{17000} = 4.9 \times 10^{-8}$

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

$= 2670.4 Nm.$

iii) Fluid power = Flow rate × Change in pressure $= 0.00083 \times 15 \times 10^5$
$= 1245$ watts

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