EGBUHIE KELVIN OLAMIDE
18/ENG04/029
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ELECT-ELECT
ENG 214
Fluid Mechanics

5) Actual flowrate = $5dm^3/min = \frac{5\times10^{-3}}{60} = 0.0000833 m^3/sec$

$= 8.33\times10^{-5} m^3/sec$

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

pressure = $15 bar = 15 \times 1\times10^5 N/m^2 = 15\times10^5 N/m^2$

Nominal displacement = $10 cm^3/rev = \frac{10}{(100)^3} = 1\times10^{-5} m^3/rev$

Torque = 15Nm.

i) Volumetric Efficiency = $\frac{\text{Actual flowrate}}{\text{Ideal flowrate}} \times 100\%$

Ideal flowrate = nominal displacement × speed

ideal flowrate = $1\times10^{-5} \times 28.33$

ideal flowrate = $2.833\times10^{-4} m^3/sec$

Volumetric efficiency = $\frac{8.33\times10^{-5}}{2.833\times10^{-4}} \times 100\%$

$= 0.294 \times 100$

$= 29.4\%$

ii) Fluid Power = Actual flowrate × pressure

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Fluid power = ~~63~~ $8.33\times10^{-5} \times 15\times10^{5}$
Fluid power = 124.95 ~~Nm/sec~~ or 124.95 Watts

iii) Shaft power = Torque input × angular speed

angular speed (ω) = ~~2πN~~ $2\pi N$
where N is speed
angular speed = $2\times\pi\times 28.33$
angular speed = 178.00 rad/sec

Shaft power = 15×178
= 2670 Watts.

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

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

Overall efficiency = ~~4.6198~~ 0.04680×100
Overall efficiency = 4.68%

2) $C_d = 0.98$, ~~d~~ $d_1 = 20cm =$ ~~0.2m d2 = 10~~ ~~$\frac{20}{100}$ 0.2m~~

$d_2 = 10cm = \frac{10}{100} = 0.1m$
(throat diameter)

$d_1 = 20cm = \frac{20}{100} = 0.2m$
(inlet diameter)

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(P_1)

Inlet pressure = 17.658 N/cm^2 = 17.658 × 100^2
= 176,580 N/m^2

Vaccum pressure = $\frac{P_2}{W}$ = 30 cm Hg = $\frac{30}{100}$ = -0.3 m Hg

$\frac{P_2}{w}$ = -0.3 × 13.6

$\frac{P_2}{w}$ = -4.08 m

$\frac{P_1}{W}$ (inlet pressure) = $\frac{176580}{}$ $\frac{P_1}{\rho g}$ = $\frac{176580}{1000 \times 9.81}$

$\frac{P_1}{W}$ = 18 m

Area at inlet (A_1) = $\frac{\pi d_1^2}{4}$ = $\frac{\pi \times (0.2)^2}{4}$ = 0.0314 m^2

Area at throat (A_2) = $\frac{\pi d_2^2}{4}$ = $\frac{\pi \times (0.1)^2}{4}$ = 0.00785 m^2

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

h = 22.08

$Q_{Actual} = \frac{C_d A_1 A_2 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}}$

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$$Q_{Actual} = \frac{0.98 \times 0.0314 \times 0.00785 \times \sqrt{2 \times 9.81 \times 22.0d}}{\sqrt{0.0314^2 - 0.00785^2}}$$

$$Q_{Actual} = \frac{5.0278 \times 10^{-3}}{0.0304}$$

$$Q_{Actual} = 0.1654\, m^3/s$$

3) Diameter of the pipe $(d_1) = 30cm = \frac{30}{100} = 0.3m$

Area of pipe $(A_1) = \frac{\pi d_1^2}{4} = \frac{\pi \times (0.3)^2}{4} = 0.0707 m^2$

Diameter of orifice $(d_0) = 15cm = \frac{15}{100} = 0.15m$

Area of orifice $(A_0) = \frac{\pi d_0^2}{4} = \frac{\pi \times (0.15)^2}{4} = 0.01767 m^2$

Coefficient of discharge $(C_d) = 0.64$

Specific gravity of oil (S_g) 0.9

Reading of differential manometer $(y) = 50cm\ H_g = \frac{50}{100} = 0.5m\ H_g$

Differential head, $h = y\left[\frac{S_{mercury}}{S_{oil}} - 1\right]$ (heavier liquid)

$$h = 0.5\left[\frac{13.6}{0.9} - 1\right]$$

$$h = 0.5(15.11 - 1)$$

$$h = 0.5(14.11)$$

$$h = 7.055m$$

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

$$Q = \frac{0.~~64~~ \times 0.01767 \times 0.0707 \times \sqrt{2 \times 9.81 \times 7.055}}{\sqrt{0.0707^2 - 0.01767^2}}$$

$$Q = ~~0.01323~~ \qquad \frac{~~0.01323~~\ 9.4066 \times 10^{-3}}{0.06846}$$

$Q = ~~0.1934~~\ m^3/s \quad 0.01374\ m^3/sec$

4) Reading of the manometer $y = 170mm = \frac{170}{1000} = 0.17m$

Specific gravity of sea water $S_w = 1.026$

Specific gravity of mercury $S_{hg} = 13.6$

Head, $h = y\left(\frac{S_{hg}}{S_w} - 1\right)$

$h = 0.17\left(~~\frac{1.026}{13.6} - 1~~\right) \quad \left(\frac{13.6}{1.026} - 1\right)$

$h = 0.17(~~0.0754 - 1~~) \quad (13.2554 - 1)$

$h = 0.17(12.2554)$

$h = 2.083418m$

$V = \sqrt{2gh}$

$V = \sqrt{2 \times 9.81 \times 2.083418}$

$v = 6.3934 m/s$

1) Length of tube = 2m

Velocity at smaller end $(v_1) = 5m/s$

Scanned with CamScanner

Velocity at larger end (V_2) = 2m/s

Pressure head, $\frac{P_1}{w} = 2.5m$

Loss of head $h_L = \frac{0.35(V_1 - V_2)^2}{2g}$

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

$h_L = \frac{0.35(3)^2}{2 \times 9.81}$

$h_L = 0.1606m$

$Z_2 = 0m, Z_1 = 2m$

Applying Bernoulli's equation

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

$$2.5 + \frac{5^2}{2 \times 9.81} + 2 = \frac{P_2}{w} + \frac{2^2}{2 \times 9.81} + 0 + 0.1606$$

$$2.5 + 1.274209999 + 2 = \frac{P_2}{w} + 0.2038735984 + 0.1606$$

$$5.77420999 = \frac{P_2}{w} + 0.364435984$$

$$\frac{P_2}{w} = 5.77420999 - 0.364435984$$

$$\frac{P_2}{w} = 5.409736392$$

$$\frac{P_2}{w} \simeq 5.41m$$