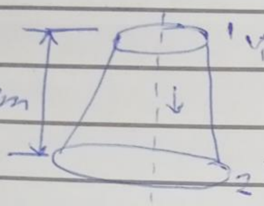
ATOGWE VICTORIA ALOIYE.
18/ENG08/003.
BIOMEDICAL ENGINEERING.
ENG 214.

1.



$\frac{P_1}{W} = 2.5m$

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

$$\frac{P_1}{W} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{W} + \frac{V_2^2}{2g} + z_2 + H_L$$

$$\frac{P_2}{W} = \frac{P_1}{W} + \frac{V_1^2 - V_2^2}{2g} + (z_1 - z_2) - \frac{0.35(V_1 - V_2)^2}{2g}$$

$$\frac{P_2}{W} = 2.5 + \frac{5^2 - 2^2}{2(9.81)} + 2 - \frac{0.35(5-2)^2}{2(9.81)}$$

$$\frac{P_2}{W} = 2.5 + 1.07 + 2 - 0.161$$

$$\frac{P_2}{W} = 5.409m \text{ of liquid}$$

2. $d_1 = 20cm = 0.2m$, $d_2 = 10cm = 0.1m$

$P_1 = 17.658 N/cm^2 = 176\,580 N/m^2$, $P_2 = -0.3cmHg$
$= -0.3mHg$

$$A_1 = \frac{\pi(0.2)^2}{4} = 0.031m^2$$

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

$$h = \frac{P_1}{W} - \frac{P_2}{W} = \frac{176\,580}{(1000 \times 9.81)} - (-0.3 \times 13.6)$$

$$h = 18 + 4.08 = 22.08m$$

$Cd = 0.98$

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

$$Q = \frac{0.98 \times 0.031 \times 7.85 \times 10^{-3} \times \sqrt{2 \times 9.81 \times 22.08}}{\sqrt{0.031^2 - (7.85 \times 10^{-3})^2}}$$

$Q = 8.05 \times 10^{-3} \times 20.81$

$Q = 0.167\ m^3/sec.$

3. $A_o = \frac{\pi (0.15)^2}{4} = 0.0177 m^2$, $A_1 = \frac{\pi (0.30)^2}{4} = 0.0707 m^2$

$y = 50 cm\ Hg = 0.5 m\ Hg$, $S.g_{oil} = 0.9$, $Cd = 0.64$

$$h = y \left[\frac{S.g_{Hg}}{S.g_{oil}} - 1\right] = 0.5 \left[\frac{13.6}{0.9} - 1\right]$$

$h = 7.05 m$

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

$$Q = \frac{0.64 \times 0.0177 \times 0.0707 \times \sqrt{2 \times 9.81 \times 7.05}}{\sqrt{0.0707^2 - 0.0177^2}}$$

$$= \frac{9.4193 \times 10^{-3}}{0.0685} = 0.1376\ m^3/sec.$$

4. $y = 170 mm\ Hg = 0.17 m\ Hg$, $S.g_{Hg} = 13.6$,
$S.g_{oil} = 1.026$

$$\Delta h = y \left[\frac{S.g_{Hg}}{S.g_{oil}} - 1\right] = 0.17 \left[\frac{13.6}{1.026} - 1\right]$$

$\Delta h = 2.08 m$

$V = \sqrt{2g\Delta h} = \sqrt{2 \times 9.81 \times 2.08}$

$V = 6.388\ m/s$

$1 dm^3 = 0.001 m^3$
$0.05 = ''$

5. $Q = 0.05 dm^3/min = 8.33 \times 10^{-5} m^3/sec$

Speed of rotation $= 1700 Rev/min = 28.3 rev/sec$

Nominal displacement $= 10 cm^3/rev = 10^{-5} m^3/rev$

Torque Input $= 15 Nm$

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

Ideal Flowrate = Nominal displacement × Speed rotation

$= 10^{-5} \times 28.3 = 2.83 \times 10^{-4} m^3/sec$

a. Volumetric Efficiency $= \frac{\text{Actual Flowrate}}{\text{Ideal Flowrate}} \times 100$

$= \frac{8.33 \times 10^{-5}}{2.83 \times 10^{-4}} \times 100 = 29.45\%$

b. Fluid Power, $P_F = Q \times \Delta P$

$= 8.33 \times 10^{-5} \times 15 \times 10^5 = 124.95$ Watts

c. Shaft Power $= T \times \omega$

$\omega = 2 \times \pi \times$ speed of rotation $= 2 \times \pi \times 28.3$

$= 177.81 rad/sec$

∴ Shaft power $= 15 \times 177.81 = 2667.2$ Watts

d. Overall Efficiency $= \frac{\text{Fluid Power}}{\text{Shaft Power}} \times 100$

$= \frac{124.95}{2667.2} \times 100 = 4.68\%$