4. Specific gravity of mercury = 13.6
" " of Sea = 1.026
Difference in mercury level = 170mm = 0.17m

$$h = \left[\frac{S.G \text{ of mercury}}{S.G \text{ of Liquid}} - 1\right] g$$

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

$$h = 2.083$$

$$v = C_v \times \sqrt{2gh}$$

$$v = 1 \times \sqrt{2 \times 9.81 \times 2.083}$$

$$v = \underline{6.39 m/s}$$

5. Volumetric flow rate = $0.05 m^3/min = 8.3333 \times 10^{-5} m^3/s$
pressure change = 15 bar = $1.5 \times 10^6 N/m^2$
Speed of rotation = 1700 rev/min = 28.333 rev/s
torque input = 15 Nm
Normal displacement = $10 cm^3/rev = 1 \times 10^{-5} m^3/rev$

a) Volumetric efficiency = $\frac{\text{Actual flow rate}}{\text{theoretical flow rate}} \times \frac{100}{1}$

Actual flow rate = 8.33×10^{-5}

theoretical flow rate = speed of rotation × displacement
$= 28.333 \times 1 \cdot 10^{-5}$
$= 2.83 \times 10^{-4} m^3/s$

Volumetric efficiency = $\frac{8.33 \times 10^{-5}}{2.83 \times 10^{-4}} \times \frac{100}{1}$
$= \underline{29.45\%}$

b. Fluid power = $Q(P_2 - P_1)$
$(P_2 - P_1) = 1.5 \times 10^6 N/m^2$
$= 8.3333 \times 10^{-5} \times 1.5 \times 10^6$
$= \underline{124.99}$ watts

$$Q = \frac{0.98 \times 0.0314 \times 7.854 \times 10^{-3}}{\sqrt{0.0314^2 - (7.854 \times 10^{-3})^2}} \sqrt{2 \times 9.81 \times 17.59}$$

$$Q = \frac{0.98 \times 0.0314 \times 7.854 \times 10^{-3} \times 18.5773}{0.03}$$

$$Q = \underline{0.149 m^3/s}$$

3. Orifice diameter = 15cm = $15 \times 10^{-2} m$
pipe diameter = 30cm = $30 \times 10^{-2} m$
$P_1 - P_2$ = 50cmHg = $6666.12 N/m^2$
Specific gravity of oil = 0.9, Cd = 0.64

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

$$A_0 = \frac{\pi (15 \times 10^{-2})^2}{4} = 0.0177 m^2$$

$$A_1 = \frac{\pi (30 \times 10^{-2})^2}{4} = 0.0707 m^2$$

$$h = \frac{P_1 - P_2}{w} = \frac{6666.12}{8829} = 0.755 m$$

$$S.g = \frac{w}{1000 \times 9.81}$$

$w = 0.9 \times 1000 \times 9.81$
$w = 8829$

$$Q = 0.64 \times 0.0177 \times 0.0707 \times \frac{\sqrt{2 \times 9.81 \times 0.755}}{\sqrt{0.0707^2 - (0.0177^2)}}$$

$$Q = 0.64 \times 0.0177 \times 0.0707 \times \frac{3.849}{\sqrt{0.0707^2 - (0.0177^2)}}$$

$\therefore Q = \underline{0.045 m^3/s}$

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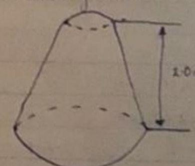
Assignment

1. 

Using bernoulli's equation

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

$z_1 \neq z_2$

$$2.5 + 2.0 + \frac{5^2}{2 \times 9.81} = \frac{P_2}{w} + 0 + \frac{2^2}{2 \times 9.81}$$

$$2.5 + 2.0 + 1.27 = \frac{P_2}{w} + 0 + 0.20$$

$$\frac{P_2}{w} = 5.77 - 0.20$$

$$\frac{P_2}{w} = 5.57m$$

Inlet diameter = 20cm = 20×10^{-2} m
Inlet pressure = 17.658 N/cm² = 176580 N/m²
Throat diameter = 10cm = 10×10^{-2} m
Throat pressure = 30cmHg = 3999.67 N/m², Cd = 0.98

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

$$h = \frac{P_1 - P_2}{w} = \frac{176580 - 3999.67}{1000 \times 9.81} = 17.59m$$

$$A_1 = \frac{\pi (0.2)^2}{4} = 0.0314 m^2$$

c. Shaft power = $\tau \times \omega$

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

$= 2 \times \pi \times 28.3$

$= 177.81$ rad/s

Shaft power $= 15 \times 177.81$

$= 2667.2$ watts

d. Overall efficiency $= \frac{\text{Fluid power}}{\text{shaft power}} \times \frac{100}{1}$

$= \frac{124.95}{2667.2} \times \frac{100}{1}$

$= 4.68\%$