~~red~~ white = 16
blue = 8

36

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mechanical Engineering

ENG214

Assignment

$= 46.85\%$

$= \sout{46.9\%} = 46.9\%$

1) $z_1 = 0$

$z_2 = 2.0\,m$

$v_1 = 5\,m/s$

$v_2 = 2\,m/s$

$h_1\ \frac{P_1}{w} = 2.5\,m$

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

$$h_f = 0.35\frac{(v_1 - v_2)^2}{2g}$$

$$= 0.35\frac{(5-2)^2}{2\times9.81} = 0.1606\,m$$

Bernoulli Equation

$$\frac{P_1}{w} + \frac{v_1^2}{2g} + z_1 = \frac{P_2}{w} + \frac{v_2^2}{2g} + z_2 + h_f$$

$$\frac{P_2}{w} = \frac{P_1}{w} + \frac{v_1^2}{2g} + z_1 - \frac{v_2^2}{2g} - z_2 - h_f$$

$$\frac{P_3}{w} = 2.5 + \frac{5^2}{2 \times 9.81} + 0 - \frac{2^3}{2 \times 9.81} - 2 - 0.606$$

$$\frac{P_3}{w} = 1.409 \, m$$

$$\frac{P_3}{w} = 1.41 \, m$$

2) $d_1 = 20cm$
$d_2 = 10cm$
$P_1 = 17.658 N/cm^2$
$P_2 = 30cm$ of mercury
$C_d = 0.98$

Solution

$d_1 = 20cm = 0.2m$
$d_2 = 10cm = 0.1m$
$P_1 = 1.7658 \times 10^{-3} N/m^2$

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

$$A_2 = \frac{\pi d_2^2}{4} = \frac{\pi \times (0.1)^2}{4} = 7.854 \times 10^{-3} m^2$$

specific gravity of mercury = 13.6

$$\frac{P_1}{w} = \frac{P_1}{\rho g} = \frac{1.7658 \times 10^{-3}}{1000 \times 9.81}$$

$$= 1.8 \times 10^{-7}$$

$$\text{vacaum Pressure} = \frac{P_2}{w} = 30cm \text{ of } Hg$$

$$= 0.3m \times 13.6$$

$$= 4.08m$$

~~Q = 0.98 × 0.649~~

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

~~$Q = 0.98 \times 7.854 \times 10^{-3} \times 0.0314 \times \sqrt{2 \times 9.81 \times}$~~

~~$h = y\left(\frac{S.G \text{ of } Hg}{S.G \text{ of }}\right)$~~

$h = \frac{P_1 - P_2}{w} = 1.7658 \times 10^{-3} + 4.08$
$= 4.0818$

$$Q = \frac{0.98 \times 7.854 \times 10^{-3} \times 0.0314 \times \sqrt{2 \times 9.81 \times 4.0818}}{\sqrt{(0.0314^2)^2 - (7.854 \times 10^{-3})^2}}$$

$$Q = \frac{2.4168 \times 10^{-4} \times 8.9490176}{0.0304}$$

$Q = 0.0711 \ m^3/sec$

Power

3) $d_1 = 30cm$ (diameter of pipe)
$d_2 = $ ~~200~~ $15cm$ (diameter of orificemeter)
Specific gravity of oil $= 0.9$
The reading of the differential manometer $= 50cm$ of Hg
Coefficient of discharge of orificemeter $= 0.64$

Solution

$d_1 = 30cm = 0.3m$
$d_2 = 15cm = 0.15m$

$$A_1 = \frac{\pi d_1^2}{4} = \frac{\pi \times (0.3)^3}{4} = ~~0.070m^2~~ = 0.0707m^2$$

$$A_2 = \frac{\pi d_2^2}{4} = \frac{\pi \times (0.15)^3}{4} = 0.0177m^2$$

$y = 50cm$ of Hg
$y = 0.5m$ of Hg

$$h = y\left(\frac{\text{Specific gravity of mercury}}{\text{Specific gravity of oil}} - 1\right)$$

$$h = 0.5\left(\frac{13.6}{0.9} - \frac{1}{1}\right)$$

$$h = 7.056$$

~~h = 5.64~~

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

$N/mm^2 = N/m^2$ ~~divide~~ multiply by ~~10~~ 61000000

$N/cm^2 = N/m^2$ divide by ~~10~~ 10000

$$Q = \frac{0.64 \times 0.0177 \times 0.0707 \times \sqrt{2 \times 9.81 \times 7.086}}{\sqrt{(0.0707)^2 - (0.0177)^2}}$$

$$Q = \frac{8.008896 \times 10^{-4} \times 11.766}{0.0684}$$

$Q = 0.1378 \ m^2/Sec$

$\frac{P_3}{w} = 1.41m$

4) $y = 170mm$

$= \frac{170}{1000}$

$y = 0.17m$

Specific gravity of mercury = 13.6

Specific gravity of seawater = 1.026

$h = y\left(\frac{S.G\ of\ Hg}{S.G\ of\ Seawater} - 1\right)$

$h = 0.7\left(\frac{13.6}{1.026} - 1\right)$

$h = 2.08m$

velocity $= \sqrt{2gh}$

$= \sqrt{2 \times 9.81 \times 2.08}$

$v = 6.39 m/s$

5)

Flow rate $= 0.05 m^3/min$

m^3/min to m^3/sec

$60 sec = 1 min$

$= \frac{0.05}{60}$

$Q = 8.33 \times 10^{-4} m^3/sec$

speed $V = 1700 rev/min$

$= \frac{1700}{60}$

$= 28.3 rev/sec$

$= 28.3 rps$

(o/p) Pressure $= 15 bar$

$1 bar = 1 \times 10^5 N/m^2$

$15 bar = x$

$x = 1500000 N/m^2$

Normal displacement $= 10 cm^3/rev$

$100cm = 1m$

$100^3 cm^3 = 1m^3$

$10cm = x$

$x = \frac{10}{1000000}$

$x = 1 \times 10^{-5} m^3/rev$

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

294.35

Ideal flowrate = normal displacement × speed

$= 28.3 \times 1 \times 10^{-5}$

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

volumetric Efficiency = $\frac{8.33 \times 10^{-4}}{2.83 \times 10^{-4}} \times 100\%$

$= 294.35\%$

Fluid Power (P_F) = $Q \cdot \partial P$

(Q: flowrate; ∂P: change in pressure)

$= 8.33 \times 10^{-4} \times 1500000$

$= 1249.5$ watts or Nm/sec

Shaft Power = $T \cdot \omega$

(T: Torque input; ω: angular speed)

$T = 15 Nm$

$\omega = 2\pi N$ for rps

$\omega = 2 \times \pi \times 28.3 = 177.81$ rad/sec

Shaft power $= 15 \times 177.81$

$=$ ~~2667 watts~~

$= 2667.15$

overall Efficiency $= \frac{\text{fluid Power}}{\text{Shaft Power}} \times 100\%$

$= \frac{1249.5}{2667.15} \times 100$

$= 46.85\%$

$=$ ~~46.9%~~ $= 46.9\%$

b)

$Z_1 = 0$

$Z_2 = 2.0\,m$

$V_1 = 5\,m/s$

$V_2 = 2\,m/s$