EBONG PRINCE VINCENT
18/ENG04/028
Elect/Elect
ENG 214

1) $Z_1 = 2m$
$Z_2 = 0m$
$l = 2m$,
$V_1 = 5m/s$
$V_2 = 2m/s$
$\frac{P_1}{w} = 2.5m$

$\text{Head loss} = \frac{(0.35(5.2)}{2\times9.81}$

Head loss = 0.1601m

Applying Bernoulli's equation

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

$2.5 \times \frac{(5)^2}{2\times9.81} + 2 = \frac{P_2}{w} + \frac{(2)^2}{2\times9.81} + 0 + 0.1601$

$2.5 \times 1.2742 = \frac{P_2}{w} + 0.2039 + 0.1601$

$5.7742 = \frac{P_2}{w} + 0.3640$

$\frac{P_2}{w} = 5.7742 - 0.3640$

$\frac{P_2}{w} = 5.4102m$//

2)
$d_1 = 20cm = 0.2m$ (d=
$A_1 = \frac{\pi(d_1)^2}{4}$

$= \frac{\pi\times(0.02)^2}{4} = \frac{\pi\times(0.2)^2}{4}$

$= 0.3142m^2$

$d_2 = 10cm = 0.1m$

$A_2 = \frac{\pi(d_2)^2}{4} = \frac{\pi\times(0.1)^2}{4}$

$= 0.007855m^2$

$P_1 = 17.658N/cm^2$
$= 176580N/m^2$

$\frac{P_1}{w} = \frac{P_1}{\rho\times g} = \frac{176580}{1000\times9.81}$

$= 18m$//

Vacuum pressure = 30cm
= −0.3m mercury (Hg)

$P_2 = -0.3 \times 13.6$

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

$h = \frac{P_1 - P_2}{w}$

$h = 18 - (-4.08)$
$= 22.08m$//

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

$$= \frac{0.98 \times 0.03142 \times 0.007853 \times \sqrt{2 \times 9.81 \times 22.08}}{\sqrt{0.03142^2 - 0.007853^2}}$$

$$= \frac{5.03417 \times 10^{-3}}{0.03042}$$

$Q_{actual} = 0.1655 m^3/s$

3) $d_0 = 15cm = 0.15m$

$$A_0 = \frac{\pi (d_0)^2}{4} = \frac{\pi \times (0.15)^2}{4}$$

$= 0.0177 m^2$

$d_1 = 30cm = 0.3m$

$$A_1 = \frac{\pi (d_1)^2}{4} = \frac{\pi \times (0.3)^2}{4}$$

$= 0.0707 m^2$

$C_d = 0.64$

differential radius (y)
$= 50cm = 0.5m$

Specific gravity of mercury
$= 13.6$

Specific gravity of oil $= 0.9$

Differential head $[h]$

$$= y\left[\frac{S_{Hg}}{S_{oil}} - 1\right]$$

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

$= 0.5(14.11)$

$= 7.055m$

Actual flowrate $= 0.05 m^3/min$
$= 8.33 \times 10^{-4} m^3/s$

Pressure $= 13bar = 13 \times 10^5 N/m^2$

Speed $= 1700$ rev/min
$= 28.33$ rev/s

normal displacement $= 10 cm^3/rev$
$= 1 \times 10^{-5} m^3/rev$

Torque input $= 13Nm$

Volumetric efficiency

$$= \frac{\text{Actual flow rate}}{\text{ideal flow rate}} \times 100\%$$

Ideal flowrate = nominal displacement × speed

$= 1 \times 10^{-5} \times 28.33$

$= 2.833 \times 10^{-4} m^3/s$

Volumetric efficiency

$$\frac{8.33 \times 10^{-4}}{2.833 \times 10^{-4}} \times 100\%$$

$= 2.94 \times 100\%$

$= 294\%$

Fluid power = Actual rate × pressure

$= 8.33 \times 10^{-4} \times 15 \times 10^{5}$

Fluid power $= 1249.5$ Watts //

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

$$Q = \frac{0.64 \times 0.0177 \times 0.0707 \times \sqrt{2 \cdot 9.81 \times 7.055}}{\sqrt{0.0707^2 - 0.0177^2}}$$

$$Q = \frac{9.4226 \times 10^{-3}}{0.0684}$$

$Q = 0.1378 \, m^3/s$

a) depth $h = 13m$

monument reading $= 170mm$

$= 0.17m$

Specific gravity mercury

$S_{Hg} = 13.6$

Specific gravity sea water

$S_{swater} = 1.026$

$$h = g\left[\frac{S_{Hg}}{S_{swater}} - 1\right]$$

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

$h = 0.17(12.255)$

$h = 2.08335m$

Velocity $v = \sqrt{2 \times g \times h}$

$v = \sqrt{2 \times 9.81 \times 2.08335}$

$v = 6.394 \, m/s$

Shaft power = Torque × angular speed

Angular speed

$2 \times \pi \times$ ~~speed~~ speed

$2 \times \pi \times 28.33$

Angular speed $= 178.0026$ rad/s

Shaft power

$= 15 \times 178.0026$

$= 2670.039$ watts

Overall efficiency

$$= \frac{\text{fluid power}}{\text{Shaft power}} \times 100\%$$

$$= \frac{1249.5}{2670.039} \times 100\%$$

$= 0.468 \times 100$

$= 46.8\%$