18/ENG07/002

AFOLABI KABIR

PETROLEUM ENGINEERING

18/ENG07/002 PETROLEUM ENGINEERING

1 Ideal flow rate = normal displacement x speed
$= 10 \times 1500 = 15\ dm^3/min$

i) Volumetric efficiency = $\frac{\text{Actual flow}}{\text{Idea Flow}} = \frac{10}{15}$
$= 0.67 = 67\%$

ii) fluid Power $= \Delta P Q$
$\Delta P = 12 \times 10^5 = 1200,000$
$Q = \frac{10 \times 10^{-3}}{60} = 1.67 \times 10^{-4}$

$= \Delta P Q = 200.4$ watts

iii) Shaft Power $= \frac{2\pi N T}{60} = 2 \times \pi \times 1500 \times 12.5$

$= 1964.3 Nm$

iv) Overall Efficiency = $\frac{\text{fluid Power}}{\text{Shaft Power}}$
$= \frac{200.4}{1964.3}$
$= 0.102 = 10.2\%$

2 $87\% = F.P/S.P$
fluid Power $= \Delta P Q$
$P = 100 \times 10^5 N/m^2$
$Q = 35 \times 10^{-3} = 5.83 \times 10^{-4}$
$= 5833.3$ watts

$87\% = \frac{5833.3}{x}$

$0.87 = \frac{5833.3}{x}$

$x = \frac{5833.3}{0.87}$

$= 6705\,Nm$

3 Idea flow rate = normal displacement x speed

$= 50 \times 850 = 42.5\,dm^3/min$

Volumetric efficiency = $\frac{\text{Actual flow}}{\text{Idea flow}} = \frac{35}{42.5}$

$= 0.82 = 82\%$

Fluid Power = $\Delta P Q$

$\Delta P = 100 \times 10^5$

$Q = \frac{50 \times 10^{-3}}{60} = 8.3 \times 10^{-4}$

$\Delta P Q = 8300$

Shaft = 15 Kwatts = 15000

Overall efficiency = $\frac{\text{Fluid Power}}{\text{Shaft Power}}$

$= \frac{8300}{15000} = 0.553 = 55.3\%$

4

6 $h = 20m$

$d = 10cm = 0.1m$

$A = \frac{\pi}{4} d^2 = 0.7854$

$U_F = 0$

$W = ?$

$V_F^2 = U_i^2 - 2gh$

$V_i = \sqrt{V_F^2 + 2gh}$

$V_i = \sqrt{0^2 + 2(9.8m/s^2)(20m)} = 19.80 m/s$

The flow rate is equal to the speed through the area

$Q = UA = (19.80 m/s)(7.854 \times 10^{-3} m^2) = 0.155 m^3/s$

$W = \rho g Q h$

$= (1000) \times (9.8) \times (0.155) \times (20)$

$= 30478 \, kg\,m^2/s^3$

$= 30 \times 10^3 W$

7 $\rho_i g = 19.62 N/m^2$

$C_d = 0.96$

$d_1 = 0.3m$

$d_2 = 0.2m$

$u_1 = Q\, 0.0707$ $u_2 = Q_1\, 0.0314$

$P_1 + \rho_g g z = P_2 + \rho_g g (z_2 + R_F) + \rho_w g R_F$

$P_1 - P_2 = 19.62 (z_2 - z_1) + 587.423$ --- Q_1

For the venturimeter

$$\frac{P_1}{\rho g} + \frac{u_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{u_2^2}{2g} + z_2$$

$P_1 - P_2 = 19.62 (z_2 - z_1) + 0.803 u_2^2$ --- Q_2

Combine Q_1 and Q_2

$0.808U_2^2 = 587.423$

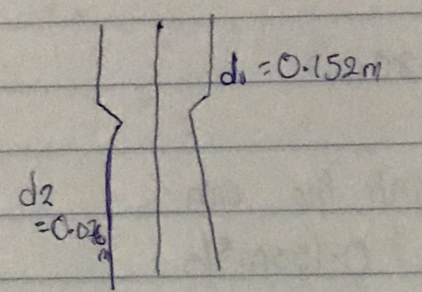
$U^2_{ideal} = 27.047 m/s$

$Q_{ideal} = 27.047 \times \pi \left(\frac{0.2}{2}\right)^2$

$= 0.85 m^3/s$

$Q = C_d Q_{ideal} = 0.96 \times 0.85 = 0.816 m^3/s$

8



$d_1 = 0.152m$ $A_1 = 0.01814M$

$d_2 = 0.076m$ $A_2 = 0.00454M$

$\rho = 800 kg/m^3$

$C_d = 0.97$

Apply Bernoulli method

$$\frac{P_1}{\rho g} + \frac{U_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{U_2^2}{2g} + z_2$$

a) $P_1 = P_2$

$$\frac{U_1^2}{2g} + z_1 = \frac{U_2^2}{2g} + z_2$$

$Q = U_1 A_1 = U_2 A_2$

$U_2 = U_1 \frac{A_1}{A_2} = U_1 4$

$$U_1 = \sqrt{\frac{0.914 \times 2 \times 9.81}{15}}$$

$= 1.0934 m/s$

$q = C_d A_1 U_1$

$Q = 0.96 \times 0.01814 \times 1.0934$

$= 0.019 m^3/s$

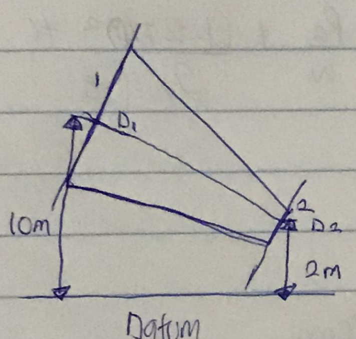
$P_1 - P_2 = 15170$

$$\frac{P_1 - P_2}{\rho g} = \frac{V_2^2 - V_1^2}{2g} - 0.914$$

$$\frac{15170}{\rho g} = Q_2 \frac{(220.43^2 - 55.11^2)}{2g} - 0.914$$

$$Q = 0.035 m^3/s$$

9



At section 1

$D_1 = 0.3m$

$A = \frac{\pi (0.3)^2}{4} = 0.707 m^2$

$Z_1 = 10m$

$V_1 = ?$

$P_1 = 400 \times 10^3 N/m^2$

At section 2

$D_2 = 0.15m$

$Area = \frac{\pi \times (0.15)^2}{4} = 0.1767 m^2$

$Z_2 = 6m$

$V_2 = ?$

$P_2 = ?$

$A_1V_1 = A_2V_2 = 40\text{litre/sec} = 40 \times 10^{-3} m/sec$

$$V_1 = \frac{40 \times 10^{-3}}{0.707}$$

$$= 0.566 m/s$$

$$V_2 = \frac{40 \times 10^{-3}}{0.01767}$$

$$= 2.264 m/s$$

Apply Bernoulli's method

$$\frac{400 \times 10^3}{9800} + \frac{(0.556)^2}{2 \times 9.8} + 10 = \frac{P_2}{W} + \frac{(1.274)^2}{2 \times 9.8} + 6$$

$$P_2 = 436.8 \, kN/m^2$$

10 Reading of the manometer $= 170mm$
Specific gravity of mercury $Sh_1 = 13.6$
Specific gravity of water $S_1 = 1.026$

$$h = y\left[\frac{Sh_1}{S_1} - 1\right]$$

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

$$h = 2.083$$

Velocity of submarine

$$V = \sqrt{2gh}$$

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

$$= 6.39 m/s$$