CHIOKE VICTOR U.P.
18/ENG02/031
COMPUTER ENGINEERING
ENG 214 ASSIGNMENT

1. Volumetric flow rate
changing from dm^3/min to m^3/min
Since $10dm = 1m$
$\therefore 10^3 dm^3 = 1m^3$
$1000 dm^3 = 1m^3$
$10 dm^3 = ?$
$? = \frac{10}{1000} = 0.01 m^3/min$

Actual flow rate $= \frac{0.01}{60} = 1.67 \times 10^{-4} m^3/sec$

Speed = 1500 rev/min
changing to rps

$= \frac{1500}{60} = 25$ rev./sec

$\partial P = 12 \text{ bar} = 12 \times 10^5 N/m^2$

Nominal displacement $= 10 cm^3/rev$
Since $100^3 cm^3 = 1m^3$
then $10cm^3 = x$
$\therefore x = \frac{10}{100^3} = 1 \times 10^{-5} m^3/rev$

a) Ideal flow rate = Nominal Disp. X Speed
$= 1 \times 10^{-5} \times 25$
$= 2.5 \times 10^{-4} m^3/sec$

a) Volumetric Efficiency = $\frac{\text{Actual flowrate}}{\text{Ideal flow rate}} \times 100\%$

$= \frac{1.67 \times 10^{-4}}{2.5 \times 10^{-4}} \times 100\% = 66.8\%$

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

$= 1.67 \times 10^{-4} \times 12 \times 10^{5} = 200.4$ Watts

c) Shaft Power = $T \cdot \omega$

$T = 12.5$ Nm

$\omega = 2 \times \frac{22}{7} \times 25 = 157.14$ rad/sec.

Shaft Power = $12.5 \times 157.14 = 1964.25$ Watts

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

$= \frac{200.4}{1964.25} \times 100 = 10.2\%$

2. Since Overall Efficiency = $\frac{P_F}{P_S} \times 100$

We first calculate P_F

Volumetric flow rate

Since $1000\,dm^3 = 1m^3$

$\therefore\ 35\,dm^3 = ?$

$? = \frac{35}{1000} = 0.035 m^3/min$

Actual flow rate $= \frac{0.035}{60} = 5.83 \times 10^{-4}\ m^3/sec$

$\therefore P_F = Q \times \partial P$

$\partial P = 100bar = 100 \times 10^5 N/m^2$

$\therefore P_F = 5.83 \times 10^{-4} \times 100 \times 10^5$
$= 5830$ watts

$87\% = \frac{5830}{P_s} \times 100\%$

$87\% = \frac{583000\%}{P_s}$

$P_s = \frac{583000}{87} = 6701.15$ watts

3. Actual flow rate $= 35\ dm^3/min$
changing to m^3/min
Since $1000 dm^3 = 1 m^3$
$35 dm^3 = ?$
$? = \frac{35}{1000} = 0.035\ m^3/min$

Nominal displacement $= 50 cm^3/rev$
changing to m^3/rev
Since $100^3 cm^3 = 1 m^3$
$50 cm^3 = ?$
$\therefore ? = \frac{50}{100^3} = 5 \times 10^{-5}\ m^3/rev$

Changing Speed to rps

$\frac{850}{60} = 14.17$ rev/sec.

$\therefore$ Ideal flow rate $= 5\times10^{-5} \times 14.17 = 7.085\times10^{-4}$ m³/s

Volumetric Efficiency $= \frac{A_{FR}}{I_{FR}} \times 100\%$

$A_{FR} = \frac{0.035}{60} = 5.83\times10^{-4}$ m³/sec

$V_E = \frac{5.83\times10^{-4}}{7.085\times10^{-4}} \times 100\% = 82.3\%$

Overall Efficiency $= \frac{P_F}{P_S} \times 100\%$

$P_F = Q \times \partial P$
$= 5.83\times10^{-4} \times 100\times10^{5} = 5830$ watts

$P_s = 15$ KW $= 15000$ watts

$\therefore$ Overall Efficiency $= \frac{5830}{15000} \times 100\%$

$= 38.87\%$

4. Z ~~= 2400 cm = 24 m~~ = 24000 cm = 240 m

$Q = 13$ lit/sec $\equiv 0.013 \, m^3/sec$

$V_j = 66 \, m/s$

$$P = \rho g Q \left(\frac{P}{\rho g} + \frac{v^2}{2g} + Z \right)$$

$$P = QP + \frac{\rho Q v^2}{2} + \rho g Q z$$

Bringing in power of jet at this point

Pressure head will be = 0 $ $Z = 0$

$$\therefore P = \frac{\rho Q . v^2}{2}$$

i $P = \frac{1000 \times 0.013 \times 66^2}{2} = 28.314 \, KW$

ii) P ~~at~~ from resevoir $= \rho g Q Z$

$= 1000 \times 9.81 \times 0.013 \times 240 = 30.607 \, KW$

iii) Firstly finding power loss in transmission

$30.607 - 28.314 = 2.2932 \, KW = 2293.2$

$$h = \frac{\text{Power loss}}{\rho g Q}$$

$$= \frac{2293.2}{1000 \times 9.81 \times 0.013} = 17.98 \, m$$

iv) Efficiency $= \frac{P_{jet}}{P_{resevoir}} \times 100\%$

$= \frac{28.314}{30.607} \times 100\% = 92.5\%$

5. Sp. gravity of Oil = 0.89
Z = 30,000 = 300m
Q = 200 lit/sec = 0.22 m^3/sec
V = 7m/s
making both P and Z = 0 like before

i) $P = \frac{\rho Q v^2}{2}$

=

Since $S_g = \frac{x}{1000}$ $x = 0.89 \times 1000 = 890$

$\rho = x = 890$

$\therefore$ $P = \frac{890 \times 0.22 \times 7^2}{2}$ = ~~4.79~~ 4797.1 watts

ii) Power from resevoir $= \rho g Q Z$
~~P = 576239.4 Watts~~
P = 890 × 9.81 × 0.22 × 300 = 576239.4 Watts

iii) Finding power loss in transmission,
576239.4 − 4797.1 = 571442.3 Watts

$$h = \frac{571442.3}{890 \times 9.81 \times 0.22} = 297.5\,m$$

iv) $$\text{Efficiency} = \frac{P_{jet}}{P_{reservoir}} \times 100\%$$

~~= 4797~~

$$= \frac{4797.1}{576239.4} \times 100\% = 0.83\%$$

6. $h = 20m$

$d = 10cm = 0.1m$

$A = \frac{\pi \cdot (0.1^2)}{4} = 7.854 \times 10^{-3}$

$v_f = 0$

$W = ?$

$v_f^2 = v_i^2 - 2gh$

$v_i = \sqrt{v_f^2 + 2gh}$

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

Flow rate $Q = 19.80 \times (7.854 \times 10^{-3}) = 0.1555 m^3/s$

Using this we find W

$W = \rho g Q h$

$= 1000 \times 9.8 \times 0.1555 \times 20$

$= 30478 \ kgm^2/s^3$

7. $\rho_g g = 17.62$

$C_d = 0.96$

$d_1 = 0.3$

$d_2 = 0.2$

$u_1 = Q/0.0707 \quad u_2 = Q/0.0314$

~~$P_1 \ \rho_g$~~ g

~~ρ_g~~

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18/ENG02/031
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ENG 2~~1~~4

7. For the manometer,

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

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

For the venturimeter

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

$$P_1 - P_2 = 19.62(z_2 - z_1) + 0.8034u_2^2$$

Combining eqn. 1 and 2

$$0.8034u_2^2 = 587.423$$

$$u_{2ideal} = \sqrt{\frac{587.423}{0.803}} = 27.047 m/s$$

$$Q_{ideal} = 27.047 \times \frac{\pi \times 0.2^2}{4} = 0.85 m^3/s$$

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

8. $d_{vertical} = 0.152$

$d_{throat} = 0.076$

$R.d = 0.8$

~~Recall that~~

$C_d = 0.91$

Using Bernoulli's eqn.

$$\frac{P_1}{\rho g} + \frac{v_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{v_2^2}{2g} + Z_2$$

Remember that

$Q = A_1 V_1$, $Q = A_2 V_2$

$$A_2 = \frac{\pi \times 0.076^2}{4} = 4.64 \times 10^{-3} m^2$$

$$A_1 = \frac{\pi \times 0.152^2}{4} = 0.0181 m^2$$

Since $P_1 - P_2 = 15170$

and $Z_1 - Z_2 = 0.914$

$$\therefore \frac{P_1 - P_2}{\rho g} = \frac{v_2^2 - v_1^2}{2g} - 0.914$$

Since $Q = AV$

$\therefore V = \frac{Q}{A}$

$$\therefore \frac{P_1 - P_2}{\rho g} = \frac{\left(\frac{Q}{A_2}\right)^2 - \left(\frac{Q}{A_1}\right)^2}{2g} - 0.914$$

$$\frac{15170}{800 \times 9.81} = \frac{Q^2\left[\left(\frac{1}{4.64 \times 10^{-3}}\right)^2 - \left(\frac{1}{0.0181}\right)^2\right]}{2g} - 0.914$$

$$1.933 + 0.914 = \frac{Q^2(46447.68 - 3052.4)}{19.62}$$

$$55.86 = 43395.28 Q^2$$

~~$Q^2 = 43395.28$~~

$$Q^2 = \frac{55.86}{43395.28}$$

$$Q = \sqrt{1.287 \times 10^{-3}}$$

$$= 0.035 \, m^3/s$$

9. $d_1 = 300mm = 0.3m$

$d_2 = 150mm = 0.15m$

$A_1 = \frac{\pi \times 0.3^2}{4} = 0.07069m^2$

$A_2 = \frac{\pi \times 0.15^2}{4} =$ ~~0.177m²~~ $0.0177m^2$

$Q = \frac{40 \text{ lit/sec}}{1000} = 0.04 m^3/sec$

$Z_1 = 10m, \quad Z_2 = 6m$

$P_1 = 400kN/m^2$

$P_2 = ?$

Finding V_1 and V_2

$V_1 = \frac{Q}{A_1} = \frac{0.04}{0.07069} = 0.57 m/s$

$V_2 = \frac{Q}{A_2} = \frac{0.04}{0.0177} = 2.26 m/s$

Using Bernoulli's eqn. you can say that

$$\frac{P_2}{\rho g} = \left(\frac{P_1}{\rho g} + Z_1 + \frac{V_1^2}{2g}\right) - \left(\frac{V_2^2}{2g} + Z_2\right)$$

$$\frac{P_1}{\rho g} + (Z_1 - Z_2) + \left(\frac{V_1^2}{2g} - \frac{V_2^2}{2g}\right).$$

$$\frac{400}{9.81} + 4 + \left(\frac{0.57^2 - 2.26^2}{19.62}\right) = \frac{P_2}{9.81}$$

$$\frac{P_2}{9.81} = 40.77 + 4 - 0.2438$$

$$\frac{P_2}{9.81} = ~~44.526~~ \; 44.5262$$

$$P_2 = ~~436.74~~ \; 436.8\,kN$$

10. Manometer reading = 170mm = 0.17

Sp. gravity of Hg = 13.6
" " " seawater = 1.026

$y = 0.17$

$$h = y\left(\frac{S_{hl}}{S_L} - 1\right)$$

$$= 0.17\left(\frac{13.6}{1.026} - 1\right)$$

$$= 2.083m$$

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

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

$$V = \sqrt{40.81}$$

$$V = 6.4 m/s \equiv 23.04 km/hr$$

~~Converting to km/hr~~