ELIKWU Emmanuel 18/ENG06/021 MECHANICAL ENGINEERING

1 Real flowrate = 10dm³/min T = 12.5Nm.

$= \frac{10 \times 10^{-3}}{60} = 1.67 \times 10^{-4} m^3/s$.

Pressure = 12 bar = $12 \times 10^6 N/m$.

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

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

Ideal flowrate = Nominal displacement × speed

$= 1 \times 10^{-5} \frac{m^3}{rev} \times 25$ rev/sec

$= 2.5 \times 10^{-4} m^3/sec$

i) Volumetric efficiency = $\frac{\text{Real flowrate}}{\text{Ideal flowrate}} \times 100\% = \frac{1.67 \times 10^{-4}}{2.5 \times 10^{-4}} \times 100\%$

= 66.8%

ii) Fluid power = Q.dp

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

= 200.4 watts.

iii) Shaft power = T·ω

$\omega = 2\pi N = 2 \times \pi \times N$

$= 2 \times \pi \times 25$

= 157.0796

≃ 157.08

∴ shaft power = 12.5 × 157.08

= 1963.5 watts

(2) Overall efficiency = 87% = $\frac{f.p}{s.p}$

$S.p = \frac{f.p}{87\%} = \frac{\Delta p \times Q}{87\%} = \frac{100 \times 10^5 \times 5.833 \times 10^{-7}}{0.87}$

= 67 watts

3 nominal displacement = $50cm^3$ x rev
D_p = 100bar
Shaft power = 15KW = 150000watt
Actual flow rate = 35dm³/min
Speed rotation = 850 r.p.m

Volumetric efficiency = $\frac{\text{Actual flow}}{\text{Ideal flow}} = \frac{\text{Actual flow}}{\text{nominal disp} \times \text{speed}}$

$= \frac{35}{850 \times 50}$ dm³/min ÷ cm³/min

$\frac{35}{42.5} = 0.82$ or 82%

4 Power of Jet = $\frac{1}{6} \rho v^2 a$

$= 1/6 \frac{\times 1000}{9.81} \times 66^2 \times 0.13 = 28862$ kg/sec

$= 28862 \times 9.81 = 283140$ watt

ii At reservior pressure is atmospheric and velocity of jet surface equal zero; p=0, v=0

Power supplied from reservoir = $\rho Qgz = rQz$

$= 1000 \times 0.13 \times 240$

$= 31200$ kgm/sec

$= 31200 \times 9.81 = 306072W$

$= 306.072$ KW

iii) H_r = Total head at reservior
HJ = total head at the Jet
h = head loss in transmission

a_1 = Power supplied from reservoir = $rQH_1 = 3200$ kgm/sec
b = Power of issuing Jet = $rQH_2 = 28862$ kgm/sec

Power lost in transmission = Vah = a-b = 2338 kgm/sec
head loss in pipe = h = power lost/ra

$h = 2338/(1000 \times 0.13)$

$= 17.98m$

$40000 = 416.67Q + 0.0625Q^2$

$0.0625Q^2 + 416.67Q - 40000 = 0$

$Q^2 + 666671Q - 610,000 = 0$

$Q = 9465$ ft/day

5. $\rho = 890 kg/m^2$

$h = 300 m$

$Q = 220 m/s$ 0.22 m^3/s

$v = 7 m/s$

I) Power Jet $= \frac{1}{2}\rho Q v^2 = \frac{1}{2} \times 890 \times 0.24 \times 7^2$

$= 4.7979$ watt

II) Power supplied from reservoir $= P = wQH$

$= 890 \times 9.81 \times 0.22 \times 300$

$= 576239.4 W$

6) $P = \rho g Q Z$

$Z = 20 m$

$\rho = 1000$

$g = 9.81$

$Q = VA$

$d = 10cm = 10 \times 10^{-2} m$

$A = \frac{\pi d^2}{4} = 7.85 \times 10^{-3} m^2$

But we need the velocity at height of Initial velocity. Using one of the equation of motion,

$v^2 = u^2 - 2gh$

$u = \sqrt{v^2 + 2gh}$

$u = \sqrt{0^2 + 2 \times 9.81 \times 20}$

$u = \sqrt{392.4}$, $u = 19.809 \simeq 19.81 m/s$

the velocity = 19.81

$Q = VA$

$= 19.81 \times 7.85 \times 10^{-3}$

$= 0.15558 m^3/s$

$\simeq 0.156 m^3/s$

Then

$P = \rho g Q Z$

$= 1000 \times 9.81 \times 0.156 \times 20$

$P = 30510.2677$ watts

$\simeq 30.5$ Kilowatts

10) Reading of manometer = 170mm

= 0.17m

Specific gravity of mercury = 13.6

Seawater = 1.026

$y = 0.17m$

for $h = y\left(\frac{s_{1}}{s_{L}} - 1\right)$

$= 0.17\left(\frac{18.6}{1.026} - 1\right)$

$= 0.17 \times 12.255$

$= 2.0834m$

Recall $V = \sqrt{2gh}$

$V = \sqrt{2 \times 9.81 \times 2.0834}$

$V = \sqrt{40.87}$

$V = 6.393m/s$

(9) $\frac{P_1}{\rho g} + z_1 + \frac{V^2}{2g} = \frac{P_2}{\rho g} + z_2 + \frac{V_2^2}{2g}$