~~red~~ white = 16
blue = 6
36

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mechanical Engineering

ENG214

Assignment

main assignment

1) Flow rate $= 10\,dm^3/min$

$10\,dm = 1\,m$

$10^3\,dm^3 = 1\,m^3$

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

$10\,dm^3 = x$

$x = \frac{10}{1000}$

Volumetric flowrate $x = 0.01\,m^3/min$

Actual flowrate $= 0.01\,m^3/min$

m^3/min to m^3/sec

$= \frac{0.01}{60}$ ~~60s~~ $60\,sec = 1\,min$

$Q = 1.67 \times 10^{-4}\,m^3/sec$

Speed (N), $= 1500\,rev/min$

$= \frac{1500}{60}$

$= 25\,rev/sec$

Pressure (P) $= 12\,bar$

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

$12\,bar = x$

$x = 1200000\,N/m^2$

~~Norma~~

Nominal displacement $= 10\,cm^3/rev$

$100\,cm = 1\,m$

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

$10\,cm^3 = x$

$x = \frac{10}{1000\,000}$

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

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

Ideal flowrate = Nominal displacement × speed

$= 1 \times 10^{-5} \times 25$

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

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

$= 66.8\%$

Fluid Power (Pf) = Q · ∂P (Q: Actual flow rate; ∂P: change in Pressure)

$= 1.67 \times 10^{-4} \times 1200000$

$= 200.4$ watts or Nm/sec

Shaft Power = T · ω (T: Torque input; ω: angular speed)

$T = 12.5Nm$
$w = 2\pi N$

$w = 2 \times \pi \times 25 = 157.08 rad/sec$

Shaft Power $= 12.5 \times 157.08$
$= 1963.5 watts$

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

$= \frac{2004}{1963.5} \times 100\%$

$= 10.2\%$

2) flow rate $= 35 dm^3/min$
$10 dm = 1 min$
$10^3 dm^3 = 1m^3$
$1000 dm^3 = 1m^3$
$35 dm^3 = x$
$x = \frac{35}{1000}$
$x = 0.035 m^3/min$

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

Pres
Nom
over
S
f

Pressure change(∂P) = 100bar

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

$100 bar = x$

$x = 10000000 N/m^2$

~~nominal displacement~~ =

overall Efficiency = 87%

Shaft Power = ~~T×ω~~

fluid Power (P_f) = $Q \cdot \partial P$

$= 5.83 \times 10^{-4} \times (10000000)$

$= 5830$ watts or Nm/sec

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

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

Shaft Power = $\frac{5830 \times 100}{87}$

$= 6701.15$ watts or ~~Nm/sec~~

3) nominal displacement = $50 cm^3/rev$

$100 cm = 1 m$

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

$50 cm^3 = x$

$x = \frac{50}{1000000}$

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

Pressure = 100 bar

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

$100 bar = x$

$x = 10000000 N/m^2$

Shaft power = 15 kwatts

= 15,000 watts

Actual flow rate = $35 dm^3/min$

$10 dm = 1 m$

$10^3 dm^3 = 1 m^3$

$1000 dm^3 = 1 m^3$

$35 dm^3 = x$

$x = \frac{35}{1000}$

$x = 0.035 m^3/min$

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

Speed (N) = 850 rev/min

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

Ideal flow

volumetric

Fluid

Shaf

Over

Ideal flowrate = Nominal displacement × speed

$= 5\times10^{-5} \times 14.17$

$= 7.085\times10^{-4}\ m^3/sec$

Volumetric efficiency $= \dfrac{\text{Actual flow rate}}{\text{Ideal flow rate}} \times 100$

$= \dfrac{5.83\times10^{-4}}{7.085\times10^{-4}} \times 100\%$

$= 82.29 = 82.3\%$

Fluid Power $= Q \times \delta P$

$= 5.83\times10^{-4} \times 10000000$

$= 5380$ watt so Nm/sec

~~Shaft Power = Fxb/S~~

Overall efficiency $= \dfrac{\text{Fluid Power}}{\text{Shaft Power}} \times 100\%$

$= \dfrac{5380}{15000} \times 100$

$= 38.9\%$

$= 38.9\%$

4) water Level $Z = 2,4000cm$

$Z = 24,000cm$

$100cm = 1m$

$Z = \frac{24000}{100}$

$Z = 240m$

volumetric flow rate $Q = 13$ Litres/sec

$1000 Litres = 1m^3$

$Q = \frac{13}{1000}$

$Q = 0.013 m^3/sec$

Velocity of jet = 66m/sec

i) The jet issuing from the nozzle will be at atmospheric pressure and at datum level, hence

$P = 0$ \$ $Z = 0$

Density of water $= 1000 kg/m^3$

$P = 0$ \$ $Z = 0$

$$P = 0 \cdot Q + \frac{\rho Q v^2}{2} + \rho g \cdot Q \cdot 0$$

$$P = \frac{\rho Q \cdot v^3}{2}$$

$$= \frac{1000 \times 0.013 \times (66)^3}{2}$$

$= 28314$ watts

$= 28.314$ kilo watts

Power of Jet $= 28.314 kW$

ii) Power supplied from a reservoir at atmosperic pressure $P = 0$ & $V = 0$

$$P = 0 \cdot Q + \rho \cdot Q \cdot (0)^2 \div 2 + \rho g Q z$$

$$P = \rho g Q z$$

$= 1000 \times 9.81 \times 0.013 \times 240$

$= 30607.2$ watts

$= 30.6072$ kilowatts

iii) Head used to overcome losses

Power loss in transmission = Power of Reservoir − Power of Jet

$= 30.6072 - 28.314$

~~= 22932 wa~~

$= 2293.2$ watts

$$\text{Head loss} = \frac{\text{Power Lost in transmission}}{\rho g Q}$$

$$= \frac{2293.2}{1000 \times 9.81 \times 0.013}$$

$h = 17.982m$

iv) Efficiency of the pipeline and nozzle in transmitting operation

$$\text{Efficiency} = \frac{\text{Power of Jet}}{\text{Power of reservoir}} \times 100\%$$

$$= \frac{28311}{30607.2} \times 100\%$$

$$= 92.5\%$$

5) Specific gravity of oil = 0.89

Water Level Z = ~~30rre~~ 30,000cm

$Z = 30,000$

$100cm = 1m$

$$Z = \frac{30000}{100}$$

$Z = 300m$

volumetric flow rate, $Q = 220$ Litres/sec

1000 Litres $= 1m^3$

$$Q = \frac{220}{1000}$$

$Q = 0.22 m^3/sec$

velocity of Jet = 7m/sec

Density of ~~water~~ oil $= 0.89 \times 1000$

$= 890 kg/m^3$

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iii)

iii)

~~The Jet issuing from the nozzle~~

i) Power of jet $= \frac{\rho Q \cdot V^2}{2}$

$= \frac{890 \times 0.22 \times (7)^2}{2}$

$= 4797.1$ watts

$= 4.7971$ kilowatts

ii) power supplied from reservoir

$P = \rho g Q z$

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

$P = 576239.4$ watts

$P = 576.2394$ kilo watts

~~iii) Head Loss in b~~

iii) Head used to overcome Lossess

Power Loss in transmission = Power of reservoir − Power of jet

~~$= 576.2394 -$~~

$= 576239.4 - 4797.1$

$= 571442.3$ watts

Head Loss $= \frac{\text{Power Lost in tramission}}{\rho g q}$

$= \frac{571442.3}{890 \times 9.81 \times 0.22}$

$h = 297.503m$

v) Efficiency of the Pipeline and nozzle in transmitting operation

$$\text{Efficiency} = \frac{\text{Power of jet}}{\text{Power of reservoir}} \times 100\%$$

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

$$= 0.832\ \%$$