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MATRIC NO: **18/ENG05/004**

DEPT: **MECHATRONICS ENG**

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18/ENG08/004

i) Actual flow rate = $10 dm^3/min$

$10 dm = 1 m$

$dm^3 = m^3$

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

$1000 dm^3 = 1 m^3$

$10 dm^3 = x$

Volumetric flow rate =

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

Actual flow rate = $0.01 m^3/min$

m^3/min to m^3/sec

$60 sec = 1 min$

$= \frac{0.01}{60}$

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

Speed, N = $1500 rev/min$

$= \frac{1500}{60}$

$= 25 rev/sec$

$= 25 rps$

Pressure = 12 bar

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

$12 bar = x$

$x = 12 \times 10^5 N/m^2$

$\partial P = 12 \times 10^5 N/m^2$

Nominal displacement = $10 cm^3/rev$

$100 cm = 1 m$

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

$10 cm^3 = x$

$x = \frac{10}{1,000,000}$

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

Ideal flow rate = nominal × speed displacement

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

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

i) Volumetric efficiency = $\frac{\text{Actual flow rate}}{\text{Ideal flow rate}} \times 100\%$

$= \frac{1.67 \times 10^{-4}}{8.5 \times 10^{-4}} \times 100\%$

$= 66.8\%$

ii) $P_P = Q \cdot \partial P$

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

$= 200.4$ watts or Nm/sec

Shaft power $= T \cdot \omega$

where T = torque input (Nm)

ω = angular speed (rad/s)

$T = 12.5$ Nm

$\omega = 2\pi N$ for rps

$\omega = \frac{2\pi N}{60}$ = rpm

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

Shaft power $= 12.5 \times 157.14$

$= 1964.25$ Watts

iii) Overall efficiency =

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

$= \frac{200.4}{190.3} \times 100\% = 10.2\%$

~~1) A pump delivers 35 dm³/~~

2) $\partial P = 100$ bar

1 bar $= 10^5$ N/m²

$\partial P = 100 \times 10^5$ N/m²

Actual flow rate, $Q = 35$ dm³/min

$= \frac{35}{1000 \times 60}$ to m³/sec

$= 5.83 \times 10^{-4}$ m³/sec

$P_I = Q \cdot \partial P$

$= 5.83 \times 10^{-4} \times 100 \times 10^5$

$= 5830$ watts

Overall efficiency $= \frac{\text{Fluid power} \times 100\%}{\text{Shaft power}}$

Shaft power $= \frac{\text{Fluid power} \times 100\%}{\text{Overall efficiency}}$

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

Shaft power $= 6.701 \times 10^3$ watts

3)

Nominal displacement = 50cm³/rev

$x = \frac{50}{1,000,000}$

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

Actual flow rate = 35 dm³/min

$= \frac{35}{1000 \times 60}$

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

$\partial P = 100 bar$

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

$P_F = Q \cdot \partial P = 5.83 \times 10^{-4} \times 100 \times 10^5 = 5830\ N$

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

$= \frac{5830}{15,000} \times 100$

Overall efficiency = 38.87%

Ideal flow rate = nominal × speed displacement

~~Speed~~

Speed, N = 850 rpm

$= \frac{850}{60}$

$= 14.17 rps$

Ideal flow rate = $5 \times 10^{-5} \times 14.17$

$= 7.085 \times 10^{-4}\ m^3/sec$

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

$= \frac{5.83 \times 10^{-4}}{7.085 \times 10^{-4}} \times 100\%$

Volumetric efficiency = 82.29% or 82.3

4) Z = 2,4000cm

100cm = 1m

$Z = \frac{2,4000}{100}$

Z = 240m

Volumetric flow rate, $Q = 13\,lit/sec$

1000 litres = $1 m^3$

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

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

Velocity of jet = 66 m/sec

The jet issuing from the nozzle will be at ~~[illegible]~~ atmosphere pressure and at datum level, hence

$P = 0$ and $z = 0$

Density, ρ for water, 1000 kg/m³

Introducing $P = 0$ and $z = 0$ into eqn (3)

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

Eqn (4) becomes

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

$= \frac{1000 \times 13 \times 10^{-3} \times (66)^2}{2}$

$= 283.14$ watts

$P = 28.314$ Kwatts

Power supplied from a reservoir.

ii) For a become the reservoir operations at an atmospheric pressure $P = 0$ and $V = 0$

Introducing $P = 0$ and $V = 0$ into eqn (4)

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

$P = \rho g Q z$

$= 1000 \times 9.81 \times 13 \times 10^{-3} \times 240$

$= 30607.2$ watts

$P = 30.6072$ Kwatts.

iii) Power loss in transmission

= Power of reservoir − Power of jet

= 30607.2 − 283.14

= 2293.2 watts

Head loss in pipeline

$h = \frac{\text{Power lost in transmission}}{\rho g Q}$

$= \frac{2293.2}{1000 \times 9.81 \times 13 \times 10^{-3}}$

$h = 17.982m$

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

$= \frac{28{,}314}{30607.2} \times 100\%$

$\varepsilon = 92.5\%$