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Fluid Mechanics · Assignment

flowrate (Q) = 10dm³/min
Pressure change (ΔP) = 12bar
Speed(N) = 1500rpm
Nominal displacement = 10Cm³/rev
Torque Input (T) = 12.5N-m

i) Ideal flow rate = Nominal Displacement X Speed
= 10Cm³/rev X 1500 rmp
= 15000cm³/min = 15dm³/min

Volumetric efficiency = Actual flow / Ideal flow
= 10/15 = 0.6667 or 66.67 %

ii) $Q = \frac{10 \times 10^{-3}}{60}$ m³/sec = 16.7×10^{-5} m³/sec

$\Delta P = 12 \times 10^{5}$ N/m²

fluid power = ΔP x Q = 16.7×10^{-05} m³/sec x 12×10^{5} N/m² = 200 watts

Shaft power = $\frac{2\pi NT}{60} = \frac{2\pi \times 1500 \times 12.5}{60}$
= 1963.5 watts

Overall efficiency = F.P/S.P = 200/1963.5
= 0.102 or 10.2%

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Flowrate (Q) = 35 dm^3/min
Pressure change (ΔP) = 100bar
Overall efficiency = 87%

Shaft Power = $\frac{2\pi NT}{60}$

fluid = $\Delta P \times Q$

$Q = \frac{35 \times 10^{-3}}{60}$ m^3/sec

$= 58.3 \times 10^{-5}$ m^3/sec

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

fluid power
$= 58.3 \times 10^{-5} \times 100 \times 10^5$
$= 5830$ watts

Overall Efficiency = $\frac{\text{fluid power}}{\text{shaft power}}$

$0.87 = \frac{5830}{\text{shaft power}}$

Shaft power = $\frac{5830}{0.87}$ = 6701.14 watts

Nominal displacement = $50cm^3/sec$
Pressure Charge(ΔP) = 100bar
Shaft power = 15 Kilowatts = 1000
Overall Efficiency = ??
Volumetric Efficiency = ??
Flowrate (Q) = $35dm^3/min$
Speed(N) = 850 rpm

Ideal flowrate = Nominal displacement × speed
= $50cm^3/rev$ × 850 rmp
= $42500 cm^3/min$ = $42.5 dm^3/min$

Volumetric efficiency = Actual flow / Ideal flow
= 35/42.5 = 0.8235 or 82.35 %

(ii) $Q = \frac{35 \times 10^{-3}}{60} m^3/sec = 58.3 \times 10^{-5} m^3/sec$

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

Fluid power = ΔP × Q = $58.3 \times 10^{-5} m^3/sec \times 100 \times 10^5$
= 5830 watts

Shaft power = 1500 watts

Overall efficiency = $\frac{\text{fluid power}}{1500} = \frac{5830}{1500}$ = 0.3886 or 38.86%
38.86%

$H = 240m$
$Q = 0.013 m^3/s$
$v = 66 m/sec$

a) Power of jet (P_{jet}) $= \frac{1}{2} mv^2_{jet}$

$= \frac{1}{2} \rho Q v^2_{jet}$

$= \frac{1}{2} \times 1000 \times 0.013 \times 66^2$ watt

$= 28314$

$= 28.314$ kilo watts

b) Power supplied by reservoir (P_{res}) $= mgh$

$= \rho Q g h$

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

$= 30.6072$ kilowatts

c) Head used to overcome losses ($H - H_f$) $= H - \frac{v^2_{jet}}{2g}$

$= 240 - \frac{60^2}{2 \times 9.81}$

d) Efficiency of pipeline & nozzle $= \frac{P_{jet}}{P_{res}} \times 100$

$= \frac{28.314}{30.6072} \times 100$

$Z_1 = 30,000cm - 300m$
$Q_1 = 220$ litres/s $= (220 \times 10^{-3})\ m^3/s$
$V_2 = 7m/s$

Power of Jet $= \rho g QH$
Where $\rho = 0.89 \times 1000 = 890kg/m^3$
$g = 9.81m/s^2$
$Q = (220 \times 10^{-3})m^3/s$

$H = Z_2 + \frac{P}{\rho g} + \frac{v^2}{2g}$

$H = 0 + \frac{0}{\rho g} + \frac{(7)^2}{2 \times 9.81}$

$H = 49/19.62 = 2.497J$
Power $= 890 \times 9.81 \times 220 \times 10^{-3} \times 2.497$
$= 4797.1$ watts

(iii) Head used to overcome the loss = Power loss / $\rho g Q$
$= (576239.4 - 4797.1)/(100 \times 9.81 \times 220 \times 10^{-3})$
$= 571442.3/2158.2$
$= 264.7772681$

(iv) Efficiency = $\frac{\text{Power of Jet}}{\text{Power of resovoir}} \times 100$

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

$= 0.83248386\%$

Power supplied from reservoir

$H = Z_1 + \frac{P}{\rho g} + \frac{v^2}{2g} = 300 + 0 + 0$

$= 300J$

~~Power supplied from reservoir~~
~~$H = Z_1 + \frac{P}{\rho g} + \frac{v^2}{2g} = 300 + 0$~~

Power $= 890 \times 9.81 \times 220 \times 10^{-3} \times 300$
$= 576239.4kgm/sec$

Power = workdone / time

work done = mgh / time

v = velocity of stream

ρ = density of water (1000kg/m³)

$m = \rho \times v$

$v = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 20}$

$= 19.7989 m/s$

$P = \frac{\rho \pi r^2 v gh}{t}$

$Power = 1000 \frac{kg}{m^3} \times \left(\frac{10 \times 10^{-2}}{2}\right) \times 19.7989 m/s \times 9.8 m/s^2 \times \frac{m}{\pi}$

$= 1000 \times \pi \times 2.5 \times 10^{-3} \times 19.7989 \times 9.8 \times 20$

$= 30478.03 w$

Power = 30478.03 N

Diameter (D) = 0.3m

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

$A_1 = 0.070686 m^2$

Throat diameter (D_2) = 0.2m

$A_2 = \frac{\pi}{4} \times (0.2)^2$

$A_2 = 0.031416 m^2$, coefficient of discharge (cd) = 0.96

Specific weight of gas (γ) = 19.62 N/m^3

∴ density of gas (S_g) = $\frac{19.62}{9.81}$

$S_g = 2 kg/m^3$

Piezometric head difference (h) = $x\left(\frac{S_m}{S_g} - 1\right)$

$= 0.06 \times \left(\frac{1000}{2} - 1\right)$

$h = 29.94 m$

∴ Volume flow rate (Q) = $Cd \frac{A_1 \cdot A_2 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}}$

$= \frac{0.96 \times 0.070686 \times 0.031416 \sqrt{2 \times 9.81 \times 29.94}}{\sqrt{(0.070685)^2 - (0.03148)^2}}$

$= Q = 0.81599 m^3/s$

A₁ =

A₂ =

(ii) Q

$A_1 = \frac{\pi}{4} D_1^2 = \frac{\pi}{4} (0.152)^2 = 0.018146 m^2$

$A_2 = \frac{\pi}{4} D_2^2 = \frac{\pi}{4} (0.076)^2 = 4.5365 \times 10^{-3} m^2$

(i) $Q = Cd \frac{A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \sqrt{2gh}$

$= \frac{0.97 \times 0.018146 \times 4.5365 \times 10^{-3} \times \sqrt{2 \times 9.81 \times 0.914}}{(0.018146)^2 - (4.5365 \times 10^{-3})^2}$

$Q = 0.01924 m^3/s$

(ii) $h = \left(\frac{P_1 - P_2}{\rho g}\right) = \frac{15170}{0.8 \times 10^3 \times 9.81} = 1.933 m$

$Q = Cd \frac{A_1 A_2}{\sqrt{A_1^2 - A_2^2}} (\sqrt{2gh}$

$Q = \frac{0.97 \times 0.018146 \times 4.5365 \times 10^{-3} \times \sqrt{2 \times 9.81 \times 1.933}}{\sqrt{(0.018146)^2 - (4.5365 \times 10^{-3})^2}}$

$Q = 0.02798 m^3/s$

$d_1 = 300mm$
$= 0.3m$
$A_1 = \pi d^2/4 = \pi(0.3)^2/4$
$= 0.0707m^2$

$d_2 = 150mm = 0.15m$
$A^2 = \pi d^2/4 = \pi(0.15)^2/4 = 0.0177m^2$
$Q = 40 l/s$
$= (40 \times 10^{-3}) m^3/s$

$Z_1 = 10m, \; Z_2 = 6m, \; P_1 = ??, \; P_2 = 400 KN/m^2 = 400,000 N/m^2$
$Q = VA$
$V_1 A_1 = Q \therefore (V_1)(0.0907) = (40 \times 10^{-3})$
$V_1 = (40 \times 10^{-3})/0.0707$
$V_1 = 0.5658 m/s$
$Q = V_2 A_2$
$V_2 (0.0177) = 40 \times 10^{-3}$
$V_2 = (40 \times 10^{-3})/0.077$
$V_2 = 2.2599 m/s$

$$Z_1 + \frac{P_1}{\omega} + \frac{V_2}{2g} = Z_2 + \frac{P_2}{\omega} + \frac{V_2}{2g}$$

$$Z_1 + \frac{P_1}{\rho g} + \frac{V_1^2}{2g} = Z_2 + \frac{P_2}{\rho g} + \frac{V_2^2}{2g}$$

$$0 + \frac{400000}{9 \times 81 \times 1000} + \frac{(0.5658)^2}{2(9.81)} = 6 + \frac{P_2}{9.81 \times 1000} + \frac{(2.2599)}{2.9.81}$$

$$079 = \frac{P_2}{9.81 \times 1000} + 6.260303$$

$$\frac{P_2}{9.51 \times 1000} = 50.79 - 6.26$$

$P_2 (9.81 \times 1000)(44.53)$
$P_2 = 436836.326 N/m^2$
$P_2 = 436.836 KN/m^2$

Co
h=

=

k

Calculate

$h = y\left[\frac{\rho_m}{\rho_f} - 1\right]$

ρ_m = density of mercury
ρ_f → density of flowing fluid
y → monomatric reading

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

$h = 2.0834$

calculate the velocity of the submarine

$V = \sqrt{2gh}$

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

$= 6.393$ m/sec