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Answers

1 Speed of rotation = 1500 rev/min
nominal displacement = 10 cm^3/rev
Torque input = 12.5 Nm
rate = 10 dm^3/min

Solution

Ideal flow rate = nominal disp × Speed
=> 10 × 1500 = 15000 cm^3/min

Volumetric efficiency = $\frac{\text{Actual flow}}{\text{Ideal flow}}$

$= \frac{10}{15} = 0.67 = 67\%$

$Q = (10 \times 10^{-3}) \div 60 \, m^3/s = 16.7 \times 10^{-6} m/s$

$\Delta p = 12 \times 10^5 \, N/m^2$

ii) Fluid power = $Q\Delta p$
$= 16.7 \times 10^{-6} \times 12 \times 10^5 = 20.04$ watts

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

$= \frac{2\pi \times 1500 \times 12.5}{60} = 1963.5$ Nm

iv) Overall Efficiency = $\frac{\text{Fluid Power}}{\text{shaft power}}$

$= \frac{20.04}{1963.5}$

2] delivers 35 dm^3/min
pressure change = 100 bar
efficiency = 88%
shaft power = $2\pi NT/60$

Fluid power = $Q\Delta P$
$Q = (35 \times 10^{-3})/60 = 5.8 \times 10^{-4}$
$\Delta P = 100 \times 10^5 \, N/m^2$
Fluid Power = 5800 watts
Efficiency = $\frac{\text{Fluid power}}{\text{Shaft power}}$

$0.88 = \frac{5800}{SP}$

$\therefore SP = \frac{5800}{0.88} = 6590$ Nm

3) Nominal displacement = 50 cm^3/rev
pressure = 100 bar
shaft power = 15 kw
Actual flow rate = 35 dm^3/min
Speed = 850 rpm

Solution

ideal flow rate = 50 × 850 =
volumetric efficiency $= \frac{35}{42.5} = 0.82$

fluid power $= (35 \times 10^{-3})/60 \times 100 \times 10^5$
$= 5.8 \times 10^{-10}$ watts

Overall efficiency $= \frac{5.8 \times 10^{-10}}{15 \times 10^{-3}}$
$= 3.9 \times 10^{-7}$

4 $\rho = 1000\ kg/m^3$

$z = 240m$

$Q = 13 lit/sec = 13 \times 10^{-3}\ m^3/sec$

velocity of jet $= 0.6 m/s$

Since output of pipe is at datum $P = 0$ $z = 0$

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

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

$= 28314$ watts

ii Power supplied through reservoir

substituting $P = 0$ and $v = 0$ in eq 1

$P = \rho g Q z = 1000 \times 9.81 \times 3 \times 10^{-3} \times 240$

$= 30607.2$ watts

iii Head loss $h = \frac{\text{Power lost in trans}}{\rho g Q}$

$$= \frac{(30607.2 - 28314)}{1000 \times 9.81 \times 1.3 \times 10^{-3}}$$

$h = 17.982\ m$

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

5) $Sg = 0.89$

$\rho = 890$

$z = 300$

$Q = 0.22 m^3/sec$

Velocity $= 7 m/s$

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

i) Power of jet $= \frac{\rho Q v^2}{2} = \frac{890 \times 0.22 \times 7^2}{2}$

$= 4797.1$ watts

ii) Power supplied from reservoir

$P = \rho g Q z$

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

$=$ ~~576239.4 watts~~ 576239.4 watts

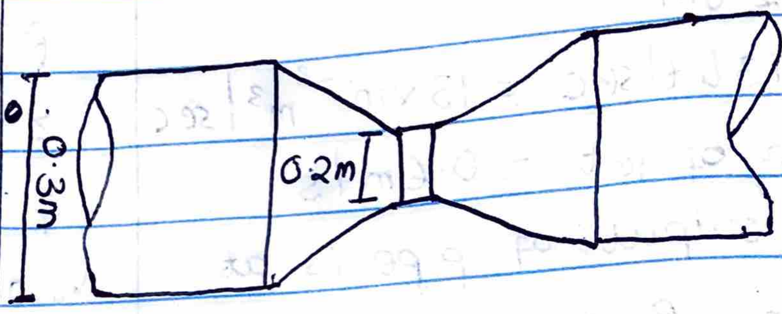
iii) Head loss $h = \frac{\text{Power loss in transmission}}{\rho g Q}$

$=$ ~~576239.4 watts~~

$$= \frac{57629.4 - 4797.1}{0.22 \times 390 \times 9.81}$$

$= 29.75 m.$

7)



Diameter of inlet = 0.3 m

Area of inlet $= \frac{\pi \times 0.3^2}{4} = 0.071 m^2$

Diameter of throat = 0.2m

Area of throat $= \frac{\pi \times 0.2^2}{4} = 0.031 m^2$

Pressure difference on U-tube (y) = 0.06m

Specific weight of gas = 19.62 N/m³

= 0.01962 kN/m³

Specific gravity of gas $= \frac{0.01962}{9.81} = 2 \times 10^{-3}$

Differential reading (h) $= y\left[\frac{SgW}{SgG} - 1\right]$

$= 0.06\left[\frac{1}{2 \times 10^{-3}} - 1\right]$

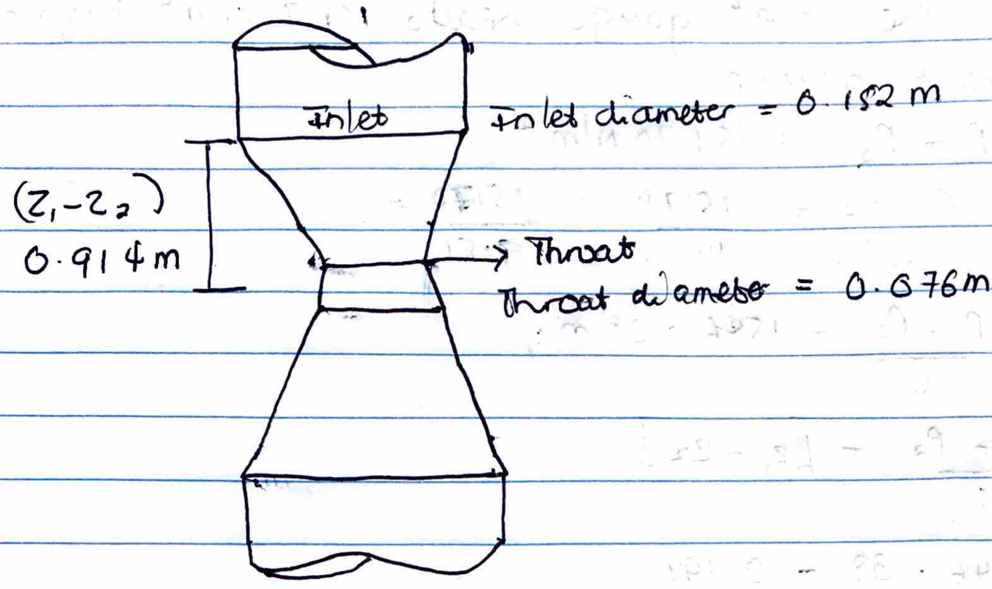
$= 29.94$

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

$$= \frac{0.98 \times 0.071 \times 0.031}{\sqrt{0.071^2 - 0.031^2}} \times \sqrt{2 \times 9.81 \times 29}$$

$= 0.803 m^3/s$

NUMBER 8



Diameter of inlet = 0.152 m

Area of inlet = $\frac{\pi \times 0.152^2}{4} = 0.018\, m^2$

Diameter of throat = 0.076 m

Area of throat = $\frac{\pi \times 0.076^2}{4} = 4.54 \times 10^{-3} m^2$

The differential reading (h) = $\left[\frac{P_1}{w} + Z_1\right] - \left[\frac{P_2}{w} + Z_2\right]$

$= \left[\frac{P_1}{w} - \frac{P_2}{w}\right] - \left[Z_1 - Z_2\right]$

a) When the pressure gauge reading is the same.

i.e $\left[\frac{P_1}{w} = \frac{P_2}{w}\right]$

$h = \left[Z_1 - Z_2\right] = 0.194 m$

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

$= 0.97 \times \frac{0.018 \times 4.54 \times 10^{-3}}{\sqrt{0.018^2 - (4.54 \times 10^{-3})^2}} \times \sqrt{2 \times 9.81 \times 0.194}$

$= 8.88 \times 10^{-3} m^3/s$

b) when the inlet gauge reads 15170 N/m² higher than the throat gauge

$\therefore P_1 - P_2 = 15170 \, N/m^2$

$\Rightarrow \frac{P_1 - P_2}{w} = \frac{15170}{w} = \frac{15170}{9.81} =$

$\Rightarrow \frac{P_1 - P_2}{w} = 1546.38 \, m.$

$h = \frac{P_1 - P_2}{w} - [z_1 - z_2]$

$h = 1546.38 - 0.194$

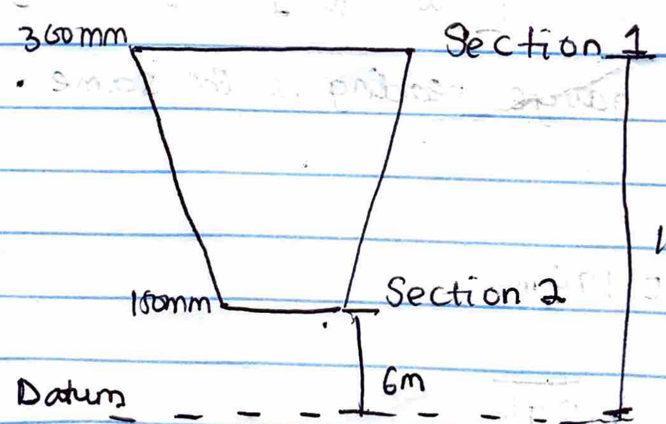
$= 1546.2 \, m$

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

$Q = 0.97 \times \frac{0.018 \times 4.5 \times 10^{-3}}{\sqrt{0.018^2 \times (4.54 \times 10^{-3})^2}} \times \sqrt{2 \times 9.81 \times 1546.2}$

$= 0.793 \, m^3/s$

9)



Section 1

Diameter (d_1) = 300mm

Pressure (P_1) = 40 kN/m²

$z_1 = 10 \, m$

Section 2

Diameter (d_2) = 150mm

Pressure (P_2) = ?

$z_2 = 6 \, m$

Volumetric rate (Q) = 40 lit/sec
$= 0.04 m^3/s$

Recall $Q = A_1 V_1 = A_2 V_2$

But $A_1 = \frac{\pi d_1^2}{4} = \frac{\pi \times 0.3^2}{4} =$

$A_1 = 0.236 m^2$

$\therefore 0.04 = 0.236 \times V_1$

$V_1 = 0.169 m/s$

But $A_2 = \frac{\pi d_2^2}{4} = \frac{\pi \times 0.15^2}{4}$

$= 0.118 m^2$

$V_2 = \frac{0.04}{0.118} = 0.339 m/s$

From Bernoulli's equation

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

$$\frac{400}{9.81} + \frac{0.169^2}{2\times9.81} + 10 = \frac{P_2}{9.81} + \frac{0.339^2}{2\times9.81} + 6$$

$$40.77 + 1.456\times10^{-3} + 10 + \frac{P_2}{9.81} + 5.857\times10^{-3} + 6$$

$$50.771 = \frac{P_2}{9.81} + 6.006$$

$498.064 = P_2 + 58.919$

$439.145 = P_2$

$P_2 = 439.145 kN/m^2$

10) Reading of differential manometer (y) = 0.17m
Specific gravity of mercury = 13.6
Specific gravity of sea water = 1.025

to find head (h) $= 0.17\left[\frac{13.6}{1.025} - 1\right] = 2.09.$

$\therefore$ Velocity of Submarine $= \sqrt{2gh} =$

$\Rightarrow \sqrt{2\times9.81\times2.09} = 6.403 m/s.$