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1.) $L = 2.0m$

$V_1 = 5m/s$ $\quad$ $P_2/\rho g = ?$

$P_1/\rho g = 2.5m$ of liquid

$V_2 = 2m/s$

loss of head $(h_L) = \frac{0.35(V_1 - V_2)^2}{2g}$

$= \frac{0.35(5-2)^2}{2 \times 9.81} = 0.16m$

using bernaullis eqn

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

$\therefore 2.5 \times \frac{5^2}{2 \times 9.81} + 2.0 = \frac{P_2}{\rho g} + \frac{2^2}{2 \times 9.81} + 0 + 0.16$

$2.5 \times 1.27 + 2.0 = \frac{P_2}{\rho g} + 0.204 + 0.16$

$5.77 = \frac{P_2}{\rho g} + 0.364$

$\therefore \frac{P_2}{\rho g} = 5.77 - 0.364 = 5.406m$ of liquid

2.) d inlet $= \frac{20cm}{100} = 0.2m$

a inlet $= \frac{\pi}{4} \times (0.2)^2 = 0.0314m^2$

d throat $= \frac{10cm}{100} = 0.1m$

$a_{throat} = \frac{\pi}{4} \times (0.1)^2 = 7.85 \times 10^{-3} m^2$

ρ for water $= 1000 kg m^3$

$P_1 = 17.658 N/cm^2 = 17.658 \times 10^4 N/m^2$

$\therefore \frac{P_1}{\rho g} = \frac{17.658 \times 10^4}{1000 \times 9.81} = 18 m$ of water

$\frac{P_2}{\rho g} = -30cm$ of mercury

$= -0.3m$ of mercury

$= -0.3 \times 13.6 = -4.08 m$ of water

$\therefore$ Differential head $(h) = \frac{P_1}{\rho g} - \frac{P_2}{\rho g} = 18 + 4.08$

$= 22.08 m$ of water

using discharge equation

$Q = Cd \frac{a_1 a_2}{\sqrt{a_1^2 - a_2^2}} \times \sqrt{2gh}$

$= 0.98 \times \frac{0.0314 \times 7.85 \times 10^{-3}}{\sqrt{0.0314^2 - (7.85 \times 10^{-3})^2}} \times \sqrt{2 \times 9.81 \times 22.08}$

$= 0.98 \times 8.107 \times 10^{-3} \times 20.81$

$= 0.1653 m^3/s = 165.3$ Lit/s

3.) $A_{orifice} = \frac{\pi}{4} \times (15)^2 = 176.714 cm^2$

$A_{pipe} = \frac{\pi}{4} \times (30)^2 = 706.858 cm^2$

$h = \left[\frac{13.6}{0.9} - 1\right] \times 50 cm$ of oil

$= 705.556 cm$ of oil

$$Q = \frac{Cd \times A_0 A_p}{\sqrt{A^2 p - A_0^2}} \times \sqrt{2gh}$$

$$= 0.64 \times \frac{176.714 \times 706.858}{\sqrt{706.858^2 - 176.714^2}} \times \sqrt{2 \times 9.81 \times 705.556}$$

$$= 0.64 \cdot 182.5094 \times 117 \times 65.6$$

$$= 13742.96 cm^3/sec$$

4.) $h = x\left[\frac{Sg}{Sm} - 1\right] = 0.17\left[\frac{13.6}{1.026} - 1\right] = 2.0834m$

using $v = \sqrt{2gh}$

$v = \sqrt{2 \times 9.81 \times 2.034} = 6.393 m/s$

converting to km/hr

$\frac{6.393 \times 60 \times 60}{1000} = 23 km/hr$

5.) Volumetric flow rate

10dm = 1m

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

$1000 dm^3 = 1m^3$

$5 dm^3 = ?$

$? = \frac{5}{1000} = 0.005$

Volumetric flow rate = $0.005 m^3/min$

Actual flow rate = $\frac{0.005}{60} = 8.33 \times 10^{-5} m/sec$

~~Speed = 1700~~

Speed = 1700 rpm

$\frac{1700}{60} = 28.33$ rev/sec

$dP = 15$ bar $= 15 \times 10^5 N/m^2$

Nominal displacement = $10 cm^3/rev$

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

$10\,cm^3 = x$

$x = \frac{10}{100^3} = 1 \times 10^{-5} m^3/rev$

$\therefore$ Ideal flowrate = Nominal × speed

$28.33 \times 1 \times 10^{-5}$

$= 28.33 \times 10^{-4}$

a.) Volume efficiency = $\frac{\text{Actual flowrate}}{\text{Ideal flow rate}} \times 100\%$

$= \frac{8.33 \times 10^{-5}}{2.833 \times 10^{-4}} \times 100$

$= 29.4\%$

b.) Fluid power = $Q \cdot d \cdot P$

$= 8.33 \times 10^{-5} \times 15 \times 10^{5}$

$= 124.95\ Nm/sec$

c.) Shaft power = $T \cdot N$

$T = 15Nm$

$w_0 = 2 \times \frac{22}{7} \times 28.33 = 178.07\ rad/sec$

$\therefore$ Shaft power = $15 \times 178.07 = 2671.05$ watts

) Overall eficiency = $\frac{\text{fluid power}}{\text{shaft power}} \times 100\%$

$= \frac{124.95}{2671.05} \times 100 = 4.67\%$