WAKAMA FESTO NENGI
18/SCI14/025
CIVIL ENGINEERING

1) length of tube $L = 2m$
velocity at smaller end $V_1 = 5m/s$
velocity at larger end $V_2 = 2m/s$
pressure head at smaller end $= \frac{P_1}{\rho g} = 25m$

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

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

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

$\therefore Z = 2m, \ Z_2 = 0$

$\Rightarrow 2.5 + \frac{(5)^2}{2 \times 9.81} + 2 = \frac{P_2}{\rho g} + \frac{2^2}{2 \times 9.81} + 0 + 0.16$

$\Rightarrow 2.5 + 1.27 + 2 = \frac{P_2}{\rho g} + 0.203 + 0.16$

$\frac{P_2}{\rho g} = (2.5 + 1.27 + 2) - (0.203 + 0.16)$

$= 5.77 - 0.363 = 5.407m$ of fluid

2) $D_1 = 20cm$
$A_1 = \pi/4 \times 20^2 = 314.16cm^2$
$D_2 = 10cm$
$A_2 = \pi/4 \times 10^2 = 78.74cm^2$

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

$C_d = 0.96$
$P = 17.658 N/cm^2$
$= 17.658 \times 10^4 N/m^2$

where $\frac{P_1}{\rho g} = \frac{17.658 \times 10^4}{9.81 \times 100} = 18m$ of water

$\frac{P_2}{\rho g} = -30cm$ of mercury
$= -0.3m$ of mercury
$= -0.3 \times 13.6$
$= -4.08$ of water

$h = \frac{P_1}{\rho g} - \frac{P_2}{\rho g}$
$= 18 - (-4.08)$
$= 22.08m$ of water

$Q = \frac{0.98 \times 314.16 \times 78.54 \times \sqrt{2 \times 9.81 \times 22.08}}{\sqrt{(314.16)^2 - (78.74)^2}}$

$Q = 165483.3122 cm^3/s$
$Q = 165.48 l/s$

3) $Q = \frac{C_d A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \times \sqrt{2gh}$

$h = y\left[\frac{S_m}{S_{of}} - 1\right] \Rightarrow \frac{50}{100}\left(\frac{13.6}{0.9} - 1\right)$

$= 7.05m$

$Q = \frac{0.64 \times \pi/4 (0.3)^2 \times \pi/4 \times (0.15^2) \times \sqrt{2 \times 9.81 \times 7.05}}{\sqrt{(\pi/4 (0.3^2))^2 - (\pi/4 (0.15^2))^2}}$

$Q = 0.13742 m^3/sec$

4) $h = y\left(\frac{\rho_m}{\rho_f} - 1\right)$

$= \frac{170}{1000}\left(\frac{13.6}{1.026} - 1\right)$

$h = 2.083m$

v = velocity of submarine

$v = \sqrt{2gh}$

$= \sqrt{2 \times 9.81 \times 2.089}$

$= 6.393 m/s$

5) flowrate (Q) = $50 dm^3/min$

Pressure Change = 15bar

Speed (N) = 1700 rpm

Normal displacement = $10cm^3/rev$

Torque Input (T) = 15Nm

i) Ideal flow rate = Normal displacement x speed

$= 10cm^3/rev \times 1700 rpm$

$= 17000 cm^3/min$

$\rightarrow 0.017 m^3/min$

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

$= 0.05 / 0.017$

$\Rightarrow 2.9411$

or 294.11 %

ii) $Q = \frac{0.05 m^3/sec}{60}$

$= 83.3 \times 10^{-3} m^3/sec$

$\Delta p = 15 \times 10^5 N/m^2$

fluid power = $\Delta p \times Q$

$= 83.3 \times 10^{-3} m^3/sec \times 15 \times 10^5 N/m^2$

$= 1250$ watts

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

$= \frac{2\pi \times 1700 \times 15}{60}$

$= 2670.354$ watts

Overal Efficiency = $\frac{\text{fluid Power}}{\text{Shaft Power}}$

$= \frac{1250}{2670.354}$

Overal efficiency = 46.81%