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18/ENG08/1014
Biomedical Engineering.

1) $L = 20m$
$V_1 = 5m/s$
$P/\rho g = 2.5m$ of liquid
$V_2 = 2m/s$

loss of head $= h_i = \frac{0.35(V_1 - V_2)^2}{2g} = \frac{0.35(5-2)^2}{2g}$

$\Rightarrow \frac{3.15}{2 \times 9.81} = 0.160m$

Pressure head $= \frac{P_2}{\rho g}$

By using bernoulis principle

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

where

$Z_2 = 0$, $Z_1 = 2.0$

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

$\therefore \frac{P_2}{\rho g} = (2.5 + 1.274 + 2.0) - (0.204 + 0.16)$

$= 5.41_n$

2) $d_1 = 20cm$
$a_1 = \pi/4 \times (20)^2 + 314.29 cm^2$
at throat
$d_2 = 10cm$
$a_2 = \pi/4 \times 10^2 = 78.57 cm^2$
$D_1 = 17.658 N/cm^2 / 17.658 \times 10^4 N/m^2$
$\rho = 100 kg/m^3$

$\frac{P_1}{\rho g} = \frac{1.7658 \times 10^4}{9.81 \times 1000} = 18m$ for water

$\frac{P_2}{\rho g} = -30mm$ for mercury

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

differential head

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

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

$= 0.98 \times \frac{314.29 \times 78.57}{\sqrt{(314.29)^2 - (78.57)^2}} \times \sqrt{2 \times 9.81 \times 22.08}$

$= 1655.18$ //

3) Diameter of orifice

$d_0 = 15cm$

$a_0 = \pi/4 (15)^2 = 176.7cm^2$

Diameter of pipe

$d_1 = 30cm$

$a_1 = \pi/4 (30)^2 = 706.85cm^2$

Sp.gr of oil = 0.9

Reading of different manometer $x = 50cm$ of mmhg (mercury)

Differential head

$h = x\left(\frac{Sg}{So} - 1\right) = 50\left[\frac{13.6}{0.9} - 1\right]$ cm of oil

$= 50 \times 14.11 = 705.5cm$

$Cd = 0.64$ //

Computer

$Q = \frac{Cd \cdot a_1 a_2}{\sqrt{(a_1)^2 - (a_2)^2}} \times \sqrt{2gh}$ (Rate of flow)

$= \frac{0.64 \times 176.7 \times 706.85}{\sqrt{(176.7)^2 - (706.85)^2}} \times \sqrt{2 \times 9.81 \times 705.5}$

$= \frac{9404631.783}{684.40} = 137414.25 cm^3/s$

$Q = 137.414$ litre/s

f) Manometer reading = 200mmHg

specific gravity of mercury = $S_{Hg} = 13.6$

specific gravity of water = 1.026

$h = x\left[\frac{S_{Hg}}{S_L} - 1\right] = x$

$= 0.7\left[\frac{13.6}{1.026} - 1\right] = 2.083$ m

Velocity of submarine

$v = \sqrt{2gh}$

$= \sqrt{2 \times 9.81 \times 2.083}$

$= \sqrt{40.87} m/s$

$= 6.394 m/s$