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1) $V_1 = 5\,m/s$ $V_2 = 2\,m/s$

Smaller end = 2.5m $L = 2.0$

$$h_1 = \frac{0.35(v_1 - v_2)^2}{2g}$$

$L = t_1 - t_2 = 2m$

$$\frac{P_1}{w} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{w} + \frac{V_2^2}{2g} + Z_2$$

$$\frac{P_2}{w} = \frac{P_1}{w} + \frac{1}{2g}(V_1^2 + V_2^2) + (Z_1 - Z_2)h$$

$$= 2.5 + \frac{(5^2 - 2^2)}{2 \times 9.81} + 2 - \frac{(0.35(5-2)^2)}{2 \times 9.81}$$

$$= 2.5 + 1.07 + 2 - 0.16055$$

$P_2 = 5.409$ bar

Pressure at lower end = 5.409 bar

2) Inlet diameter = ~~200m~~ ~~200~~ 20 cm

Throat diameter = 10 cm

$Cd = 0.98$

Initial, $P_1 = 17.658\,N/cm^2$

$$A_1 = \frac{\pi d^2}{4} = \frac{1}{4} \times (20/100)^2 \times \pi$$

$$= 0.0314\,m^2$$

$$A_2 = \frac{\pi d^2}{4} = \frac{1}{4} \times (10/100)^2 \times \pi$$

$$= 7.85 \times 10^{-3}\,m^2$$

If $y = 30cm$ (0.3m of mercury)

$P_1 = 17.658$

$$= \frac{17.658}{1000} = 1.765 \times 10^{-3}\,N/m$$

$$\frac{P_1}{w} = \frac{1.7658 \times 10^{-3}}{9.81} = 1.8 \times 10^{-4}\,m$$

$$\frac{P_2}{w} = 0.3 \times 13.6 = 4.08$$

$$h = \frac{P_1}{w} - \frac{P_2}{w} = 1.8 \times 10^{-4} - (-4.08)$$

$$= 4.08018\,m$$

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

$$Q = 0.98 \times \frac{0.0314 \times 7.85 \times 10^{-3}}{\sqrt{0.0314 \times 7.8 \times 10^{-3}}} \times \sqrt{2 \times 9.81 \times 4.08}$$

$$= 0.070\,m^3/s$$

3) $D_1 = 15cm$ $D_2 = 30cm$

50cm = 0.5m of mercury

$S.G = 0.9$ $Cd = 0.64$

$$A_1 = \frac{\pi d^2}{4} = \frac{1}{4} \times (15/100)^2 \times \pi$$

$$= 0.6176m$$

$$A_2 = \frac{\pi d^2}{4} = \frac{1}{4} \times (30/100)^2 \times \pi$$

$$= 0.0706m$$

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$h = y\left(\frac{13.6}{0.9} - 1\right)$

$= 0.50\left(\frac{13.6}{0.9} - 1\right) = 7.055$

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

$= 0.64 \times \frac{(0.0176 \times 0.0706)}{\sqrt{(0.0176)^2 - (0.0706)^2}} \times \sqrt{2 \times 9.81 \times 7.055}$

$= 2.83 \times 10^{-3}$ m

4) Orifice diameter = 15cm

Pipe diameter =

1700mm of mercury = 0.17

S. G of mercury = 18.6

S. G of sea water = 1.026

$h = y\left(\frac{\text{S.G of mercury}}{\text{S.G of sea water}} - 1\right)$

$h = 0.17\left(\frac{18.6}{1.026} - 1\right)$

$= 2.083$

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

$= 6.39$ m/s

5) $Q = 0.65\ dm^3/min$

$= 8.33 \times 10^{-5}\ m^3/s$

Speed of rotation = 1700 rev/min

= 28.3 rev/s

Nominal ~~Normal~~ displacement = $10\ cm^3$/rev

$= 10^{-5}\ m^3$/rev

Torque Input = 15 Nm

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

Ideal Flowrate = Nominal displacement × speed rotation

$= 10^{-5} \times 28.3$

$= 2.83 \times 10^{-4}\ m^3/s$