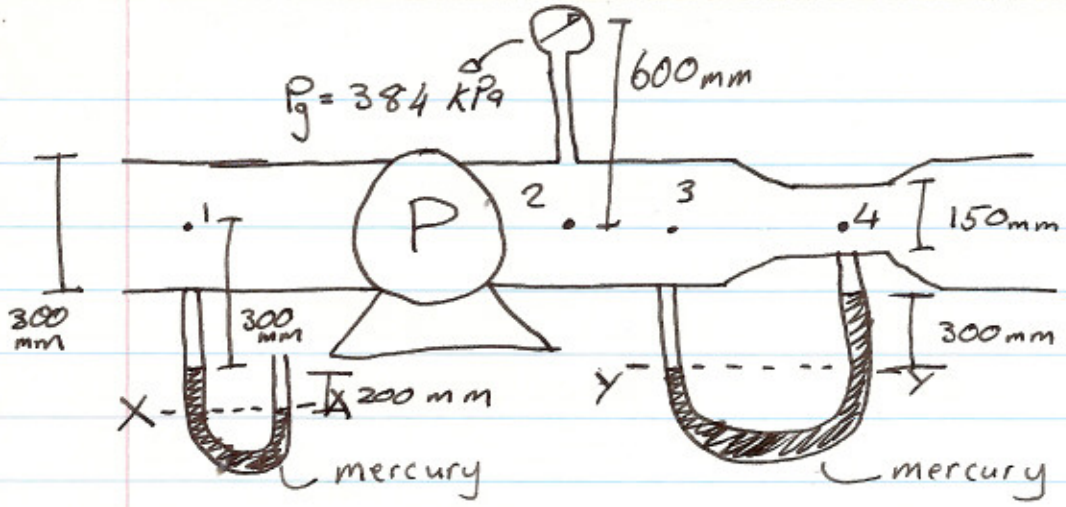


SG mercury = 13.6

LHS: $P_{x-x} = P_1 + \rho gh + 13.6\rho gh'$; $h = 0.300\ m$

RHS: $P_{x-x} = 0$ $\quad h' = 0.200\ m$

$P_{x-x} = P_{x-x}$

$\therefore P_1 + 1000 \times 9.81 \times 0.300 + 13.6 \times 1000 \times 9.81 \times 0.200 = 0$

$\therefore \underline{P_1 = -29626.2\ Pa} \rightarrow$

$P_{gauge} = P_2 - \rho gh$; $\quad h = 0.600\ m$

$\therefore P_2 = P_{gauge} + \rho gh$

$= 384000 + 1000 \times 9.81 \times 0.600$

$= \underline{389886\ Pa} \rightarrow$

$\underline{P_2 = P_3} \rightarrow$

LHS: $P_{Y-Y} = P_3 + \rho g\alpha + \rho gh$

RHS: $P_{Y-Y} = P_4 + \rho g\alpha + 13.6\rho gh$

$\therefore P_3 + \cancel{\rho g\alpha} + \rho gh = P_4 + \cancel{\rho g\alpha} + 13.6\rho gh$

$\therefore 389886 + 1000 \times 9.81 \times 0.300 = P_4 + 13.6 \times 1000 \times 9.81 \times 0.300$

$\therefore \underline{P_4 = 352804.2\ Pa} \rightarrow$

$$Q_1 = Q_2 = Q_3 = Q_4 \Rightarrow V_3 = V_4 \left(\frac{D_4}{D_3}\right)^2$$

$$\therefore H_3 = H_4$$

$$\therefore \cancel{z_3}^{0} + \frac{P_3}{\gamma} + \frac{V_3^2}{2g} = \cancel{z_4}^{0} + \frac{P_4}{\gamma} + \frac{V_4^2}{2g}$$

$$\therefore \frac{389886}{9810} + \frac{\left[V_4 \cdot \left(\frac{D_4}{D_3}\right)^2\right]^2}{2g} = \frac{352804.2}{9810} + \frac{V_4^2}{2g}$$

$$\therefore 39.7437\ m + \frac{V_4^2}{2\times 9.81} \times \frac{1}{16} = 35.9637\ m + \frac{V_4^2}{2\times 9.81}$$

$$\therefore 39.7437 - 35.9637 = \frac{V_4^2}{19.62} - \frac{V_4^2}{313.92}$$

$$\therefore \sqrt{3.78\ m \times \frac{2616}{125}} = V_4$$

$$\therefore \underline{V_4 = 8.8943\ m/s}$$

$$\therefore \underline{V_3 = 2.2236\ m/s} \quad (= V_2)(= V_1)$$

$$H_1 + h_p = H_2$$

$$\cancel{z_1}^{0} + \frac{P_1}{\gamma} + \cancel{\frac{V_1^2}{2g}}^{0} + h_p = \cancel{z_2}^{0} + \frac{P_2}{\gamma} + \cancel{\frac{V_2^2}{2g}}^{0}$$

$$\therefore h_p = \frac{P_2 - P_1}{\gamma}$$

$$= \underline{42.7637\ m}$$

$$Q = vA$$

$$= 8.8943 \text{ m/s} \times \frac{\pi \times 0.150^2}{4}$$

$$= 0.1572 \text{ m}^3/\text{s}$$

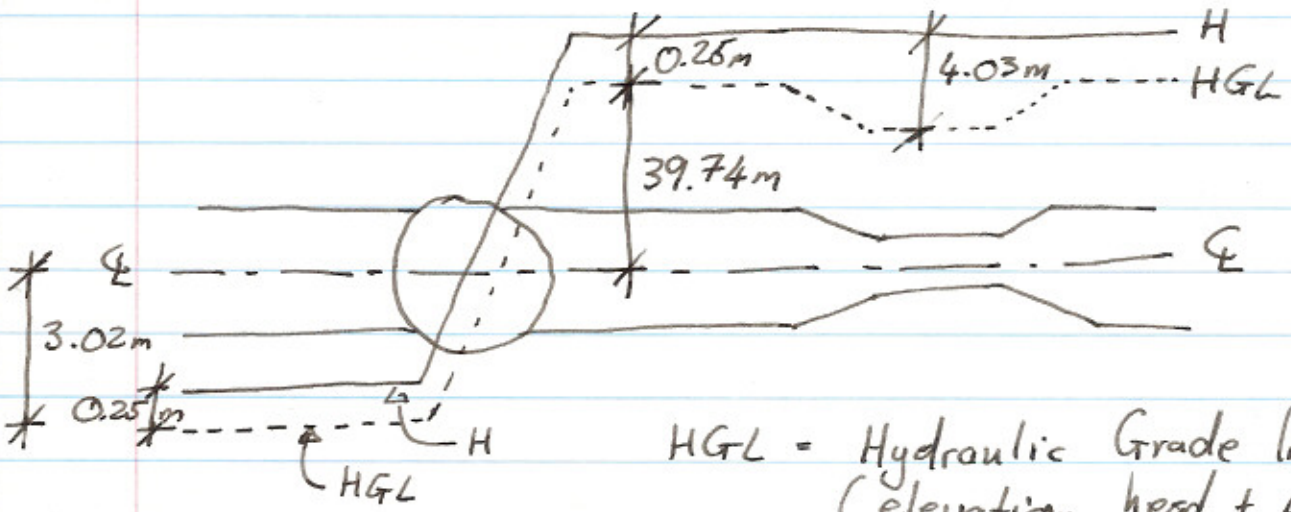
$$\therefore \text{Power} = \rho g Q \Delta H \quad ; \quad \Delta H = h_p$$

$$= 1000 \times 9.81 \times 0.1572 \times 42.7637$$

$$= ~~65.9~~ \; 65947.27 \text{ W}$$

$$= 65.95 \text{ kW}$$

Energy Lines:



HGL = Hydraulic Grade line
(elevation head + pressure head)