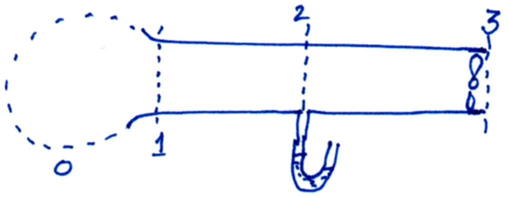
1

- Storms is due to depression in pressure. Hence in any cavities filled with air if present, air will expand, pushing out air and raising the water level. Low pressure itself may lead to raising of level, if connected to high pressure region far away. Higher level of water is easier to pump.
- Since water is pushed out of cavities, the water at the bottom of the well is stirred and the old stagnant water with putroid smell enters the well proper.

2

Perform energy balance between 0 and 2:



$$\frac{V_2^2 - V_1^2}{2} + \frac{p_2 - p_1}{\rho} + \hat{W}_s = 0$$

No pumps etc. in this section. $V_1 \simeq 0$.

Hence $\frac{p_2 - p_1}{\rho} = -\frac{V_2^2}{2}$; $V_2 = \sqrt{\frac{1000 \times 9.81 \times 0.01}{1.18} \times 2} = \underline{12.89 \, m/s}$

Perform now energy balance between 2 & 3: $V_2 \simeq V_3$

$$\frac{p_3 - p_2}{\rho} + \hat{W}_s = 0; \quad -\hat{W}_s = \frac{98.1}{1.18} = 83.13$$

$$\dot{m} = \rho_2 \times \dot{Q}_2 = \rho_2 \times \frac{\pi d^2}{4} V_2 \simeq 1.18 \times \frac{\pi \times 0.4^2}{2} \times 12.89 = 1.911 \, kg/s.$$

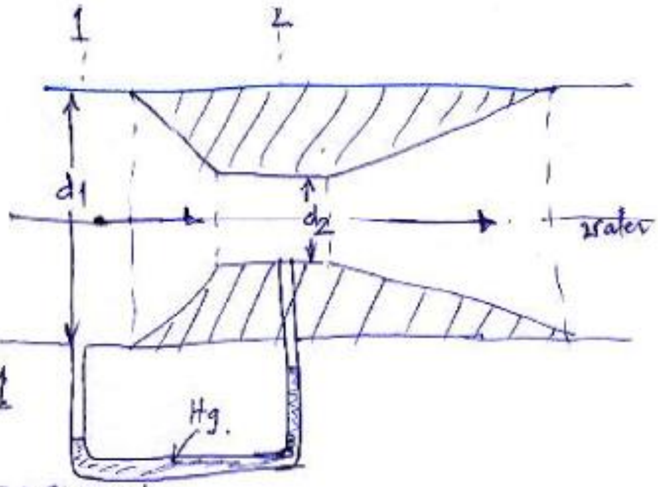
$$-W_s = 83.13 \times \dot{m} = \underline{\underline{158.8 W}} \quad [\simeq 0.21 \, hp]$$

3

Solution:

Bernoulli between 1&2.

Neglect friction.



$$\frac{V_2^2 - V_1^2}{2\beta} + \frac{p_2 - p_1}{\rho_w} = 0$$

If flow is turbulent, $\beta = 1$

$$V_1 = \frac{Q}{\pi d_1^2/4} = \frac{0.1/60}{\pi \times 0.05^2/4} = 0.8488 \text{ m/s.}$$

Mass Balance gives: $V_1 d_1^2 = V_2 d_2^2$; $V_2 = V_1\left(\frac{d_1}{d_2}\right)^2 = \frac{V_1}{\alpha^2}$

Substituting in Bernoulli:

$$V_1^2\left(\frac{1}{\alpha^4} - 1\right) = \frac{2\Delta P}{\rho_w} \Rightarrow V_1 = C_D\sqrt{\frac{2\Delta P}{\rho_w\left(\frac{1}{\alpha^4}-1\right)}}$$

C_D is the coeff. of discharg

$$Q = (\pi d_1^2/4) \, . \, V_1$$

Use the original equation:

$$\frac{\hat{V}_2^2 - \hat{V}_1^2}{2} + g(z_2 - z_1) + \int_1^2 d\left(\frac{p}{\rho}\right) + \hat{Q} + \left(\hat{U}_2 - \hat{U}_1\right) = 0$$

Between entrance and exit, $V_2 = V_1$, $z_2 = z_1$, and $\hat{Q}$ (adiabatic). P = constant (water). Hence $\hat{U}_2 - \hat{U}_1 = (p_1 - p_2)/\rho = (1000 \,.\, 9.81 \,.\, 0.30)/1000 = 2.943$ J/kg = $C_p \,.\, \Delta T$; Hence $\Delta T = 7 \times 10^{-4}$ °C.