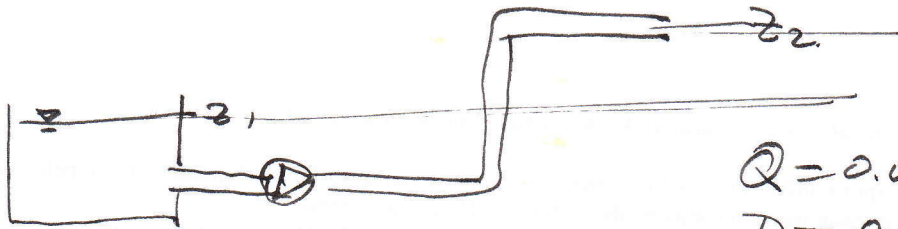


①



$$Q = 0.04 \text{ m}^3/\text{s}$$

$$D = 0.1 \text{ m}, \quad \epsilon = 0.2 \text{ mm}$$

$$L = 40 \text{ m}, \quad z_1 = 10 \text{ m}, \quad z_2 = 20 \text{ m}$$

$$\bar{V} = \frac{4Q}{\pi D^2} = \frac{0.04 \times 4}{3.14 \times 0.1^2} = 5.1 \text{ m/s}$$

$$Re = \frac{\bar{V}D}{\nu} = \frac{5.1 \times 0.1}{10^{-6}} = 5.1 \times 10^5, \quad \epsilon/D = \frac{0.2}{100} = 0.002$$

$$f = 0.024$$

$$\frac{p_1}{\rho g} + z_1 + \frac{V_1^2}{2g} + h_p = \frac{p_2}{\rho g} + z_2 + \frac{V_2^2}{2g} + f \frac{L}{D} \frac{V^2}{2g} + \sum K \frac{V^2}{2g}$$

$$h_p = (z_2 - z_1) + \left(1 + 0.024 \frac{40}{0.1} + 1.3\right) \frac{V^2}{2g}$$

$$= 10 \text{ m} + (1 + 9.6 + 1.3) \frac{5.1^2}{2 \times 9.8} = 25.8 \text{ m}$$

$$\eta = 0.25, \quad P = \rho Q g h_p = 10^3 \times 0.04 \times 9.8 \times 25.8 = 10.1 \text{ kW}$$

$$\eta = 0.5, \quad P_{\text{motor}} = P/\eta = 20.2 \text{ kW}$$

② 设计题. $A = 1.5 \times 0.5 \text{ m}$, $C_d = 0.2$.

$$\bar{V} = 60/3.6 = 16.7 \text{ m/s}, \quad \text{不计损失}$$

$$t = 2 \times 10^5 \text{ km} / 60 \text{ km/hr} = 1.2 \times 10^3 \text{ s}$$

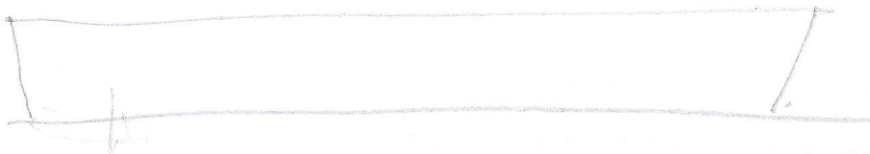
$$F = C_d \left(\frac{1}{2} \rho \bar{V}^2 \right) A = 2 \times \left(\frac{1}{2} \times 1.2 \times 16.7^2 \right) \times 0.5 \times 1.5 = 251 \text{ N}$$

$$P = F \cdot \bar{V} = 251 \times 16.7 = 4.2 \text{ kW}$$

$$\text{能量 } P \cdot t = 4.2 \times 10^3 \times 1.2 \times 10^3 = 5 \times 10^{10} \text{ J}$$

$$\text{1 kWh } L = \frac{5 \times 10^{10} \text{ J}}{1.2 \times 10^7 \text{ J/kWh}} = 862 \text{ kWh}$$

$$= 1.7 \times 10^4 \text{ kWh}$$



$$L = 7\text{m}, D = 0.5\text{m}, V = 6\text{m/s}.$$

$$a) Re = \frac{U \cdot x}{\nu} = 50,000,$$

$$x = \frac{5 \times 10^5 \times 10^{-6}}{6} = \frac{0.5}{6} = 0.083\text{m}.$$

$$b) \text{ TBL from } x=0.$$

$$\delta = \frac{0.38x}{\left(\frac{Ux}{\nu}\right)^{1/5}} = \frac{0.38x^{4/5}}{\left(\frac{U}{\nu}\right)^{1/5}} = 0.080\text{m}$$

$$c) C_d = \frac{0.455}{(\log_{10} Re_L)^{2.58}}$$

$$Re_L = \frac{6 \times 7}{10^{-6}} = 42 \times 10^7 = 7.6$$

$$C_d = 0.0024$$

$$F = C_d \cdot \frac{1}{2} \rho V^2 \cdot \frac{\pi D^2}{8} = \frac{C_d \rho V^2 \pi D^2}{16}$$

$$= 105.7\text{N}$$

$$P = F \cdot V = 634\text{W}$$