

Parameters from Excel

$$\varepsilon := e \quad \varepsilon = 2.718$$

$$v := 0.000000365$$

$$\rho := 972$$

$$g := 9.81$$

Variables from Excel:

$$\text{Internal Diameters} \quad D_{in} := \begin{pmatrix} 6.8 \\ 6.8 \\ 8.8 \\ 10.8 \end{pmatrix}$$

$$D := \frac{D_{in}}{1000}$$

$$D = \begin{pmatrix} 6.8 \times 10^{-3} \\ 6.8 \times 10^{-3} \\ 8.8 \times 10^{-3} \\ 0.011 \end{pmatrix}$$

$$\text{Mass Flow Rates} \quad mf := \begin{pmatrix} 0.024 \\ 0.035 \\ 0.048 \\ 0.13 \end{pmatrix}$$

CALCULATIONS

$$\text{CSA} \quad A := \frac{\pi}{4} D^2$$

$$\text{Volume Flow Rate} \quad Q := \frac{mf}{\rho}$$

$$\text{Velocity} \quad V := \frac{Q}{A}$$

Reynolds Number

$$\text{Re} := \frac{\overrightarrow{(V \cdot D)}}{v}$$
$$\text{Re} = \begin{pmatrix} 1.267 \times 10^4 \\ 1.847 \times 10^4 \\ 1.958 \times 10^4 \\ 4.32 \times 10^4 \end{pmatrix}$$

PROBLEM SECTION

Friction Factor Assume f := 0.02

Given

$$\frac{1}{\sqrt{f}} = -2 \cdot \log \left(\frac{\varepsilon}{3.7} + \frac{2.51}{N_{\text{Re}} \cdot \sqrt{f}} \right)$$

$$\text{Fn}(N_{\text{Re}}) := \text{find}(f)$$

$$N_f := \begin{cases} \text{for } i \in 0..3 \\ \text{Temp}_i \leftarrow \text{Fn}(\text{Re}_i) \\ \text{Temp} \end{cases}$$

$$N_f = \begin{pmatrix} 13.949 \\ 13.947 \\ 13.947 \\ 13.945 \end{pmatrix} \quad \text{f} := N_f$$

Head Loss per metre:

$$H_m := \left[\left(\frac{\overrightarrow{(V \cdot V)}}{D} \cdot 2 \cdot g \right) \cdot f \right]$$
$$H_m = \begin{pmatrix} 1.86 \times 10^4 \\ 3.956 \times 10^4 \\ 2.05 \times 10^4 \\ 5.4 \times 10^4 \end{pmatrix}$$