Paramaters from Excel

$e := 45 \cdot 10^{-6}$ Wrought iron roughness (45 microns, Source: efunda.com)

$\nu := 0.000000365$

$\rho := 972$

$g := 9.81$

Variables from Excel:

Internal Diameters $Din := \begin{pmatrix} 6.8 \\ 6.8 \\ 8.8 \\ 10.8 \end{pmatrix}$

$D := \frac{Din}{1000}$

$D = \begin{pmatrix} 6.8 \times 10^{-3} \\ 6.8 \times 10^{-3} \\ 8.8 \times 10^{-3} \\ 0.011 \end{pmatrix}$ $\varepsilon := \frac{e}{D}$ $\varepsilon = \begin{pmatrix} 6.618 \times 10^{-3} \\ 6.618 \times 10^{-3} \\ 5.114 \times 10^{-3} \\ 4.167 \times 10^{-3} \end{pmatrix}$

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

CALCULATIONS

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

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

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

Reynolds Number

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

PROBLEM SECTION

Friction Factor Assume $f := 0.02$

Given

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

$$Fn(N_{Re}, N_\varepsilon) := \text{Find}(f)$$

$$N_f := \left| \begin{array}{l} \text{for } i \in 0..3 \\ \quad Temp_i \leftarrow Fn(Re_i, \varepsilon_i) \\ Temp \end{array} \right. \qquad N_f = \begin{pmatrix} 0.038 \\ 0.037 \\ 0.035 \\ 0.031 \end{pmatrix} \qquad f := N_f$$

Head Loss per metre:

$$Hm := \overrightarrow{\left[\left(\frac{\overrightarrow{(V \cdot V)}}{D} \cdot 2 \cdot g\right) \cdot f\right]} \qquad Hm = \begin{pmatrix} 51.165 \\ 104.676 \\ 51.009 \\ 120.284 \end{pmatrix}$$

Equations submitted by Mike1984Armstrong

$$Hm := \left(\overrightarrow{\left[\left(\frac{V \cdot V}{D} \cdot 2 \cdot g\right) \cdot f\right]}\right)$$

$$Hm = \begin{pmatrix} 51.165 \\ 104.676 \\ 51.009 \\ 120.284 \end{pmatrix} \qquad \left(\frac{V^2}{D} \cdot 2 \cdot g\right) \cdot f = 327.133$$