ENGR335

Computer Solution to Example 10.6

Calculate the exit velocity for a 100 meter long pipe.

$H := 20 \qquad g := 9.8 \qquad d := 0.5 \qquad \nu := .0000010 \qquad L := 100$ (SI units)

$ks := .000046$

Extended Bernoulli Equation
with f by Haaland Correlation

$$s(x) := \frac{x^2}{2\cdot g}\cdot\left[4\cdot\frac{L}{d}\cdot\left[3.4735 - 1.5635\cdot\ln\left[\left(2\cdot\frac{ks}{d}\right)^{1.11} + 63.635\cdot\frac{\nu}{d\cdot x}\right]\right]^{-2} + 1\right] - H$$

$x := 3$ x is the "guess" for the root solver

$V := \mathrm{root}(s(x), x)$ V is the exit velocity in meters/second

$V = 10.6964$

$$f := 4\cdot\left[3.4735 - 1.5635\ln\left[\left(2\cdot\frac{ks}{d}\right)^{1.11} + 63.635\frac{\nu}{d\cdot V}\right]\right]^{-2}$$ f is the friction factor

$f = 0.0121$

$Re := d\cdot\frac{V}{\nu}$ $\qquad Re = 5.3482 \times 10^6$

Q is the volume flow rate in meters cubed per second

$Q := \frac{\pi}{4}\cdot d^2\cdot V$ $\qquad Q = 2.1002$

Now a program is written to calculate the exit velocity over a range of pipe lengths (L varies from 50 meters to 1000 meters).

$$s(x, L1) := \frac{x^2}{2\cdot g}\cdot\left[4\cdot\frac{L1}{d}\cdot\left[3.4735 - 1.5635\cdot\ln\left[\left(2\cdot\frac{ks}{d}\right)^{1.11} + 63.635\cdot\frac{\nu}{d\cdot x}\right]\right]^{-2} + 1\right] - H$$

$V1(x, L1) := root(s(x, L1), x)$

V1 is a function - where x is the guess and L1 is the pipe length.

$$V2 := \left| \begin{array}{l} \text{for } k \in 0..95 \\ \quad \left| \begin{array}{l} L2 \leftarrow 50 + k \cdot 10 \\ V2_k \leftarrow V1(1, L2) \end{array} \right. \\ V2 \end{array} \right.$$

A for loop is used to calculate velocity for 96 pipe lengths. The guess for each call of function V1 is 1.

$i := 0..95$

$$Q2 := \frac{\pi}{4} \cdot d^2 \cdot V2$$

$L2_i := 0.5 + i \cdot 10$