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Part I

Problem statement

Pipe networks can be analogous to Electrical Circuits. Therefore, it can be tempting to use electrical flow solvers for pipe networks.

1 Unit Comparison

Voltage is energy per unit charge unit wise. $\frac{J}{C}$ Joules per coulomb.

Whereas Pressure can be thought of as Energy per unit volume. $\frac{J}{m^3}$ Joules per meter cubed. That would be the unit of pascals.

$$(workDone)\ Joules = (pressure)\ Pa * (volume)\ m^3$$

$$(pressure)\ Pa = \frac{(workDone)\ Joules}{(volume)\ m^3}$$

Compare this to voltage:

$$(voltage)\ Volts = \frac{(workDone)\ Joules}{(Charge)\ Coulomb}$$

Likewise for volumetric flowrate, this is

$$(flowrate)\ m^3/s = \frac{(vol)\ m^3}{(time)\ s}$$

And for current,

$$(current)\ C/s = \frac{(Charge)\ Coulomb}{(time)\ s}$$

2 nonlinearities in flow resistance

However, the components exhibiting flow resistance often do not obey Ohm's law.

$$electrical\ resistance\ (\Omega) = \frac{V\ (Volts)}{I\ (Ampere)}$$

$$flow\ resistance = \frac{\Delta P\ (Pa)}{\dot{V}\ (m^3)}$$

For ohm's law, the ratio V/I reduces to a constant, but flow resistance often reduces to some expression.

If we were to use Fanning friction factor for pipe (cite perry's handbook)

$$f = \frac{\Delta P}{(\frac{4L}{D})\ \frac{1}{2}\rho u^2}$$

$$\Delta P = f(\frac{4L}{D})\ \frac{1}{2}\rho u^2$$

In Perry's chemical engineering handbook, the formula used for fanning's friction factor by Churchill is:

$$f = 2\left[\left(\frac{8}{Re}\right)^{12} + \left(\frac{1}{A+B}\right)^{3/2}\right]^{1/12}$$

Where:

$$A = \left[2.457 \ln \frac{1}{\left(\frac{1}{(7/Re)^{0.9}} + 0.27\frac{\varepsilon}{D}\right)}\right] \quad ; \; B = \left(\frac{37530}{Re}\right)^{16}$$

$$Re = \frac{ux}{\nu} = \frac{\dot{V}x}{A_{XS}\nu}$$

Where A_{XS} represents cross sectional area. We can see that this is strongly non linear with respect to volumetric flowrate.

Part II

Matrices

$$\begin{bmatrix} 1 & 2 & 3 \\ a & b & c \end{bmatrix}$$