Data Sheet for Fluid Mechanics Course

One atmosphere = 760 mm Hg = 101.3 kN = 14.7 psia

ρ_{H_2O} = 1000 kg m^{-3} = 62.3 lb$_m$/ ; ρ_{Hg} = 13600 kg^{-3} = 845 lb$_m$/ft^3

μ_{H_2O} = 0.001 Pa s = 1cP = 2.09 x 10^{-5}lb$_f$ .s/ft^2

Acceleration due to gravity = 9.81 ms^{-2} = 32.2 fts^{-2} ; g$_c$= 32.2 lbm ft/lb$_f$ s^2

1 ft^3 = 28.1 L = 7.48 gal

1hP = 0.746 kW = 550 ft lb$_f$/s

1ft = 12 in, 1 in = 2.54 mm , 1 m = 100 cm = 1000 mm

Universal gas constant = 10.73 $\frac{(\text{lbf/in}^2)\text{ft}^3}{\text{lbmol.°R}}$; °R = °F + 460 ; K = ℃ + 273

Equations required for problems involving pipe fittings, pipe friction, and entrance and exit losses.

1] Bernoulli's equation:

$$\Delta\left(\frac{p}{\rho} + gz + \frac{V^2}{2}\right) = +\frac{dW_{ao}}{dm} - \mathcal{F}_{tot}$$

$$\mathcal{F}_{tot} = \mathcal{F}_{\text{pipe friction}} + \mathcal{F}_{\text{fittings}} + \mathcal{F}_{enlargement\ and\ contraction}$$

2] Continuity equation: $\dot{m} = \rho AV = \rho Q$

3] Reynolds: $\text{Re} = \frac{\rho VD}{\mu} = \frac{4\rho Q}{\pi\mu D} = \frac{4\dot{m}}{\pi\mu D}$

4] Hagen equation: $Q = \frac{\pi\Delta\mathcal{P}D^4}{128\mu\Delta x}$

5] Friction Losses

- Pipe friction $\mathcal{F}_{\text{Pipe}} = \frac{4f\Delta xV^2}{2D}$
- Entrance losses (Contraction) $\mathcal{F}_{\text{Contraction}} = K\frac{V^2}{2}$; K from chart
- Exit losses (Expansion) $\mathcal{F}_{\text{Expansion}} = K\frac{V^2}{2}$; $K = \left[1 - \left(\frac{D_1}{D_2}\right)^2\right]^2$
- Pipe fittings $\mathcal{F}_{\text{Fittings}} = \frac{4f[\sum nD]V^2}{2D} = 4f[\sum n]\ \frac{V^2}{2}$

6] Friction Factor

- Laminar: $f = \frac{16}{\text{Re}}$
- Turbulent :$f = 0.001375\left[1 + \left(20000\frac{\epsilon}{D} + \frac{10^6}{\text{Re}}\right)^{1/3}\right]$ (or any other convenient method)