

Pipe-Flow Calculations

Total head loss (due to wall friction and minor losses) is

$$h = \left(\lambda \frac{L}{D} + K \right) \frac{V^2}{2g}. \quad (1)$$

The friction factor λ may be specified directly, or, for turbulent flow, computed by solving the Colebrook-White equation:

$$\frac{1}{\sqrt{\lambda}} = -2.0 \log_{10} \left(\frac{k_s}{3.7D} + \frac{2.51}{\text{Re} \sqrt{\lambda}} \right). \quad (2)$$

The variables are:

h = head loss;

λ = Darcy friction factor;

K = minor-loss coefficient;

L = pipe length;

D = pipe diameter;

Q = volumetric flow rate (aka *discharge* or *quantity of flow*);

V = bulk velocity (defined by $V = \frac{Q}{\pi D^2 / 4}$);

g = acceleration due to gravity;

k_s = equivalent sand roughness height;

ν = kinematic viscosity;

Re = Reynolds number (defined here by $\text{Re} = \frac{VD}{\nu}$).

Note that exit to atmosphere is equivalent (as far as the piezometric head is concerned) to a minor loss coefficient of 1.0.