

Metric Flow Equations

$$\text{Velocity: } V = \frac{Q}{A} = \frac{4Q}{\pi D^2} = \frac{1273240Q}{d^2} = \frac{21.22q}{d^2}$$

Where Q is the flow in cubic meters per second; A is the area of the pipe's cross-section in square meters; D is the internal diameter of the pipe in meters; d is the internal diameter of the pipe in millimeters; and q is the flow in liters per minute.

$$\text{Velocity Head: } h_v = \frac{V^2}{2g_c} = 0.05099V^2 = \frac{0.08266Q^2}{D^4} = \frac{22.958q}{d^4}$$

Where V is the flow velocity in meters per second; g_c is the acceleration due to gravity; Q is the flow in cubic meters per second; D is the internal diameter of the pipe in meters; d is the internal diameter of the pipe in millimeters; and q is the flow in liters per minute.

$$\text{Head: } H = \frac{0.102 \text{ kPa}}{\text{sp gr}} = \frac{10.2B}{\text{sp gr}}$$

Where kPa is the pressure in kilopascals, B is the pressure in bars; and sp gr is the density.

$$\text{Power Required: } P = \frac{Q(\text{kPa})}{\text{eff}} = \frac{q(\text{kPa})}{60000 \cdot \text{eff}} = \frac{q(B)}{600(\text{eff})} = \frac{q(H) \text{ sp gr}}{6118(\text{eff})}$$

Where Q is the flow in cubic meters per second; q is the flow in liters per minute; B is the pressure in bars; H is the head in meters of liquid; sp gr is the density; kPa is the pressure in kilopascals; and eff is the efficiency expressed as a decimal.

$$\text{Reynold's Number: } R = \frac{VD}{\nu} = \frac{1000 Vd}{k} = \frac{1273240Q}{Dk} = \frac{21221q}{dk}$$

Where V is the velocity of flow in meters per second; D is the internal diameter of the pipe in meters; ν is the kinematic viscosity in square meters per second; k is the kinematic viscosity in centistokes; Q is the flow in cubic meters per second; q is the flow in liters per minute; and d is the internal diameter of the pipe in millimeters.

$$\text{Darcy's Friction Formula: } H_f = \frac{fLV^2}{2g_c D} = \frac{0.08266fLQ}{D^5} = \frac{22965fLq}{d^5}$$

Where f is the friction factor; L is the length of the pipe in meters; V is the velocity of flow in meters per second; g_c is the acceleration due to gravity; D is the internal diameter of the pipe in meters; Q is the flow in cubic meters per second; q is the flow in liters per minute; and d is the internal diameter of the pipe in millimeters.