INDUSTRY PIPING FORMULAS

**Pressure Rating**

\[ P = \frac{2St}{D-t} \]

\[ S = \frac{P(D-t)}{2t} \]

P is the pressure rating in psi.

S is the Hydrostatic Design Basis (usually 4000 psi) divided by the safety factor (which is 2 for the three standards).

DR is the Dimension Ratio for D2241 and C905 but is OD/t for D1785

*Where:*

P = pressure, psi

S = circumferential stress, psi

D = outside diameter of pipe, inches

d = inside diameter of pipe, inches (average based on mean wall)

t = average wall thickness, inches

**Volume capacity-gallons** per ft. length = \( V_G = V \times 0.004329 \)

**Volume capacity-cubic inches** per ft. length = \( V = 0.7854 \times d^2 \times 12 \)

**Outside pipe surface**, sq. ft per ft. length = \( AO = \frac{D^2 \pi}{12} \)

**Inside pipe surface**, sq. ft. per ft. length = \( A_I = \frac{d \pi}{12} \)

**Cross-sectional plastic area**, sq. in. = \( A = \frac{(D^2 - d^2) \pi}{4} \)

**Cross sectional flow area**, sq. in. = \( A_F = \frac{d^2 \pi}{4} \)

**Weight of PVC pipe**, lb. per ft. length = \( W_{PVC} = 0.632 \times A \)

**Weight of CPVC pipe**, lb. per ft. length = \( W_{CPVC} = 0.705 \times A \)

**Weight of water in pipe**, lb. per ft. length = \( W_w = 0.433 \times A_F \)

**Weight of water filled pipe**, lb. per ft. length = \( W_{WPVC} = W_{CPVC} + W_w \)

**Radius of gyration**, inches = \( r_g = \sqrt{\frac{D^2 + d^2}{4}} \)

**Moment of inertia**, inches fourth = \( I = Ar_g^2 \times 0.0491 \times (D^4 - d^4) \)

**Section modulus**, inches cube = \( Z = \frac{2A}{D} = 0.0982 \times \frac{(D^4 - d^4)}{D} \)

**Thermal Expansion and Contraction**

\[ \Delta L = 12 \gamma L (\Delta T) \]

*Where:*

\( \Delta L \) = expansion or contraction of pipe in inches

\( \gamma \) = Coefficient of thermal expansion

(see PVC or CPVC material Thermal properties)

L = Length of pipe run in feet

\( \Delta T \) = Temperature change °F (Maximum temperature – Temperature @ Installation or maximum system temperature – lowest system temperature, whichever is greater)
Friction Loss (Hazen-Williams equations)

\[ f = 0.2083 \times \left( \frac{100}{C} \right)^{1.852} \times \frac{G^{1.852}}{d^{4.865}} \]

*Where:*

- \( f \) = friction head of feet of water per 100' for the specific pipe size and I.D.
- \( C \) = a constant for internal pipe roughness (=150 for thermoplastic pipe)
- \( G \) = flow rate of U.S. gallons per minute
- \( d \) = inside diameter of pipe in inches

**Water Velocities**

\[ V = 0.3208 \times \frac{G}{A} \]

*Where:*

- \( V \) = velocity in feet per second
- \( G \) = gallons per minute
- \( A \) = inside cross sectional area in square inches

**Gallons Per Minute Through Pipe**

\[ \text{GPM} = 0.0408 \times \text{Pipe Diameter In} \times \text{Pipe Diameter \ } \times \text{Feet Per Minute Velocity} \]

**Pressure Drop in Valves**

\[ P = \frac{G^2 \times S_g}{C_v^2} \]

*Where:*

- \( P \) = Pressure drop in PSI; feet of water = PSI/.4332
- \( G \) = Gallons per minute
- \( S_g \) = Specific gravity of liquid
- \( C_v \) = Gallons per minute per 1 PSI pressure drop (see Valve product Cv from manufacturer)

**Water Conversions**

- 1 foot of head = 0.434 PSI
- 1 gallon = 231 cubic inch = 8.333 pounds
- 1 pound water = 27.7 cubic inches

1 cubic foot water = 7.5 gallon = 62.5 pounds (salt water = 64.3 pounds)
1 miner’s inch = 9 to 12 gallons per minute

\[ \text{Horsepower to Raise Water} = \frac{\text{Gallons Per Minute} \times \text{Total Head in Feet}}{3960} \]