

Useful List of Equivalents (U. S. Customary Units)

1 U.S. gallon of water = 8.33 lbs @ std cond.
 1 cubic foot of water = 62.34 lbs @ std cond. (= density)
 1 cubic foot of water = 7.48 gallons
 1 cubic foot of air = 0.076 lbs @ std cond. (= air density)
 Air specific volume = 1/density = 13.1 cubic feet /lb
 Air molecular weight M = 29
 Specific gravity of air G = 1 (reference for gases)
 Specific gravity of water = 1 (reference for liquids)
 Standard conditions (US Customary) are at
 14.69 psia & 60 DEG F*
 G of any gas = density of gas/0.076
 G of any gas = molecular wt of gas/29
 G of gas at flowing temp = $\frac{G \times 520}{T + 460}$

Flow conversion of gas

$$\text{scfh} = \frac{\text{lbs/hr}}{\text{density}}$$

$$\text{scfh} = \frac{\text{lbs/hr} \times 379}{M}$$

$$\text{scfh} = \frac{\text{lbs/hr} \times 13.1}{G}$$

Flow conversion of liquid

$$\text{GPM} = \frac{\text{lbs/hr}}{500 \times G}$$

*Normal conditions (metric) are at 1.013 bar and 0 DEG. C

& 4 DEG. C water

Note: Within this control valve handbook, the metric factors are at 1.013 bar and 15.6°C.

Universal gas equation

$Pv = mRTZ$ Where P = press lbs/sq ft v = volume in ft ³ m = mass in lbs R = gas constant = $\frac{1545}{M}$ T = temp Rankine Z = gas compressibility factor = Z	Metric P = Pascal v = m ³ m = kg R = gas constant = $\frac{8314}{M}$ T = temp Kelvin
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Gas expansion $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$
(perfect gas)

Velocity of sound C (ft/sec)

$$C = 223 \sqrt{\frac{k(T + 460)}{M}}$$

where T = temp DEG F
 M = mol. wt
 k = specific heat ratio Cp/Cv

Velocity of Sound C (m/sec)

$$C = 91.2 \sqrt{\frac{k(T + 273)}{M}}$$

where T = temp DEG C
 M = mol. wt
 k = specific heat ratio Cp/Cv

References

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6. "Flow Characteristics for Control Valve Installations," H. W. Boger, ISA Journal, October 1966.
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8. ANSI/ISA S75.01, Flow Equations for Sizing Control Valves.
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10. IEC 534-2-2, 1980, Sizing Equations for Compressible Flow Under Installed Conditions.