Weight of gas

The weight of any gas can be expressed as a function of its density and volume as

$$W = \rho g V \tag{1}$$

where in imperial units:

W is the weight of the gas (lb_f)

ρ is the density (lb_m/ft^3)

V is the volume of the gas (ft^3)

g = is the acceleration of gravity, or 32.2 (ft/s^2)

The density of a gas can be expressed as

$$\rho = \frac{P(MW)}{RTZ} \tag{2}$$

Where in imperial units:

P is the gas pressure (psia)

MW is the gas molecular weight (--) air has a MW of 28.964

R is the universal gas constant 10.732(psia)(ft^3)/(lbmol)(^oR)

T is the absolute gas temperature (^oR)

Z is the gas compressibility factor (--)

Example

Calculate the weight of air in an 10.7 ft^3 tank assuming temperature is 60 ^oF.

Solution:

For air the gas compressibility is a function of pressure and temperature. At 1515 psia (104.5 bar) and 60 ^oF (60+460=520 ^oR), the gas compressibility is 0.993. See http://www.engineeringtoolbox.com/ideal-gas-law-d_157.html to determine the compressibility of air.

The air density can then be calculated as

$$\rho = \frac{P(MW)}{RTZ} = \frac{1514.7(psia)(28.964)}{10.732\frac{(psia)(ft^3)}{(lbmol)(^oR)}520(^oR)0.993} = 7.92\frac{lb_m}{ft^3} \tag{3}$$

Substituting the air density (3) into (1) gives

$$W = \rho g V = 7.92\frac{lb_m}{ft^3}32.2\frac{ft}{s^2}10.7\,ft^3\frac{1lb_f s^2}{32.174lb_m} = 84.8lb_f$$

There are 379.5 scf of air per lb_m of air so this would equate to 32,174 scf of air.