

Ideal-Gas / Van der Waals Equation of State

Van der Waals equation:

$$\left(P + \frac{a}{v^2}\right)(v - b) = RT$$

where v ($= 1/\rho$) is the specific volume.

If a and b are both zero the equation of state reduces to the ideal-gas equation:

$$p = \rho RT$$

Note that R , a , b are in mass units and are related to the corresponding molar units (denoted by a^*) by:

$$R = \frac{R^*}{M}, \quad a = \frac{a^*}{M^2}, \quad b = \frac{b^*}{M}$$

a and b are related to the critical temperature and pressure by

$$P_c = \frac{1}{27} \frac{a}{b^2}, \quad T_c = \frac{8}{27} \frac{a}{Rb}$$

or, conversely,

$$a = \frac{27}{64} \frac{R^2 T_c^2}{P_c}, \quad b = \frac{1}{8} \frac{R T_c}{P_c}$$

The variables are:

P = pressure;

T = temperature;

ρ = density;

v = specific volume ($= 1/\rho$);

M = molar mass;

R = gas constant;

a , b = Van der Waals constants.