

The RG model: The RG (Real Gas) model uses the generalized compressibility chart to extend the applicability of the ideal gas model within reasonable accuracy.

Assumptions:

A real gas obeys the real gas equation of state:

$$Z \equiv \frac{v}{v^{\text{IG}}} = v / \left(\frac{RT}{p} \right) = \frac{pv}{RT} \quad (1)$$

$$Z = Z(p_r, T_r), \text{ where } p_r \equiv \frac{p}{p_{\text{cr}}} \text{ and } T_r \equiv \frac{T}{T_{\text{cr}}} \quad (2)$$

RG model equations:

$$\Delta h^{\text{RG}} = h_2^{\text{RG}} - h_1^{\text{RG}} = (h_2 - h_1)^{\text{IG}} - RT_{\text{cr}}(Z_{h,2} - Z_{h,1}) = \Delta h^{\text{IG}} - RT_{\text{cr}}\Delta Z_h; \quad \left[\frac{\text{kJ}}{\text{kg}} \right] \quad (3)$$

$$\text{where } Z_h \equiv \frac{h^{\text{IG}} - h}{RT_{\text{cr}}}; \quad Z_h = Z_h(p_r, T_r) \quad (4)$$

$$\Delta u^{\text{RG}} = u_2^{\text{RG}} - u_1^{\text{RG}} = \Delta h^{\text{RG}} - (p_2 v_2 - p_1 v_1) = \Delta h^{\text{RG}} - R(Z_2 T_2 - Z_1 T_1); \quad \left[\frac{\text{kJ}}{\text{kg}} \right] \quad (5)$$

$$\Delta s^{\text{RG}} = s_2^{\text{RG}} - s_1^{\text{RG}} = (s_2 - s_1)^{\text{IG}} - R(Z_{s,2} - Z_{s,1}) = \Delta s^{\text{IG}} - R\Delta Z_s; \quad \left[\frac{\text{kJ}}{\text{kg} \cdot \text{K}} \right] \quad (6)$$

$$\text{where } Z_s \equiv \frac{s^{\text{IG}} - s}{R}; \quad Z_s = Z_s(p_r, T_r) \quad (7)$$

General state equations: (Applies to any substance)

$$m = \rho V; \quad \rho = \frac{1}{v}; \quad \text{ke} = \frac{V^2}{2000}; \quad \text{pe} = \frac{gz}{1000}; \quad e \equiv u + \text{ke} + \text{pe}; \quad j \equiv h + \text{ke} + \text{pe}; \quad h \equiv u + pv \quad (8)$$

$$E = me; \quad S = ms; \quad KE = m(\text{ke}); \quad PE = m(\text{pe}) \quad (9)$$

$$\dot{m} = \rho AV; \quad \dot{V} = AV; \quad \dot{E} = \dot{m}e; \quad \dot{S} = \dot{m}s \quad (10)$$

$$Tds = du + pdv = dh - vdp; \quad c_v \equiv \left(\frac{\partial u}{\partial T} \right)_v; \quad c_p \equiv \left(\frac{\partial h}{\partial T} \right)_p \quad (11)$$

Reference: Chapter 1 introduces the concept of states and properties, Chapter 3 covers various material models and state evaluation, and Chapter 11 introduces advanced concepts on property evaluation. Read more about the RG model in Sec. 3.5.5.