The IG model: The IG (Ideal Gas) model is the most accurate gas model. At low pressure and/or high temperature (relative to the critical values), a vapor behaves like an ideal gas.

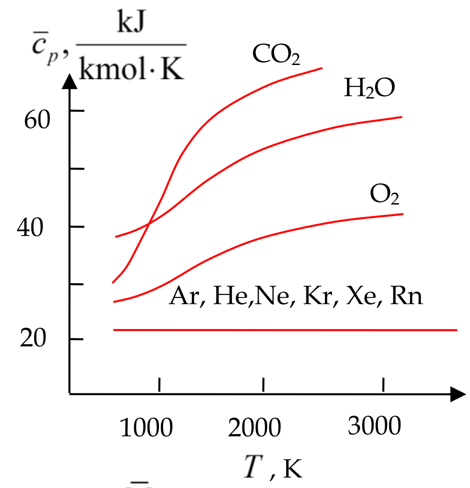

Fig. 3.51 $\bar{c}_p = \bar{M}c_p$ for various gases as a function of temperature. Noble gases are true perfect gases.

Assumptions:

(i) An ideal gas obeys the ideal gas equation of state:

$$pv = RT; \left[\text{kPa}\frac{\text{m}^3}{\text{kg}} = \frac{\text{kJ}}{\text{kg}}\right]$$

$$\text{where, } v = \frac{\bar{v}}{\bar{M}}; \left[\frac{\text{m}^3}{\text{kg}}\right] \text{ and } R \equiv \frac{\bar{R}}{\bar{M}}; \left[\frac{\text{kJ}}{\text{kg}\cdot\text{K}}\right] \quad (1)$$

.

(ii) For both the IG and PG models, u is assumed to be a function of temperature only (it is actually a corollary to the first assumption.

IG model equations: (Constant value of R and c_p are read from tables

$$p = \rho RT = \frac{RT}{v} = \frac{m}{\cancel{V}}RT = \frac{m}{\cancel{V}}\frac{\bar{R}}{\bar{M}}T = \frac{m}{\bar{M}}\bar{R}\frac{T}{\cancel{V}} = n\bar{R}\frac{T}{\cancel{V}}, \qquad \text{where } R \equiv \frac{\bar{R}}{\bar{M}} \quad (2)$$

$$h = h(T),\ u = u(T)\ \ s = s(p,T)\ \ \text{(use ideal gas tables)};\ c_p = c_v + R \quad (3)$$

General state equations: (Applies to any substance)

$$m = \rho\cancel{V};\ \rho = \frac{1}{v};\ \text{ke} = \frac{V^2}{2000};\ \text{pe} = \frac{gz}{1000};\ e \equiv u + ke + pe;\ j \equiv h + ke + pe;\ h \equiv u + pv \quad (4)$$

$$E = me;\ S = ms;\ KE = m(\text{ke});\ PE = m(\text{pe}) \quad (5)$$

$$\dot{m} = \rho AV;\ \dot{\cancel{V}} = AV;\ \dot{E} = \dot{m}e;\ \dot{S} = \dot{m}s \quad (6)$$

$$Tds = du + pdv = dh - vdp;\quad c_v \equiv \left(\frac{\partial u}{\partial T}\right)_v;\ c_p \equiv \left(\frac{\partial h}{\partial T}\right)_p \quad (7)$$

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 IG model in Sec. 3.5.2.