Lezione 7

Modello termodinamico dei gas

Definizioni

- equazione di stato $\mathrm{f}\left(p, v, T\right) = 0$
- equazione calorica $\mathrm{g}(p, T, u) = 0$

- *gas ideale*: equazione di stato $pv = RT$
- *gas perfetto*: un gas ideale $c_p = \text{cost}$
- *gas semi-perfetto*: un gas ideale $c_p = \mathrm{f}\left(T\right)$

↑

solamente

Equazione di stato

$$pv = RT$$

$$v = \frac{1}{\rho} = \frac{V}{m}$$

$$p\tilde{v} = \tilde{R}T$$

$$pV = mRT$$

$$pV = N\tilde{R}T$$

$$\tilde{R} = 8314 \frac{\mathrm{J}}{\mathrm{kmol\,K}}$$

$$R = \tilde{R}\frac{N}{m} = \frac{\tilde{R}}{\tilde{m}}$$

Gas semi-perfetto

$$h = a_0 + a_1 T + a_2 T^2 + \ldots + a_n T_n$$

$$\tilde{h} = \tilde{a}_0 + \tilde{a}_1 T + \tilde{a}_2 T^2 + \ldots + \tilde{a}_n T_n$$

$$A_{ij} = \frac{\tilde{a}_{ij}}{\tilde{R}} \qquad \left(i = 0, n_j\right)$$

$$a_{ij} = \frac{\tilde{a}_{ij}}{\tilde{m}_j} \quad = \tilde{R} \quad \frac{A_{ij}}{\tilde{m}_j} = R A_{ij}$$

$$\tilde{h}_j = \sum_{i=0}^{n_j} \tilde{a}_{ij} T^i = \tilde{R} \sum_{i=0}^{n_j} A_{ij} T^i$$

$$c_p = \frac{\mathrm{d}h}{\mathrm{d}T}$$

$$\tilde{c}_{pj} = \sum_{i=1}^{n_j} i\, \tilde{a}_{ij} T^{i-1}$$

$$\mathrm{d}h = T\,\mathrm{d}s - v\,\mathrm{d}p$$

$$\mathrm{d}s = c_p \frac{\mathrm{d}T}{T} - R\frac{\mathrm{d}p}{p}$$

$$\tilde{s}_j = \int_{T_R}^{T} \tilde{c}_{pj} \frac{\mathrm{d}T}{T} - \tilde{R}\ln\frac{p}{p_R} + \tilde{s}_{Rj} = \tilde{\phi}_j\left(T\right) - \tilde{R}\ln\frac{p}{p_R} + \tilde{s}_{Rj}$$

$$\tilde{\phi}_j = \tilde{a}_{1j}\ln T + \sum_{i=2}^{n_j} \frac{i}{i-1}\tilde{a}_{ij}T^{i-1}$$

$T_R = 298{,}15\ \mathrm{K}$; $p_R = 101325\ \mathrm{Pa}$

Miscele

$$H = \sum H_j$$

$$h = \frac{H}{m} = \sum_j \frac{H_j}{m} = \sum_j \frac{m_j \sum_i a_{ij} T^i}{m} = \sum_j y_j h_j$$

$$p = \sum_j p_j = \sum_j N_j \frac{\tilde{R} T}{V}$$

$$\frac{p_j}{p} = \frac{N_j}{\sum_j N_j} = X_j$$

$$S = \sum_j S_j = \sum_j N_j \tilde{\phi}_j(T) - \tilde{R} \sum_j N_j \ln \frac{p_j}{p_R} + \sum_j N_j \tilde{s}_{Rj}$$

$$-\tilde{R} \sum_j N_j \ln \frac{p_j}{p_R} = -\tilde{R} \sum_j N_j \ln \left(\frac{p_j}{p} \frac{p}{p_R} \right) = -\tilde{R} \sum_j N_j \left(\ln \frac{p_j}{p} + \ln \frac{p}{p_R} \right)$$

$$S(p,T) = \sum_j S_j(p,T) - \tilde{R} \sum_j N_j \ln \frac{p_j}{p}$$

$$s(p,T) = \sum_j y_j s_j(p,T) - R \sum_j X_j \ln X_j$$