2. Apply equations of state to mixtures,
3. Calculate the properties of mixtures from a cubic equation of state.

9.1 Composition

Let us form a mixture of N components that contains n_i mol of component i, $1 = 1, \cdots, N$. The total number of moles is

change "1" to "i"

$$n = n_1 + n_2 + \cdots = \sum_{i=1}^{N} n_i.$$

We understand summations like this to run over all components and for simplicity the limits will be omitted. The mol fraction of component i is defined

$$x_i = \frac{n_i}{n_1 + n_2 \cdots} = \frac{n_i}{n}.$$

The mol fractions in a mixture satisfy the normalization condition,

$$\sum x_i = 1. \tag{9.1}$$

Mathematically, this means that of the N mol fractions only $N-1$ are independent. All extensive properties of mixtures are mathematical functions of pressure, temperature, and the number of moles of all components. Using the enthalpy as an example, we write

$$H^{\text{tot}} = H^{\text{tot}}(T, P, n_1, n_2, \cdots). \tag{9.2}$$

This makes H^{tot} a function of $N+2$ independent variables. The molar form of an extensive property is obtained by dividing the extensive property by the number of moles, for example,

$$H = H^{\text{tot}}/n.$$

The molar properties of a mixture are mathematical functions of pressure, temperature and mole fractions:

$$H = H(P, T, x_1, x_2, \cdots). \tag{9.3}$$

Since mol fractions are not independent but must satisfy the normalization condition in eq. (9.1), the above is a function of $N+1$ independent variables. To avoid mathematical inconveniences from the fact that the mole fractions are not all independent, we will formulate the basic theory for the *extensive* form of a property. Once we have expressions for the extensive property, we can obtain the molar property through division by the total number of moles.