6.2.1 Multiphase Flow Notation

The notation that will be used for multiphase flow is as follows. Uppercase subscripts will refer to the property of a specific phase or component, for example, C for a continuous phase, D for a disperse phase, L for liquid, G for gas, V for vapor. In some contexts generic subscripts N, A, or B will be used for generality. Specific properties frequently used are as follows. The densities of individual components or phases are denoted by ρ_N. *Volumetric fluxes* (volume flow per unit area) of individual components will be denoted by j_N and the *total volumetric flux* is denoted by $j = j_A + j_B$. *Mass fluxes* will then be given by $\rho_N j_N$ and velocities of the individual components or phases will be denoted by u_N.

The volume fraction of a component or phase is denoted by α_N and in the case of two components or phases, A and B, it follows that $\alpha_B = 1 - \alpha_A$. Then the mixture density, denoted by ρ, is given by

$$\rho = \alpha_A \rho_A + \alpha_B \rho_B \tag{1}$$

It also follows that the volume flux of a component, N, and its velocity are related by $j_N = \alpha_N u_N$.

Two other fractional properties are the *volume quality*, β_N, defined as the ratio of the volumetric flux of the component, N, to the total volumetric flux so that, for example, $\beta_A = j_A/j$. Note that, in general, β is not necessarily equal to α. The *mass fraction*, x_A, of a phase or component, A, is simply given by $\rho_A \alpha_A/(\rho_A \alpha_A + \rho_B \alpha_B)$. On the other hand the *mass quality*, $\mathcal{X}_A$, often referred to simply as *the quality*, is the ratio of the mass flux of component, A, to the total mass flux, or

$$\mathcal{X}_A = \frac{\rho_A j_A}{\rho_B j_B + \rho_A j_A} \tag{2}$$

Furthermore, when only two components or phases are present it is often redundant to use subscripts on the volume fraction and the qualities since $\alpha_A = 1 - \alpha_B, \beta_A = 1 - \beta_B$ and $\mathcal{X}_A = 1 - \mathcal{X}_B$. Thus unsubscripted quantities α, β and $\mathcal{X}$ will often be used in these circumstances.

Finally, note for future use, that the relation between the volume fraction, α_A, and the mass quality, $\mathcal{X}_A$, for a given phase or component, A, in a two-phase or two-component mixture of A and B follows from equation 2, namely

$$\mathcal{X}_A = \frac{\rho_A \alpha_A u_A}{\rho_B (1 - \alpha_A) u_B + \rho_A \alpha_A u_A} \tag{3}$$

where u_A and u_B are the velocities of the two phases or components. Therefore $\mathcal{X}_A$ and α_A may be quite different.