Modeling with the Combined Phase Equations

One of the simpler approaches is to begin by modeling the combined phase equations (Nbb5), (Nbe9), and (Nbh11) and hence avoid having to codify the mass, force and energy interaction terms. By defining mixture properties such as the density, ρ, and the total volumetric flux, j_i, one can begin to construct equations of motion in terms of those properties. But none of the summation terms (equivalent to various weighted averages) in the combined phase equations can be written accurately in terms of these mixture properties. For example, the summations,

$$\sum_N \rho_N \alpha_N u_{Ni} \quad \text{and} \quad \sum_N \rho_N \alpha_N u_{Ni} u_{Nk} \qquad \text{(Nde1)}$$

are not necessarily given with any accuracy by ρj_i and $\rho j_i j_k$. Indeed, the discrepancies are additional rectification terms that would require modeling in such an approach. Thus any effort to avoid addressing the mass, force and energy interaction terms by focusing exclusively on the mixture equations of motion immediately faces difficult modeling questions.