

Mass, Force and Energy Interaction Terms

Most multiphase flow modeling efforts concentrate on the individual phase equations of motion and must therefore face the issues associated with construction of \mathcal{I}_N , the mass interaction term, \mathcal{F}_{Nk} , the force interaction term, and \mathcal{E}_N , the energy interaction term. These represent the core of the problem in modeling multiphase flows and there exist no universally applicable methodologies that are independent of the topology of the flow, the flow pattern. Indeed, efforts to find systems of model equations that would be applicable to a range of flow patterns would seem fruitless. Therein lies the main problem for the user who may not be able to predict the flow pattern and therefore has little hope of finding an accurate and reliable method to predict flow rates, pressure drops, temperatures and other flow properties.

The best that can be achieved with the present state of knowledge is to attempt to construct heuristic models for \mathcal{I}_N , \mathcal{F}_{Nk} , and \mathcal{E}_N given a particular flow pattern. Substantial efforts have been made in this direction particularly for dispersed flows; the reader is directed to the excellent reviews by Hinze (1961), Drew (1983), Gidaspow (1994) and Crowe *et al.* (1998) among others. Both direct experimentation and computer simulation have been used to create data from which heuristic expressions for the interaction terms could be generated. Computer simulations are particularly useful not only because high fidelity instrumentation for the desired experiments is often very difficult to develop but also because one can selectively incorporate a range of different effects and thereby evaluate the importance of each.

It is important to recognize that there are several constraints to which any mathematical model must adhere. Any violation of those constraints is likely to produce strange and physically inappropriate results (see Garabedian 1964). Thus, the system of equations must have appropriate frame-indifference properties (see, for example, Ryskin and Rallison 1980). It must also have real characteristics; Prosperetti and Jones (1987) show that some models appearing in the literature do have real characteristics while others do not.

In this book sections (Nb), (Nc), (Nd), (Ne), and (Nf) review what is known of the behavior of individual particles, bubbles and drops, with a view to using this information to construct \mathcal{I}_N , \mathcal{F}_{Nk} , and \mathcal{E}_N and therefore the equations of motion for particular forms of multiphase flow.