EPIC - Enabling Process Innovation through Computation

Krishnaswamy Nandakumar
Louisiana State University
Baton Rouge, LA, 70803, United States of America

Abstract- Multiphase transport phenomena are ubiquitous in chemical, mineral processing, food processing and materials processing industries. Our traditional approach has been to ignore fluid dynamical effects by invoking simplifying assumptions of homogeneity, but pay the price during scale-up of processes through pilot scale experiments. The question that I address in this presentation is "Can Multiphase flow modeling come to our rescue in minimizing the need for pilot scale experiments?" I will present an overview of my research in using computational fluid dynamics to explore multiphase flows. On the fundamental side, we have developed advanced algorithms for direct numerical simulation (DNS) and Discrete Particle Modelling (DPM) of multiphase flows. For dispersed rigid particles as in suspension flows, sedimentation etc, we couple the Navier-Stokes equations with the rigid body dynamics in a rigorous fashion to track the particle motion in a fluid. For deformable bubbles/droplets dispersed in another fluid, we also track their motion in an Eulerian grid. These classes of algorithms show great promise in attempting to shed light on multiphase flows with many particles or droplets, from which we can extract statistically meaningful average behaviour of suspensions or bubbly flows.

On the other hand, there is an immediate need to study flow of complex fluids of industrial importance. Such cases include the recent oil spill modelling, polymer blending processes involving melting, deformation and break-up, corrosion-erosion in pipelines and process vessels, mass transfer in packed beds with random and structured packings or in Sieve trays. In such studies we use volume averaged equations as the basis of flow models coupled with experimental validation of such predictions in an effort to develop scale invariant closure models that are needed as part of the volume averaged flow models. We will discuss the merit of this approach and the synergy between these two approaches. Estimating the uncertainties in such model predictions is also emerging as an important area of research.

At LSU we are proposing to start a new research cluster that integrates multiphase flow modelling with process diagnostics, intensification studies and optimization and control as applied to the local industries spanning chemical, pharmaceutical, food and bio process industries, the sugar industry etc. We call our effort EPIC-Enabling Process Innovation through Computation. This vision will be shared with the audience.