Issues for Industrial Modeling of Multiphase Flows: Perspective of a Petrochemical Company

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Gas-solid and liquid-solid flows are common in the petrochemical industry. NOVA Chemicals is a plastics and chemical company with a focus on polyethylene and styrenics polymers, and the production of required feedstocks (ethylene, styrene). These polymers are made in a variety of ways, but the manufacturing processes generally involve multi-phase flow in the chemical reactors, and/or auxiliary process equipment. Although we have utilized CFD for more than fifteen years to improve our understanding and for design/troubleshooting purposes, it is only recently that affordable computer power has reached a level to begin meanful simulations of industrial, multiphase flow problems.

The main areas of interest for our company in terms of multiphase CFD simulations include:

1. Gas phase polymerization reactors involving dense two-phase (gas-solid) and three-phase (gas-liquid-solid) flow. Dilute gas-solid flows are also of interest to simulate carry-over and for pneumatic conveying applications.
2. Suspension polymerization in stirred tank reactors with liquid-liquid and liquid-solid phases.
3. Liquid-liquid flows in heat transfer and separation equipment.

There have been some promising developments in terms of population balances, e.g. DQMOM, granular kinetic models for multiple solid phases, improved drag representations, wall boundary conditions, etc. Further development and extensive validation is needed on various scales (laboratory, pilot plant and commercial) before multiphase CFD can be accepted as a reliable engineering tool. Of course, further advances are also needed in terms of computing power along with algorithmic improvements to increase the execution speed and fidelity of existing CFD codes. For example, some codes can exhibit conservation problems in certain circumstances.

Our contribution to this workshop will come mainly from sharing learnings in application of commercial CFD packages on industrial multiphase flow problems. In addition, we have a collaborative research program with the University of Calgary to study high-pressure and high temperature fluidization of polyethylene beds with advanced imaging techniques, e.g. x-ray fluroscopy, high-speed CAT scans, etc. These experimental results will be used to validate CFD models for gas-solid flows. We also conduct extensive internal research programs to study heat transfer in liquid-liquid flows. Validation of CFD models is important to address scale-up issues.