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How Heat Transfer and Fluid Flow enable Process Innovation

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Abstract

The manufacturing technologies of the future for converting chemicals, materials, energy etc will be done in efficient, distributed, modular process equipment where multiphase flows are ubiquitous. Our traditional design approach has been to rely on rules of thumb, pilot scale development and testing of process equipment which takes up to 20 years to develop a single technology. The design procedures are often highly empirical, dismissing the high degree of freedom that an engineer has at early stages of design by making ad-hoc design decisions, but pay the price during scale-up of processes through expensive pilot scale experiments. The question that I address in this presentation is “Can Advanced Computational modeling tools come to our rescue in minimizing the need for pilot scale experiments?” On the fundamental side, advanced algorithms for direct numerical simulation (DNS) and Discrete Particle Modelling (DPM) of multiphase flows aid in detailed understanding but for limited size. For dispersed rigid particles the Navier-Stokes equations are coupled with the rigid body dynamics in a rigorous fashion to track the particle motion in a fluid. These classes of algorithms show great promise in attempting to shed light on multiphase flows from which we can extract statistically meaningful average behavior for use in the design of large scale engineering equipment. DNS simulations of controlled fluid-particle interactions in a shear flow are explored to learn about energy transfer in multiphase fluid-particle systems. Use of these approach to design efficient distributors and mixers will be discussed.