Other

Advanced Computer Models of Multiphase Chemical Processes

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Coast to Cosmos Adjunct Faculty Presentation

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Abstract:

Multiphase flows 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.

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.

Speaker's Bio:

Dr. K. Nandakumar is currently Gordon A and Mary Cain Chair Professor at Louisiana State University. Prior to this he was the GASCO Chair Professor at The Petroleum Institute, Abu Dhabi. Formerly he was in the Department of Chemical and Materials Engineering at the University of Alberta, Edmonton, Canada for nearly 25 years. Dr. Nandakumar received his B. Tech from Madras University in 1973, M. Sc from University of Saskatchewan in 1975 and his PhD from Princeton University in 1979. He has received the *Alexander von Humnboldt research fellowship* from the German government in 1989-90 and the *Albright & Wilson Americas Award* from the Canadian Society of Chemical Engineering in 1991 for distinguished contributions to chemical engineering before reaching the age of 40. Dr. Nandakumar was elected as *Fellow of the Chemical Institute of Canada* in 1991 and a *Fellow of the Engineering Institute of Canada* in 2006 and *Fellow of the Canadian Academy of Engineering* in 2007. He has received, from the University of Alberta, the *McCalla Professorship* (1992), the *Killam Annual professorship* (2001) for excellence in research and the *Rutherford Award* (2001) for excellence in teaching. He has also received the *Excellence in Education award* (2002) from APEGGA, the professional engineering association in Alberta. He was Editor-in-Chief of *The Canadian Journal of Chemical Engineering* during 2005-2009. Dr. Nandakumar is also the recipient of the *premier award of The Canadian Society for Chemical Engineering,* called the *R.S. Jane Memorial Award* in 2008.

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