Title **Multiphase, Multiscale, Multiphysics Models for Design Innovations in Process Industries**

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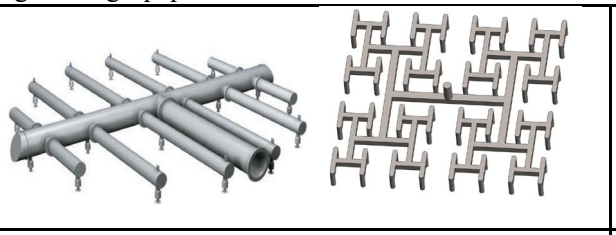
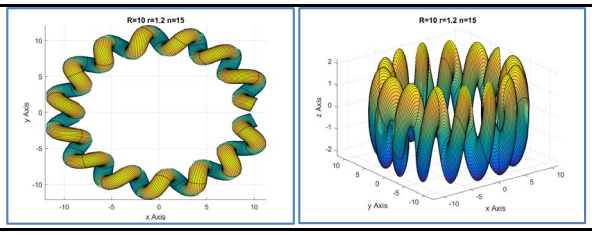
ABSTRACT

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 Element Modelling (DEM) 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.



Fractal distributor to promote homogeneity in process vessels



Toroidal helix to enhance transport processes

We call our effort as EPIC (Enabling Process Innovation through Computation) that integrates *multiphase flow modelling* with *process diagnostics, intensification studies* and *optimization* and *control* as applied to the process industries. Case studies of industrial relevance will be presented to illustrate the benefits of such an approach.

About the Speaker

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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