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RECENT ADVANCES IN MULTIPHASE FLOW AND HEAT TRANSFER; NUCLEAR ENGINEERING PERSPECTIVE

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SEMINAR ABSTRACT

Recent progress in both the understanding of the basic physics of multiphase flows and the computational capabilities using CFD methods clearly shows the great potential for detailed three dimensional simulations of two-phase flows in nuclear reactor systems. These simulations can give significant new insight into various safety issues of the current generation reactors, as well as guide future work on the development of next generation reactor systems. The purpose of this presentation is to overview the results of recent work on the development of mechanistic multidimensional models of multiphase flow for application in nuclear reactor design and safety analysis. Two major issues will be discussed: the development of mechanistic closure laws for the multifield model, and the modeling of interface tracking in gas/liquid two-phase flows.

The accuracy of predictions by the existing computational fluid dynamics (CFD) codes, both single-phase and multiphase, strongly depends on the quality of closure models for local mass, energy and momentum transfer. The recent results of research at CMR will be shown to illustrate the progress that has been made in the modeling of both variable-property single-phase fluids and of flow-regime-specific local interfacial phenomena in multiphase flows. The various new models have been implemented in the computational multiphase fluid dynamics (CMFD) code, NPHASE, and several modeling and computational issues have been resolved that are critical for the consistency of the overall CMFD model. The coupling between transient multidimensional thermal-hydraulic and space-dependent neutronic models will also be discussed.

The ability to predict the shape of the gas/liquid/solid interfaces is important for various multiphase flow and heat transfer applications. Specific issues of interest to nuclear reactor thermal-hydraulics include the shape evolution of bubbles attached to solid surfaces during nucleation, bubble-surface interactions in complex geometries, etc. The present approach combines a modified level-set method with the NPHASE code. The coupled numerical solver is capable of simulating the evolution of gas/liquid interfaces in two-phase flows for a variety of geometries and flow conditions, from individual bubbles to free surfaces (stratified flows).

<u>Biographical Information</u>

Dr. Podowski is Professor in the Department of Mechanical, Aerospace and Nuclear Engineering at RPI, and Director of Center for Multiphase Research. He is also former Chairman of Dept. of Nuclear Engineering and Engineering Physics. His research expertise includes: fundamentals and applications of multiphase flow and heat transfer, dynamics and stability of energy systems, and nuclear reactor thermal-hydraulics and safety. He has taught numerous courses in thermo-fluid sciences, nuclear reactor engineering and system dynamics, and served as Ph.D. thesis advisor to more than 20 graduate students. Dr.

Podowski is a fellow of ANS and member of ASME and AIChE. He published over 220 technical papers, including 50 archival journal papers and books/book-chapters, and also served as member (or chair) of several expert panels for DOE, NRC, IAEA, DHHS, and consultant to numerous institutions both domestic and overseas. He organized and taught several short courses on multiphase flow.