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Editorial

Computational Fluid Dynamics for Gas-Liquid Flows

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Computational fluid dynamics (CFD) codes are widely used in industrial applications for single-phase flows (e.g., in the automotive or aircraft industries). On the other hand, the application of CFD for multiphase systems is not yet mature. Safety analyses related to nuclear light water reactors require reliable simulations for different scenarios including two-phase flow situations. Prominent examples for pressurized water reactor (PWR) analyses are the prevention from departure from nucleate boiling (DNB) which is related to critical heat flux (CHF) or the pressurized thermal shock (PTS) problem which has to be considered in connection with some hypothetical loss of coolant accident (LOCA) scenarios and may also lead to two-phase flow situations in the cold leg and in the downcomer. For example, in case of boiling water reactors (BWR) analyses, the prevention from Dryout is an important issue.

The currently applied system codes based on correlations are valid for special geometries, scales, and flow patterns. This limits the transferability of small-scale experimental findings to real plant scales. On the other hand, CFD-type models depend only on local flow parameters and are for this reason much more flexible regarding geometry and scale. The increased computer power now in principle permits CFD simulations for multiphase flows and many investigations have been done in the recent years.

The problems in modeling of such gas-liquid flows using CFD codes arise from the fact that the mass, momentum, and heat transfer among the phases are strongly coupled with the complex interfacial structure. The order of magnitudes lies between the size of the smallest structures of these interfaces and the size of the typical components of nuclear reactors which finally have to be modeled. For this reason, averaging procedures are required which lead, for example, to the well-known two- or multifluid model. Due to this averaging, the primary information on the structure of the interface gets lost and has to be introduced again by the so-called closure models. Some of the physical phenomena on microscale are not yet well understood. Also, CFD-grade experimental data (i.e., data with high resolution in space and time) are often not available. Despite these open problems, there is a step-by-step progress in the simulation of gas-liquid flows in geometries and scales relevant to nuclear reactor safety (NRS).

In view of the above, it has been decided to bring out the special issue "Computational Fluid Dynamics for Gas-Liquid Flows." Two papers review and discuss the state-of-the-art of modeling and the available experimental database for the CHF and the two-phase PTS issue, respectively. Research articles focus on important topics like turbulence modeling in two-phase flows, modeling of polydispersed flows, mixing problems (including single-phase coolant flows, addressed by one paper), and jet impingement connected with bubble entrainment. Thus, this special issue provides the readers with useful information on the progress of CFD modeling for reactor-specific two-phase flows, and also on open questions, requirements for further research, modeling, and experimental data.

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