

New Development in Two-Phase Flow Heat Transfer CFD (or CMFD) Applied to Thermal-hydraulics Problems

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ABSTRACT

In practical thermal-hydraulics applications, multi-phase heat transfer flow involves phenomena acting at different time/length scales. At each level of the scale cascade, the flow physics is amenable to numerical prediction by scale-specific strategies; an example of which is interfacial heat & mass transfer.

To respond to the growing needs of reactor design of the new generations, new computational tools and methods are required to address both the microscopic and component scales segment of the problem; to complement or couple -where needed- with the 'mature' system scale treated so far with 1D system codes. The approach followed thus-far is based on interface tracking methods (ITM) which have been until now used for simple 'academic' test cases. We will show in this talk that these methods can indeed be employed for more complex practical problems. The techniques could be coupled with heat transfer (conjugate, with phase change, with buoyancy), and used under turbulent conditions as well, using RANS and LES. The complexity of the geometries could be alleviated by using the Immersed Surfaces Technology (IST), treating solid boundaries like in interface tracking context, fluid-solid surfaces instead of fluid-fluid interfaces. Various fundamental microscopic flow problems will be discussed, including thin-film boiling, predicted using ITM's. Other component scale thermal-hydraulics problems will be discussed as well, namely the ECC injection in the cold leg, the two-phase flow and heat transfer in a reduced fuel bundle, the stratified condensing two-phase flow, highlighting the advantages of the IST in treating conjugate heat transfer. The IST merits will be emphasized through other single-phase flow examples, e.g. the simplified PWR reactor core (ROCOM) involving Boron mixing.

BIO SKETCH

Dr. Djamel Lakehal is a part-time Lecturer at ETH Zurich (convective heat transfer), and General Manager of ASCOMP GmbH. He obtained a Master degree in Computational Fluid Dynamics & Transport Phenomena from Ecole Centrale of Nantes, France in 1991, and a PhD in December 1994. In the period 1995-1997, he collaborated with Prof. W. Rodi at the University of Karlsruhe as a post-doctoral researcher (turbulence modelling group). As a Research Associate at the Institute of Fluid Mechanics at the TU-Berlin (1997-1998), he collaborated with Prof. F. Thiele on studying vortex-shedding flows past bluff bodies. In 1998, he joined the Institute of Energy Technology of ETH Zurich as a Group Leader and Senior Lecturer, working with Prof. G. Yadigaroglu's Thermal-hydraulics group, where he initiated the creation of the Computational Multifluid Dynamics Group (CMFG). In November 2004, he defended his 'Habilitation' jointly at ETH and Ecole Centrale of Lyon, France. In 2004, together with former members of the CMFG, he founded ASCOMP GmbH; an ETH Spin-off Company specialized in industrial multi-fluids dynamics and heat transfer. Dr. Lakehal collaborates with the Los Alamos National Laboratory; the University of Melbourne; UC Santa Barbara; KTH Stockholm, and FZD Rossendorf in Germany.