PhD proposal

1 Title

Development of multi-scale / multi-resolution computation methodology in thermalhydraulics for some generation IV reactors

2 Laboratory

CEA - Grenoble
Laboratoire de Modélisation et de Développement des Logiciels
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3 Project

Context

In their current state of design, some generation IV gas cooled reactors are based on a technology with an assembly of plates cooled by a flow of Helium. The assessment of the different concepts currently under development is in particular based on the determination of their behavior in the nominal regime and in unsteady situations. This determination is an important subject of research for two main reasons: (i) the range of flow regimes to study is broad, going from forced convection to natural convection through mixed convection as well as transients between these regimes and (ii) the development of modern computational tools allow to foresee the fine description of a large part of the reactor by combining different resolution method at different scales. A PhD thesis ends in 2006 that allowed to put the bases of methods that couple approaches describing homogenized media (essential to describe the entire reactor core) and open media. The physical models considered are currently still limited to situations of nominal regimes.

The research project proposed aims at extending the results obtained to situations of non-nominal regimes (transient flows et mixed convection). In this purpose, we will consider a channel of rectangular section as the elementary component of the bundle. The questions that will have to be answered are: (i) does there exist reference models at “small scale” for this kind of geometry in the cases of interest and if yes can they be easily implemented in the Trio_U code; (ii) can we determine a model at the “homogeneous scale” from the results at the “small scale”; (iii) how do we have to adapt the coupling principles previously established for the nominal regimes to these models in order to get a multi-resolution coupling that is adapted to all the regimes?

Content

The project could be divided as follows. First, a bibliography analysis of the existing data on flows in rectangular channels will allow to determine possible needs for the different regimes investigated. Second, the “small scale” models of CFD type will be implemented in order to validate the code. At this stage, partner experimental teams could build and run experiments aiming at getting the possibly missing data pointed out during the first stage of the project. Then, homogenized models of this “small scale” approach will be proposed in order to adapt the modeling to the entire core of a reactor. The small scale and homogeneous approaches will be compared. At last, the coupling between the small scale and homogeneous approaches as well as with the other parts of the reactor will be investigated in order to go towards a realistic application.

The simulation code used for these development is the Trio_U code, currently developed at CEA-Grenoble and which has applied for four years to studies of gas cooled reactors. The PhD student will work with the Trio_U team.

M. Chandesris. Meso-macro scale coupling applied to turbulent flows in a nuclear reactor. PhD, Université Paris VI, defense prepared for 2006.