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# Models and numerical methods for the simulation of loss-of-coolant accidents in nuclear reactors

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In view of the simulation of the water flows in pressurized water reactors (PWR), many models are available in the literature and their complexity deeply depends on the required accuracy, see for instance [1]. The loss-of-coolant accident (LOCA) may appear when a pipe is broken through. The coolant is composed by light water in its liquid form at very high temperature and pressure (around 300 °C and 155 bar), it then flashes and becomes instantaneously vapor in case of LOCA. A front of liquid/vapor phase transition appears in the pipes and may propagate towards the critical parts of the PWR. It is crucial to propose accurate models for the whole phenomenon, but also sufficiently robust to obtain relevant numerical results.

Due to the application we have in mind, a complete description of the two-phase flow (with all the bubbles, droplets, interfaces…) is out of reach and irrelevant. We investigate averaged models, based on the use of void fractions for each phase, which represent the probability of presence of a phase at a given position and at a given time. The most accurate averaged model, based on the so-called Baer–Nunziato model, describes separately each phase by its own density, velocity and pressure. The two phases are coupled by non-conservative terms due to gradients of the void fractions and by source terms for mechanical relaxation, drag force and mass transfer. With appropriate closure laws, it has been proved [2] that this model complies with all the expected physical requirements: positivity of densities and temperatures, maximum principle for the void fraction, conservation of the mixture quantities, decrease of the global entropy… On the basis of this model, it is possible to derive simpler models, which can be used where the flow is still, see [3]. From the numerical point of view, we develop new Finite Volume schemes in [4], which also satisfy the requirements mentioned above. Since they are based on a partial linearization of the physical model, this numerical scheme is also efficient in terms of CPU time. Eventually, simpler models can locally replace the more complex model in order to simplify the overall computation, using some appropriate local error indicators developed in [5], without reducing the accuracy.

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