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Thermal relaxation coefficient sensitivity analysis in two-phase compressible model

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In recent years, CFD computations have been more and more used for predicting accident scenarios in nuclear reactor. For example, in a Loss Of Coolant Accident, the fast liquid depressurization can produce undesirable effects, such as a mass transfer or mechanical stress on the reactor vessel. In this context, the formulation of a predictive two-phase flow model is crucial.

The present work focuses on the development of a two-phase flow model based on a no-phasic equilibrium between the two phases [1, 2]. On one hand, the underlying hypothesis of this model allows to reproduce a total thermo-mechanical disequilibrium, but on the other hand, it requires a proper modeling of all the source terms needed to reproduce pressure, velocity, temperature and chemical potential phase relaxation. Several researchers propose instantaneous relaxations [3, 4], which are by the way strong hypotheses, and are not potentially able to reproduce all real scenarios or experimental observations [5, 6].

The simulation of a liquid-vapor mass transfer requires an accurate modeling of pressure, temperature and chemical potential relaxation terms and, consequently, of the associated characteristic times. Concerning the pressure relaxation, some significant developments exist yet in literature [7]. This allows to focus on the two other relaxation terms.

So in this context, the present work aims to study non-instantaneous relaxation hypotheses, focusing on characteristic times of a temperature relaxation. In order to neglect the interaction between mass and heat transfer, this work focuses on liquid-particle flows that allow to exclude the phase transition. Since the temperature relaxation term is dependent on a characteristic time, τ_T, usually modeled by a constant value, the first contribution of this work is to assess the influence of τ_T on how the shock propagates by means of a sensitivity analysis. Then, a preliminary modeling of this parameter is proposed and validated.

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