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Modelling multiphase flows with phase transition via a non-conservative explicit residual distribution formulation

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Within the framework of the equilibrium two-phase mixtures with phase transition, the following work focuses on a 4-equation model, which allows to study certain typologies of cavitation problems, where the assumption of a homogeneous temperature, pressure and velocity are allowed. The main focus is, thus, on the study of time dependent problems with strong interacting discontinuities and phase transition.
Due to the interest of engineering applications, which focus on non-conserved variables, rather than on conserved ones, this work presents a novel approach to solve systems of equations with a non-conservative formulation which guarantees the actual conservation of the mass, momentum and energy quantities [1].
This non-conservative formulation allows to avoid the classical oscillations obtained by many approaches, that might appear for the internal energy profile across contact discontinuities.
The proposed method relies on a finite element based residual distribution scheme which is designed for an explicit second-order of accuracy timestepping [2,3]. The advantages of specifically adopting the residual distributions approximation count among others, the absence of a Riemann solver, the ease in extending it to unstructured meshes and the possibility to maintain a compact stencil when refining the mesh.
Several benchmark test problems have assessed an excellent mesh convergence to the exact solutions. The obtained numerical results have shown the effective robustness on very severe test cases which involve both problems with and without phase transition [4].

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