Simulation of cavitation rolls past a forward step with a bubble model

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The simulation of cavitation low Mach number flows stays a challenging question, in particular due the surface tension effects which produce very frequently a large number of bubbles, making the modelization of them compulsory. In the proposed study, the liquid is assumed to be barotropic, and its flow is near low Mach number limit. The bubble-liquid system is modelized with the combination of a mixture model and a representation of bubbles. We assume bubble and liquid velocities are identical. The equations write:

$$\left\{ \begin{array}{rcl} \frac{\partial \rho}{\partial t} + \nabla \cdot (\rho u) & = & 0, \\ \frac{\partial \rho u}{\partial t} + \rho u \cdot \nabla u + \nabla p + \nabla \cdot \tau + \rho g e_y & = & 0, \\ \frac{\partial \rho U}{\partial t} + \nabla \cdot (\rho U) & = & S_U, \end{array} \right. \tag{1}$$

where U represents the set of bubble characteristics. In our model, they involve:
- bubble number per unit vol,
- mean radius,
- influence radius,
- vapor density,
- gas density,
- thermic boundary layer thickness inside bubble,
- temperature of bubble,
- diameter time derivative,
- evaporation rate.

Rayleigh-Plesset equations are used to determine the transient growth rate of the bubble. Surface tension, evaporation-condensation and thermical phenomena are also taken into account in source terms.
Convection of U is discretised on an unstructured tetrahedrization by a novel second-order monotone MUSCL scheme extending [1]. Low velocity implies a low Mach number preconditioning [2,3]. We use a formulation close to [4].
This approach is applied to the simulation of cavitation rolls generation in the flow past a forward step. Results will be compared with an experimental test case [5].

References.

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