NUMERICAL SIMULATION METHOD OF COMPRESSIBLE GAS-LIQUID TWO PHASE FLOWS

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ABSTRACT

A numerical simulation method of compressible gas-liquid two-phase flow is developed for analyses of a cavitation bubble. As both phases has compressibility, thermodynamic state of both phases must be described and stiffened gas equation of state [1] is utilized as $p = (\gamma - 1)\rho\varepsilon - \gamma\Pi$ in this research. Interface of two-phases is captured by Level-Set method [2]. With assumption that the pressure and the velocity of both phases are the same at the smoothed interface, conservations of mass, momentum and total energy of mixture are easily derived and the set of equations are closed.

However, as it has been found that internal energy jump across the interface is critical for the stability of computation, total energy equation is modified so that inviscid flux of energy is smoothly connected across the interface as,

$$\frac{\partial e'}{\partial t} + \frac{\partial\{(e'+p)u\}}{\partial x} = -\frac{\gamma_L \Pi_L}{\gamma_L - 1}\left\{\frac{\partial \psi}{\partial t} + \frac{\partial(\psi u)}{\partial x}\right\}$$

$$e' = e - \frac{\gamma_L \Pi_L}{\gamma_L - 1}\psi = \left(\rho_L \varepsilon_L - \frac{\gamma_L \Pi_L}{\gamma_L - 1}\right)\psi + \rho_G \varepsilon_G (1-\psi) + \frac{1}{2}\rho u^2$$

$$= \frac{p}{\gamma_L - 1}\psi + \frac{p}{\gamma_G - 1}(1-\psi) + \frac{1}{2}\rho u^2 = \frac{p}{\gamma_m - 1} + \frac{1}{2}\rho u^2$$

Subscript *L, G, m* denotes liquid phase, gas phase and mixture respectively. ψ is volume fraction of liquid phase. Detail of governing equations as well as their discretization and the result of one-dimensional simple example computation will be presented at the conference.

REFERENCES

[1] D. J. Robbins, et al., “Simulation of Multiphase Flows Using a Modified Upwind-Splitting Scheme”, *World Academy of Sci., Eng. & Tech.*, **68**, 1143-1149 (2012).

[2] M. Sussmann, P. Smereka and S. Osher, “A Level Set Approach for Computing Solutions to Incompressible Two Phase Flow”, *J. Comp. Phys*, **114**, 1, 146-159 (1994).