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Development of a practical numerical model for multi-phase flows with improved interface capturing and geometry representation

F.Xiao[1,2], K.Matsumoto[2], N.Onodera[2]

[1] Institute of Mechanics, Chinese Academy of Sciences No. 15 Beisuhuanxi road, 100080, Beijing, China (E-mail: xiao@imech.ac.cn)
[2]Department of energy sciences, Tokyo Institute of Technology, 4259 Nagatsuta, Midori-ku, Yokohama, 226-8502, Japan

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ABSTRACT

A numerical formulation for direct simulations of multi-fluid flows including moving interface has been developed in our group. The fluid solver is a novel formulation that combines the underlying concept of the CIP method[1] and the finite volume method. The resulting fluid solver, so-called VSIAM3 (Volume/Surface Integrated Average based Multi-Moment Method)[2], uses two integrated moments of a given physical field, i.e. the volume integrated average (VIA) and the surface integrated average (SIA), as the model variables that are updated every time step. In the VSIAM3, the pressure-velocity coupling is computed by a “M-grid” that is different from the conventional staggered grid or collocated grid, which then leads to a more robust and convenient numerical framework for simulating various flows and accommodate models for complex physics.

We have recently improved the interface capturing scheme with the THINC/WLIC presented in [3,4]. The new scheme maintains the compactness of the transition layer in the VOF function while substantially improves the geometrical faithfulness of the transported interface. Another improvement of the code is to the numerical representation for the boundary of complex geometry. An immersed boundary method [5] is incorporated to the multi-moment finite volume model. The M-grid greatly simplifies the modifications to the momentum equations to satisfy the kinetic conditions imposed on the boundaries of geometrical complexity.

REFERENCES

[1] T.Yabe, F.Xiao and T. Utsumi, “The constrained interpolation profile method for multiphase analysis”, *J. Comput. Phys.*, Vol. **169**, pp. 556-593 (2001).

[2] F.Xiao, A.Ikebata and T.Hasegawa, “Numerical simulations of free-interface fluids by a multi integrated moment method”, *Computers & Structures*, Vol. **83,**pp. 409-423, (2005).

[3] K.Yokoi, “Efficient implementation of THINC scheme: A simple and practical smoothed VOF algorithm”, *J. Comput. Phys.*, Vol. **226**, pp. 1985-2002, (2007).

[4] F.Xiao, Y.Honma and T.Kono: “A simple algebraic interface capturing scheme using hyperbolic tangent function”, *Int. J. Numer. Method in Fluids*, Vol. **48**, pp. 1023-1040, (2005).

[5] D.Kim and H.Choi “Immersed boundary method for flow around an arbitrarily moving body”, *J. Comput. Phys.*, Vol. **212**, pp. 662-680, (2007).