Particle Method for Incompressible Viscous Flow with Free Surfaces: Fundamental Modeling and Industrial Application

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ABSTRACT

Moving Particle Semi-implicit (MPS) method has been developed for incompressible viscous flow with free surfaces [1]. A semi-implicit algorithm is employed for incompressibility. Free surface boundaries are simply evaluated by the decrease of the particle number density. Spatial discretization is based on the difference among the neighboring particles. Since the mesh is not used for the discretization, topological change as well as large deformation of the free surfaces can by analyzed without mesh tangling.

In the MPS method, various fundamental studies have been carried out for algorithms, high-order schemes, boundary conditions, modeling for multiphase and multiphysics analysis, large-scale parallel computing techniques and improvement of numerical stability [2, 3].

Based on the fundamental studies, the MPS method has been applied to a wide range of industry problems. In the automobile industry, typical applications are oil behavior in the gear box [4] and car-water interaction on the flooded read [5]. Combination of the particle method and a multi-body dynamics software is useful for these problems.

In the chemical engineering industry, typical applications are kneading in extruders, devolatilization in mixing tanks, moulding process of carbon fiber reinforced thermo plastics, etc. These analyses require advanced modeling of bubble nucleation, bubble growth, non-linear and non-isotropic viscosity, etc.

Application to biomechanics is expected. For example, successful and failed swallowing processes are reproduced by multiphysics simulation of human organs and food bolus [6].

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