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Development of two-phase flow simulation using SPH Method

Masakazu Ichimiya[1*] and Nobuki Yamagata[2]

[1] The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8656 Japan, ichimiya@n.t.u-tokyo.ac.jp
[2] Advanced Creative Technology Co., Ltd., 2-10-3 Kojimachi, Chiyoda-ku, Tokyo 102-0083, Japan, yamagata@actact.co.jp

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Gas entrainment is one of the major defects caused in the foundry filling process. Since the smoothed particle hydrodynamics (SPH) is a Lagrangian method that does not use a lattice, large deformations and movements can be easily analyzed, so it has the potential to be applied to such gas defect prediction as a methodology. However, numerical simulation of the two-phase flow, in particular those with large density ratio, has been challenging. It is because the discontinuities of the density and the sharp pressure gradient exist over the interface. Authors have developed a two-phase flow SPH methodology that can be applied to the foundry filling process containing gas [1].

The weak compressible SPH(WCSPH) was used as the analysis method. Strictly speaking, water has a slight compressibility. The weak compressible SPH is solved by using NS equations and equations of state (EOS) alternately. The Tait equation was used for EOS.

The methodology developed in this study is applied to bubble rising in water, which is a typical problem of gas-liquid two-phase flow. The bubble / water density ratio is 1/1000. In the 2D as well as 3D calculation results for the bubble radius 20 mm, the bubble shape became a spherical cap as shown by Grace [2]. The water tests regarding the gas entrainment in the inclined part of the rectangular cavity and air exhaust from backstep part were also analized. Good agreement between the water tests and simulation results demonstrates the success of the SPH methodology development.

The methodology in this study is applied to the 3D mold filling process simulation considering air entrainment [3].

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