A new incompressible particle method constructed with conservative and dissipative forces

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ABSTRACT

In general, the mechanical energy in a physically consistent system will monotonically decrease. However, most particle methods for incompressible flow do not satisfy this condition. When the mechanical energy increases arbitrarily, numerical instabilities, such as particle scattering, may occur. Therefore, the physical consistency is of utmost importance for stable calculation. In this study, a new particle method with the consistency is developed for incompressible flow. The new method—the Moving Particle Full-Implicit (MPFI) method [1]—implicitly calculates the velocity and pressure at the same time. In the MPFI method, a monotonic energy decrease is assured because the particle interaction forces are formulated only with conservative force and dissipative force, which were derived from the potential energy and a dissipative function, respectively. To satisfy the incompressibility condition, only one linear symmetric matrix equation is solved in each time step, which is favorable for numerical efficiency. The method was verified by comparing results to those of the moving particle semi-implicit (MPS) method [2]—a particle method for incompressible flow—for the static pressure and dam break calculations. Furthermore, the free surface prediction capability of the method was validated by comparing to previously published experimental results [3] for the dam break problem.

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