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Development of Filling and Solidification Simulation using Smoothed Particle Hydrodynamics

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The occurrence of a defect is one of the great problems in the commercial process for the casting components. The defects include misrun, shrinkage cavity, porosity by gas entrapment and hydrogen precipitation. Thus, a method for simulating the filling and solidification processes was developed focusing the formation of casting defects. In the simulation, the numerical particle method of Smoothed Particle Hydrodynamics (SPH) was employed since it is capable to follow the phase change and, complex flow and free surface motion. The method of SPH can also track a history-dependent properties encountered in the casting process.

A specific algorism based on SPH was designed to simulate the filling and solidification of casting alloy. The weak coupling was employed among fluid analysis, thermal analysis and solid analysis. In the fluid analysis, Simplified Maker and Cell algorism was used for the formulation of incompressible viscous flow. The solid analysis was needed to simulate the shrinkage in the solidification process, where the springs known in the discrete element method were introduced among solid particles to simulate shrinkage. Then it was employed to simulate an aluminium alloy conical mold, focusing on the formation of defects such as shrinkage cavity and porosity. The analysis and the experimental results were compered each other on the morphology of the defects found in the gravity casting of eutectic Al-12Si alloy.

The results showed that:
1) The SPH method based on the proposed algorism can clearly simulate the formation of shrinkage cavities formed in the aluminium alloy conical mold,
2) The method using the simulated gas particle is able to predict the location of porosities in casting materials.