Development of Mold Filling Process Simulation considering Air Entrainment using SPH Method

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Key Words: *Particle Method, SPH, Die Casting, Air Entrainment, Mold Filling, OpenMP*

Die-casting is a casting method suitable for mass production because it can accurately form complicated shapes. However, when the mold is filled with the molten metal, there is unsatisfactory performance that casting cavities (gas porosity) are generated due to air entrainment, and the strength of the product varies.

Recently, with the aim of improving the quality and production efficiency of castings including this air entrainment, there has been many studies of simulating the behavior of molten metal during filling and visualizing the state of gas entrainment using CAE.

In this study, the mold filling process considering air entrainment in the die cast are simulated using the two-phase flow SPH method, that can be applied to the mold flow including gas entrainment[1], [2]. Then, the behavior of air entrainment due to the filling of molten metal (Aluminum alloy), especially the efect of injection speeds are investigated.

The particle model (number of particles: 270,000) that simplifies the 3D die-casting shape in the field is used in this simulation. And particles with a specified speed flow in continuously at the molten metal inflow gate. At the outlet (vent part), particles flowing out of the mold are erased.

In concluson, it is possible to investigate/visualize the air entrainment behavior at the time of filling the molten metal and the flow behavior due to different filling speeds, which is considered to be effective for improving the gas porosity of the cast product.
In addition, to speed up the two-phase flow program by SPH method, a parallel algorithm using OpenMP, which enables parallel calculation on a shared memory type machine, has been implemented. As the result of parallel calculation, we were able to achieve more than 3 times faster computational speed on a PC with 4 cores.

REFERENCES

[1] Ichimiya M., Development of Flow Simulation considering Gas entrainment using Particle Method. Proc., the 158th Casting Engineering Conference, JFES (2017).
[2] Ichimiya M., Yamagata N., Development of Two-Phase Flow Simulation using SPH Method, WCCM, Yokohama, July-August (2022) to be published.