Application of an arbitrary-shaped wall boundary model to a DEM simulation in a die filling process

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Abstract

Die filling is one of the powder molding processes in the field of various chemical industries. In the die filling process, not only operation conditions but also apparatus of filling system such as shapes of dies would influence the powder filling. In order to improve the quality of the final products and the efficiency of the overall processes, it is strongly desired to understand mechanism of powder filling into dies. Numerical simulation is an effective approach to investigate the powder flow. However, since there was difficulty in calculation of interaction between a particle and a complex shaped wall boundary, these studies have been focus on die filling systems with simple shaped dies. Therefore, there is little information about actual die filling systems although complex shaped dies are often required in the engineering practice.

In this study, there were two objectives in order to understand the powder flow into arbitrary-shaped dies. One objective was to apply arbitrary-shaped wall boundary model using the signed distance functions (SDF) to complex shaped dies. The other objective was to validate the adequacy of the SDF model in the die filling process. First, three-dimensional simulations of the particle flow into complex shaped dies were conducted by using the discrete element method (DEM) including the SDF model. Then, for the validation of the SDF model, macroscopic powder flows obtained from the DEM simulation were compared with that obtained from the experiment. Furthermore, spatial distribution of velocity and the final mass of filling particles were also compared. From these comparisons, it was confirmed that the simulation results agreed with the experimental ones. Consequently, it was shown that the SDF model could be an effective method for analyzing the particle flow into actual die filling systems.

Keywords: Particle simulation, Discrete element method, Signed distance function, Validation, Die filling