Development of the XEL method for granular and multi-phase flows

Mikio SAKAI
Resilience Engineering Research Center, The University of Tokyo
7-3-1 Hongo, Bunkyo-ku, Tokyo, 113-8656, Japan, E-mail:
mikio_sakai@n.t.u-tokyo.ac.jp

Application of the numerical simulation technologies is desired for the optimization of the design in industries. Especially, detailed modeling for complex phenomena is required in chemical engineering. This is because we often encounter granular and multi-phase flows such as gas-solid, solid-liquid, gas-liquid and gas-solid-liquid flows in chemical engineering. As a matter of course, boundary modeling of an arbitrary shape wall is needed in these systems. To perform such complex phenomena by numerical simulations, we develop new approach. This is called eXtended Eurelian-Lagrangian (XEL) method. Our recent results are shown in this presentation.

The XEL method covers granular flows as well as multi-phase flows, where the solid phase is modeled by the discrete element method (DEM); free surface fluid flow is modeled by the volume-of fluid method; the arbitrary shaped wall boundary is modeled by the signed distance function. When the arbitrary shaped wall is created, signed distance functions are used in the sold phase modeled by the DEM. The wall boundary for fluid phase is modeled by the immersed boundary method.

Adequacy of the XEL method is demonstrated in a screw conveying system, a fluidized bed, a wet ball mill and a twin-screw kneader. Verification or validation tests were performed in these systems. Hereafter, the XEL method is going to be applied to actual chemical engineering processes.