CFD-DEM modeling of layer inversion phenomenon in solid-liquid fluidized beds

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ABSTARCT

Layer inversion phenomenon can be observed in solid-liquid fluidized beds which contains a binary mixture with specific properties. At low liquid velocity, the two species form distinct layers, with the denser smaller particles at the bottom, and the larger lower-density particles at the top. At high velocities, the two layers are inverted, smaller particles being at the top while larger ones at the bottom. Extensive research [1, 2] has been performed to figure out this peculiar phenomenon, but the fundamentals causing this inversion is still not clear. The main aim of this work is to investigate the underlying mechanisms behind the layer inversion and also study effects of various parameters on this phenomenon. To achieve the goal, particle scale modeling is performed using a combined three-dimensional Discrete Element Model (DEM) and Computational Fluid Dynamics (CFD). The results show that the model can satisfactorily generate the layer inversion, and an explanation is provided to the occurrence of this phenomenon. It has been found that pressure gradient force plays an important role in layer inversion that increasing the liquid velocity reduces the pressure gradient force acting on particles especially on large ones. In addition, a comparison is made among different drag force models to figure out their capability in predicting layer inversion qualitatively and quantitatively. It is concluded that the drag force model proposed by Di Felice[3] fails to generate the inversion phenomenon, and the fluid-particle drag model reported by Rong et al. [4] predicts this phenomenon more accurately than other models.

REFRENCES

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