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多相流

提升管与下行床颗粒团聚行为的离散颗粒模拟

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摘要 从微观机理出发，采用计算流体力学和离散单元方法（CFD-DEM）结合的模型对二维提升管和下行床气固流动体系进行了数值模拟。模拟选用了粒径为520 μm、密度为2620 kg·m-3的球形颗粒和周期性边界条件，展示了气固并流逆重力场和顺重力场运动的颗粒聚团瞬态图像，定性或半定量地揭示了两个不同体系的颗粒微观聚集行为。提升管中颗粒聚团较为严重，且表现明显的颗粒返混现象；下行床中的颗粒聚团比较松散，且具有与宏观流动相同的流速方向，几乎无颗粒返混。通过统计分析获得宏观时均流体力学行为，包括两相的相分布和速度分布，并与文献报道的实验现象进行定性的比较。

关键词 提升管 下行床 离散单元法 计算流体力学 颗粒聚团

分类号

CFD-DEM simulation of clustering phenomena in riser and downer

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Abstract

Based on the micro-scale flow mechanism，a method combining computational fluid dynamics (CFD) and discrete element method (DEM) was established to simulate the gas-solid flow systems in the 2-dimensional riser and downer.Periodic boundary conditions were employed in the simulations,in which particles with mean diameter of 520 μm and density of 2620 kg·m-3 were used.The results qualitatively or semi-quantitatively disclosed the different particle clustering phenomena on the micro-scale in the co-current gas-solid flows against or along the gravity direction.In the riser,severe particle clustering existed and the particles in clusters showed evident backmixing.While in the downer,rather loose clustering was observed and the particles in clusters flowed in the same direction as the macro-flow.Backmixing of particles could hardly be found in the downer.Ensemble-averaged macro-flow behavior, including the distributions of gas and solids velocities and concentrations, were obtained statistically, which had qualitative agreement with the experimental data in the literature.

Key words riser downer discrete element method computational fluid dynamics clustering phenomena

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