

多相流和计算流体力学

高密度液固循环流化床流动特性研究及数值模拟

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摘要

在 $\Phi 80\text{ mm} \times 8000\text{ mm}$ 的液固循环流化床提升管中, 利用实心玻璃珠和常温水, 采用实验和数值模拟相结合的方法对高密度液固循环流化床的流动特性进行了考察。实验发现, 高密度液固提升管中, 颗粒固含率和颗粒速度径向分布均为抛物线分布, 轴向平均固含率分布总体上为下浓上稀的波动形式分布, 颗粒在提升管中的流动表现出加速-减速-再加速直至充分发展的过程。这种分布特征与较高颗粒浓度、较高表观液速和颗粒循环速率及喷管式液体分布器的影响有关。液固提升管中固体颗粒的停留时间分布曲线均为尖而窄、较对称且没有明显拖尾的单峰分布, 这表明颗粒基本是以弥散颗粒形式存在, 颗粒停留时间分布较为均匀。通过将数值模拟结果与实验结果进行比较发现, 模拟值与实验值吻合较好, 说明所建立的数学模型较为合理, 进一步通过数值模拟实验对颗粒密度和颗粒粒径对流动特性的影响规律进行了考察。

关键词 [高密度液固循环流化床](#) [固含率](#) [颗粒速度](#) [颗粒停留时间分布](#)

分类号

Experimental and computational investigation on hydrodynamics in high-density liquid-solid circulating fluidized bed

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Abstract

Hydrodynamic behavior in a high-density liquid-solid circulating fluidized bed (HDLSCFB), 80 mm in ID and 8000 mm in height was investigated experimentally and computationally. The experiment found that both the radial particle hold-up and velocity distribution in the riser was parabola-shaped, while the axial average particle hold-up and velocity distribution was wave-shaped, indicating that the glass beads particles in the riser experienced a second acceleration process before reaching a fully developed flow at the top section of the riser. This was believed to be closely related to the high particle hold-up in the riser, high UI and G_s as well as the application of tubular distributor at the bottom of the riser. The experimental results also showed that the profile of the particle residence time distribution of LSCFB had a sharp narrow symmetrical peak with no tail, suggesting a rather uniform residence time distribution of solids, a small extent of solids dispersion and a plug flow-like structure. CFD simulation results agreed well with those obtained by experiment, indicating that the computational model was suitable for simulation and prediction. Based on the computational model, the influence of particle density and diameter on the hydrodynamics was also predicted.

Key words [high-density liquid-solid fluidized bed](#) [particle hold-up](#) [particle velocity](#) [particle residence time distribution](#)

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