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工程热物理

不同物性对椭球形颗粒在移动床中流动特性影响的模拟研究

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摘要：

采用多元颗粒模型对椭球形颗粒在移动床内的流动进行了离散单元法直接数值模拟。椭球形颗粒由3个叠加在一起的球元构成，建立了椭球形颗粒的碰撞机制，详细分析了其运动过程中的受力情况，主要是碰撞力和重力，并通过实验验证了模型的正确性。探讨不同物性颗粒在移动床内的流动特性，分析颗粒物性对流型、空隙率分布以及颗粒分离情况的影响。结果表明，滑动摩擦系数越小，颗粒流动越接近整体流，滑动摩擦系数越大，颗粒流动越接近漏斗流，且滑动摩擦系数越大，空隙率的波动范围越大，滑动摩擦系数越小，空隙率分布越均匀。滚动摩擦系数和弹性恢复系数对流型和空隙率的影响都很小。在二元混合物中，颗粒直径比越大，空隙率越小。不同尺寸颗粒混合物会导致颗粒分离，在下料时，颗粒直径比越大，细颗粒含量越少，但在物料卸出90%以后，细颗粒含量反而变大。滑动摩擦系数增大，在下料初始和最终阶段，细颗粒含量变大，而在下料中间阶段，细颗粒含量变少。

关键词：　椭球形颗粒　移动床　离散单元法直接数值模拟　流动特性

Effect of Particle Properties on the Flow Behaviors of Ellipsoidal Particles in the Moving Bed

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Abstract:

Discrete element model (DEM) was developed to simulate the ellipsoidal particles flowing in the moving bed. The ellipsoidal particles was described by three overlapping sphere. Contact force and gravity force were considered when establishing the models, and the model was validated by the experiment results. In addition, flowing characteristic of particles in the moving bed was studied. The result shows that the flow mode is closer to the mass flow with the slide friction coefficient decreasing. And the voidage fluctuation range is greater as the slide friction coefficient increasing. Also, the influence of rolling friction coefficient and restitution coefficient on the flow mode and voidage can be ignored. For binary mixture, the voidage is smaller as the diameter ratio increase. The separation phenomenon will occur when different diameter particles mixing. The content of small size particle is less with increasing the diameter ratio during discharge. But when the discharge rate is more than 90%, the contrary tendency occurs. And with the sliding friction coefficient increasing, the content of small size particle increases at the initial and final discharging period, but decreases at the middle period.

Keywords: ellipsoidal particles　moving bed　discrete element model (DEM)　flow characteristic

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