TRANSPORT PHENOMENA & FLUID MECHANICS

基于颗粒流运动论的喷动流化床气固流动行为三维模拟

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摘要 A three-dimensional Eulerian multiphase model, with closure law according to the kinetic theory of granular flow, was used to study the gas/solid flow behaviors in spout-fluid beds. The influences of the coefficient of restitution due to non-ideal particle collisions on the simulated results were tested. It is demonstrated that the simulated result is strongly affected by the coefficient of restitution. Comparison of simulations with experiments in a small spout-fluid bed showed that an appropriate coefficient of restitution of 0.93 was necessary to simulate the flow characteristics in an underdesigned large size of spout-fluid bed coal gasifier with diameter of 1m and height of 6m. The internal jet and gas/solid flow patterns at different operating conditions were obtained. The simulations show that an optimal gas/solid flow pattern for coal gasification is found when the spouting gas flow rate is equal to the fluidizing gas flow rate and the total of them is two and a half times the minimum fluidizing gas flow rate. Besides, the radial distributions of particle velocity and gas velocity show similar tendencies; the radial distributions of particle phase pressure due to particle collisions and the particle pseudo-temperature corresponding to the macro-scopic kinetic energy of the random particle motion also show similar tendencies. These indicate that both gas drag force and particle collisions dominate the movement of particles.

关键词 gas/solid flow   CFD   Eulerian multiphase model   kinetic theory of granular flow   spout-fluid bed

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Three-dimensional Simulation of Gas/Solid Flow in Spout-fluid Beds with Kinetic Theory of Granular Flow

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Abstract A three-dimensional Eulerian multiphase model, with closure law according to the kinetic theory of granular flow, was used to study the gas/solid flow behaviors in spout-fluid beds. The influences of the coefficient of restitution due to non-ideal particle collisions on the simulated results were tested. It is demonstrated that the simulated result is strongly affected by the coefficient of restitution. Comparison of simulations with experiments in a small spout-fluid bed showed that an appropriate coefficient of restitution of 0.93 was necessary to simulate the flow characteristics in an underdesigned large size of spout-fluid bed coal gasifier with diameter of 1m and height of 6m. The internal jet and gas/solid flow patterns at different operating conditions were obtained. The simulations show that an optimal gas/solid flow pattern for coal gasification is found when the spouting gas flow rate is equal to the fluidizing gas flow rate and the total of them is two and a half times the minimum fluidizing gas flow rate. Besides, the radial distributions of particle velocity and gas velocity show similar tendencies; the radial distributions of particle phase pressure due to particle collisions and the particle pseudo-temperature corresponding to the macro-scopic kinetic energy of the random particle motion also show similar tendencies. These indicate that both gas drag force and particle collisions dominate the movement of particles.

Key words gas/solid flow CFD Eulerian multiphase model kinetic theory of granular flow spout-fluid bed

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