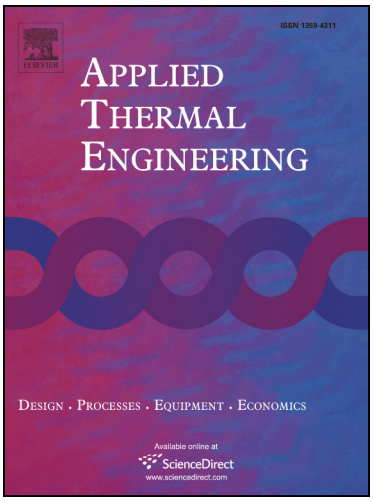

Research Paper

Modeling the heat transfer between fluid-granular medium

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Modeling the heat transfer between fluid-granular medium

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Abstract

Fluidized bed processes to have various applications, where knowledge of temperature fields is very important (combustion, drying, freezing etc...). Thermal behavior of solid-fluid in fluidized beds has been studied through the simulation by means of coupling Discrete Element Method (DEM) and Computational Fluid Dynamics (CFD). A thermal approach (conduction-convection) based on the finite volume method is proposed to calculate the heat transfer between particle-fluid and particle-particle, the effects of dissipation by friction and impact (collision) were also taken into account. Validation of results depicted that the thermal model has proven its effectiveness whether on a fixed or fluidized bed. A thermal indicator is proposed, which allows knowing the ratio of particles that have reached the temperature of the fluid imposed, which is difficult to access in practice. Finally, an evaluation of heat transfer in fluidized bed has been done, through inlet fluid velocity to the fluidization column. The evaluation revealed the effect of fluid velocity on the mechanisms of heat transfer (conduction and convection) energy in the fluidization processes. The simulations results were agreed and consistency with the experimental data in the literatures, which will allow in the longer term; to add heat transfer models and mass transfer ones between the fluid and particles (for example during a drying process) in simulations.

Keywords: Fluidization; DEM; CFD; Coupling DEM-CFD; Thermal approach; Thermal index of fluidization.

1. Introduction

Understanding heat transfer throughout the microstructure of a granular medium is an old and important problem in many areas, such as powders, metallurgy, environment and design of fixed (or dynamic) bed reactors. In the case of static granular medium the heat transfer by conduction is usually the most important mechanism. However, convection can become predominant in the presence of fluid in movement. The convection depends on the thermal properties of the particles (specific heat and thermal conductivity), particle characteristics (density, particle size), the thermal properties of the fluid, the speed and the flow rate of the fluid and the temperature difference between the particles and the fluid. The contribution by radiation depends on the temperature of the radiating body and it becomes significant only at elevated temperature. Most often, these heat transfer process are not isolated, and act together in many industrial applications. But we can also say that the contribution of convection is usually the most significant in the fluidizing process [1]. Heat transfer in the granular medium under flow