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The Granular Thermal Behaviour in a Vibrated Bed

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Extended Abstract

The thermal behaviour in dry granular system is complex. The effective conductivity for the granular materials is investigated in former literature [1]. As the literature's argument, the bulk properties of granular system are the important properties for the granular thermal behaviour. There some theoretical models basing on the contact network model are developed to describe the thermal conduction behaviour in static granular system [2]. The thermal behaviour for the granular system, in which the particles with small fluctuant motions, is quite different from the stagnant system. Hunt [3] discusses the effective thermal conductivity of particles with the random fluctuant motions by the theoretical studies basing on the kinetic theory. Moreover, the thermal diffusivity is an important thermal property of material, and is also a suitable collection of physical properties for transient solutions of the heat equation. Therefore, it is a good way to discuss the thermal behaviour of granular system via analysing the effective thermal diffusivity.

A granular bed with different vibrated conditions are produced and tested in this study. A heater, which are provide constant heat flux into the granular bed, are mounted at the bottom of the vibrated granular bed to heat the particles. An electromagnetic vibrational system served as the vertical shaker. The shaker was vertically driven by sinusoidal signals produced by a function generator through a power amplifier. The vibrational frequency and acceleration were measured by an accelerometer fixed at the shaker and connected to an oscilloscope. Spherical aluminium particles with a nominal diameter of 2 mm are used in the experiments. Under the granular bed is vibrated, the high-speed camera was used to record the front view of the particle contact structures of the bed with the same vibrated phase for each experimental test. Using a particle-tracking method with the assistance of an image-processing system, the velocity and self-diffusion coefficient of the particles could be measured and calculated. The inverse approach solution [4] with the aid of the measurement of the thermal temperature distribution in the bed can be used to calculate the effective thermal diffusivity of the vibrated granular bed. The inverse algorithm is often used to calculate unknown thermal properties by solving transient inverse heat conduction problems. A smoothing filter was applied to smooth the data on the change in temperature over time. The smoothed data were used when calculating the term of the time derivative of temperature in the transient heat conduction equation

In this study, the effective thermal diffusivity of the dry granular materials are discussed. We first analyse how modifying this intensity of vibration affects the fluctuant motion of granular material. Then we investigate the effect of self-diffusion of granular material on the thermal behaviour of the vibrated granular bed. The results show that stronger mass diffusion increases thermal diffusion. The effective thermal diffusivity and the self-diffusion coefficient were shown to be in a positive relationship. The findings of the effective thermal diffusivities of vibrated granular bed can explain the thermal conduction behaviour of the granular pile with self-diffusion.

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