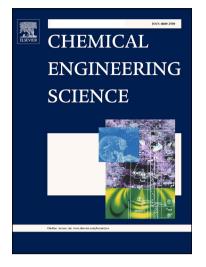
Accepted Manuscript

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PII: DOI: Reference:	S0009-2509(18)30218-5 https://doi.org/10.1016/j.ces.2018.04.020 CES 14152
To appear in:	Chemical Engineering Science
Received Date:	9 August 2017
Revised Date:	27 February 2018
Accepted Date:	7 April 2018



Please cite this article as: L-T. Sheng, S-L. Chiu, S-S. Hsiau, Effect of mass diffusion upon the thermal-diffusive behavior of a dry vibrated granular bed, *Chemical Engineering Science* (2018), doi: https://doi.org/10.1016/j.ces. 2018.04.020

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Effect of mass diffusion upon the thermal-diffusive behavior of a dry vibrated granular bed

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Abstract

We report the results of an experimental study on the thermal-diffusion mechanisms of particles with fluctuant motion in a dry granular system. Granular beds with different intensities of particle self-diffusion were produced by exerting vertical vibration-driving forces of different strengths. The effective thermal diffusivity, α_e , was determined by solving the inverse transient heat conduction problem. The self-diffusion coefficient in the vertical direction, D_{yy} , was calculated to describe the diffusive motions of the particles in the bed. The dimensionless Lewis number, *Le*, was calculated to investigate the relationship between mass diffusion and thermal diffusion. First, we demonstrated that mass diffusion increased the thermal-diffusive behavior of the dry granular system. Second, we identified a positive linear correlation with the specific slope S_{ad} between α_e and D_{yy} . In particular, the value of S_{ad} represents a characteristic of the granular system related to the relationship between thermal diffusivity and the mass diffusivity; this means that *Le* may approach the value of S_{ad} if the intensity of particle self-diffusion in the bed is sufficiently strong. *Keywords:* Particle self-diffusion, Effective thermal diffusivity, Vibrated granular bed, Lewis number

1 1. Introduction

Heat transfer in granular systems is encountered in many engineering applications, for example, in porous media
and food processing, as well as in geophysical contexts. The heat-transport mechanism in a granular system is more
complex than transport through a pure solid material because of the effect of interstitial fluid in the voids between the
particles. A number of studies have investigated the effective conductivity of a stagnant dry granular system [1, 2, 3,
4, 5, 6, 7]. For granular systems with high solid-to-interstitial-air conductivity ratios, the heat-transfer mechanisms

Preprint submitted to Chemical Engineering Science

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