Article

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Prediction of the effective thermal conductivity of packed bed with micro-particles for thermochemical heat storage

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Abstract

The heat transfer property of the powder bed greatly affects the performance of a thermochemical heat storage system. Therefore, an accurate evaluation of effective thermal conductivity (ETC) is a key for developing thermochemical heat storage systems. This paper focuses on the ETCs of commonly used porous thermochemical materials, such as $MgO/Mg(OH)_2$ and $CaO/Ca(OH)_2$ powders, as well as the corresponding composites with embedded metal foams. Random sphere-like particles packing (RSPP) method is proposed to reconstruct the microstructures of the powder and micro-scale generation method and computed tomography are adopted for the metal foams. Energy transport equations through porous media are solved by the lattice Boltzmann method (LBM) to obtain ETC. Results obtained using RSPP-LBM method agree with experimental data better than other existing methods. For thermochemical heat storage, the variation of ETC during chemical reactions is numerically predicted. Metal foam-embedded thermochemical materials are also studied to evaluate the enhancing effects of the metal foams. Results show that ETC of the powders is dominated by the gas phase, whereas that of the metal foam composites is dominated by the metal phase.

Keywords: thermochemical heat storage; effective thermal conductivity; MgO; CaO