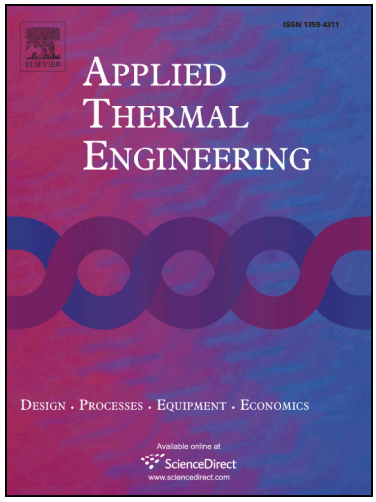

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Analysis of the thermal field and heat transfer characteristics of pebble beds packed in a face-centered cubic structure

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Abstract

Analyzing the heat transfer characteristics in a packed pebble bed is a critical task. Therefore, in this study, experiments are conducted with the pebbles packed in a face-centered-cubic (FCC) structure; a numerical simulation model is developed and validated as well. The experiments are performed under five different conditions of air inlet velocity, and both numerical and experimental thermal profiles of particular pebble surfaces are observed. In addition, the heat transfer performances of the bed are also analyzed. The correlations of heat transfer coefficient and the Nusselt number with the Reynolds number are respectively proposed as $h_{AVG} = 0.03677Re^{0.8}$, $Nu = 0.194Re^{0.8}Pr^{0.4}$ (Pr = 0.712, Re $\leq 4\times10^4$). The heat transfer intensity in an FCC structured pebble bed is observed much higher than that presented in other correlations; particularly, it is up to 8.4 times higher than that in a cylindrical pipe. It was found that the simulation results and the experimental results match with each other regarding the surface temperatures and the heat transfer coefficient. Moreover, the pressure drop from inlet to the outlet of the test section is investigated using the validated numerical model, and a correlation which helps predict the pressure drop in a packed bed is given. These findings can not only provide a deeper understanding of the thermodynamics in an FCC structured packed bed but also facilitate safer reactor and regenerator design.

Keywords: Experiment; FCC structured pebble beds; thermal field; heat transfer characteristics; simulation.

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