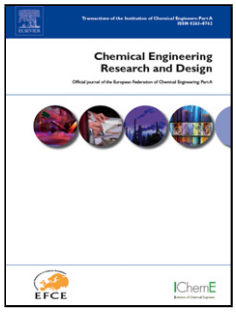

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Computational study of flow and heat transfer in fixed beds with cylindrical particles for low tube to particle diameter ratios

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Highlights:

- The structure features for fixed beds with cylindrical particles were investigated.
- The wall effect on flow and heat transfer in fixed bed was revealed.
- The 2D quasi-homogeneous model was improved depending on CFD results.

Abstract

A three dimensional CFD model was developed for studying flow and heat transfer in fixed beds with cylindrical particles for low tube to particle diameter ratios. The packing structures were generated by means of the discrete element method (DEM), in which the rigorous cylindrical particle was adopted. The detailed packing structure features were obtained, including the particle position, orientation, porosity distribution and the effect on the flow and heat transfer process was analyzed. The wall effect was found to be obvious for fixed beds with low tube to particle diameter ratios. The cylindrical particles tend to be organized in circles, which is even more visible in the vicinity of walls. The radial porosity distribution showed that the obvious oscillation existed in near wall region. The detailed velocity and temperature distribution were investigated. The average axial velocity showed similar tendency with radial porosity distribution. Large porosity caused large velocity and temperature gradients in the wall region. The radial temperature distribution was also calculated by the improved two dimensional quasi-homogeneous model, in which the local porosity and axial average velocity distributions from CFD simulations were adopted and good consistencies for temperature distribution were achieved for different tube to particle diameter ratios.

Keywords: CFD model; flow and heat transfer; fixed bed; cylindrical particles; low tube to particle diameter ratios; discrete element method; structure features; two dimensional quasi-homogeneous model

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