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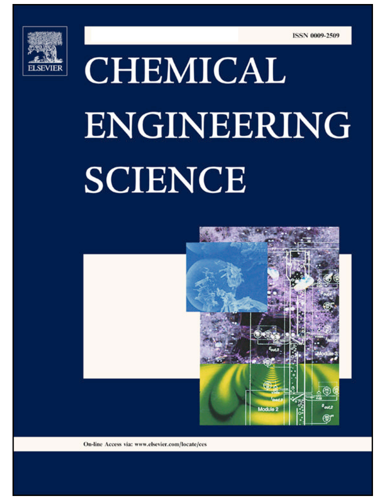

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Mass transfer phenomena in fluidized beds with horizontally immersed membranes: a numerical investigation

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Abstract

Mass transfer phenomena in gas-solid fluidized beds with horizontally immersed membrane tube banks in different configurations were investigated using a Two-Fluid Model, considering the case of a binary hydrogen/nitrogen gas mixture fed to a 2D fluidized bed where hydrogen was extracted via hydrogen perm-selective membranes. The simulations showed that the hydrogen flux is strongly non-uniform over the radius of the membranes. The hydrogen flux is lowest on top of the membranes and highest at the bottom of the membranes, which is caused by the formation of densified zones on top of the membranes and the fact that the membranes shield their own top side from hydrogen replenishment. Also, in systems with membrane tube banks, the performance of individual membranes differs significantly. The membranes located near the bed walls perform considerably worse, because of downwards solids flow near the walls, resulting in more densified zones and gas back-mixing. The average hydrogen recovery per membrane is highest for the cases with a staggered tube bank configuration and without membranes positioned close to the bed walls. In-line tube bank configurations suffer from gas channeling, reducing the hydrogen recovery per membrane. The membrane tube banks also significantly improve the bed hydrodynamics by enhanced bubble-breakage, decreasing the bubble size to approximately the membrane pitch.

Keywords

Mass transfer, fluidized bed, membranes, Two-Fluid Model, Computational Fluid Dynamics.

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