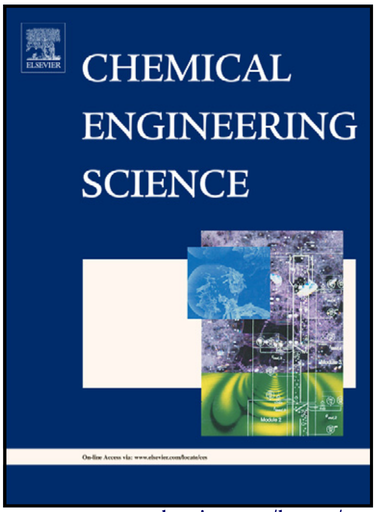

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Influence of ligament shape and thickness on vortex shedding in highly porous structures

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Abstract

Highly porous structures (porosity $\geq$ 75%) used as inserts in continuous chemical reactors with characteristic length scale in the millimeter range exhibit at industrial relevant throughputs the transport phenomenon vortex shedding. The dependency of the ligament shape and thickness of the porous media on vortex shedding is investigated in two geometries: A highly porous structure consisting of round ligaments and a highly porous structure whose ligaments are thicker and have a square cross section. The contribution of vortex shedding to the total turbulent kinetic energy is determined from proper orthogonal decompositions (POD) of fluctuating velocity fields measured with particle image velocimetry (PIV). The spatial structure of the vortex shedding phenomenon is addressed by POD eigenfunctions and by the wake length extracted by the position of zero mean streamwise velocity along the wake axis. Shedding frequencies are evaluated for a large Reynolds number range ($6 \leq Re_D \leq 1500$) by a dye injection technique. The vortex shedding phenomenon is more intense in case of the highly porous structure with square and thicker ligaments. This means that larger vortices are created and detached, Strouhal numbers are larger and the contribution of vortex shedding to the total turbulent kinetic energy is more substantial in this case compared with the structure with round and thinner ligaments.

Keywords: Transport processes, Vortex shedding, Strouhal number, PIV, POD, porous media

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