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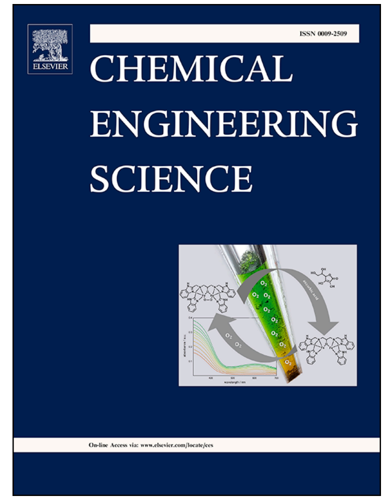

Compact Coiled Flow Inverter for Process Intensification

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Compact Coiled Flow Inverter for Process Intensification

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Abstract

The present study focuses on the intensification of flow and mixing in *coiled flow inverter (CFI)* geometries in order to achieve higher mixing efficiency with a lower base footprint. For this, two processes intensified designs of "compact coiled flow inverter (CCFI)", *namely*, symmetrical compact coiled flow inverter and asymmetrical compact coiled flow inverter, are proposed within the same floor area as covered by a standard design of a conventional CFI. The design of the symmetrical CCFI is based on incorporating as maximum as possible 90° bends, whereas the asymmetrical CCFI is based on incorporating as maximum as possible mixing volume.

In order to quantify the improvements caused by proposed designs, all three geometries (two CCFIs and one standard CFI) are compared (experimentally and numerically) with each other in terms of dimensionless dispersion number (D/UL) and mixing efficiency (that measures induced radial mixing by incorporating pressure drop penalty), over laminar flow regime ($10 \le N_{\mathrm{Re}} \le 145$). After validation of the numerical model (CFD) with experimental data, the RTD at various interior localized cross-sectional planes (throughout the length of coiled tube of the geometries) is investigated. Such a study provides the relative contribution of helical turns and 90°bends in reducing axial dispersion, and also provides an insight of the required length of coiled tube that is sufficient to achieve a desired reduction in the axial dispersion. The present study reveals that the symmetrical compact coiled flow inverter has the highest mixing efficiency per unit occupied floor area, and requires the least length of coiled tube in order to reduce the axial dispersion at same extent. Thus, the symmetrical CCFI has potential to save significant material and operational energy cost in the Industry.

Keywords: Axial dispersion, Compact CFI, CFD, RTD

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