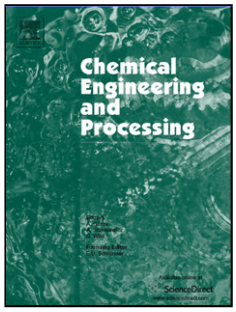

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Role of curvature of walls (concave/convex) for intensification of thermal processing with optimal exergy loss during natural convection of fluids

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Abstract

Based on its potential to develop more sustainable and energy efficient systems, process intensification is on increasing importance in various processing industries. The process intensification vs efficiency is carried out for natural convection in square enclosure and curved (concave/convex) wall enclosures via heatlines and entropy generation analysis for the development of sustainable process equipment design. As the selection of an optimal cavity is the main objective for the increase in efficiency, a comparative study has been carried out among the enclosures with equal dimensionless area (= unity) and equal heater length (= 1 unit). Two heating strategies are considered such as (a) case 1: hot bottom wall (b) case 2: hot left wall. Numerical simulations have been carried out for various values of Prandtl (Pr) and Rayleigh (Ra) numbers. Heatline trajectories illustrate that convex cavities with case 1 or case 2 may be chosen based on higher thermal mixing for various Ra. On the other hand, based on higher entropy savings with higher wall heat transfer rates, concave cavities with case 1 or case 2 are preferred. Overall, economic design of the cavity must consider the enhanced thermal mixing vs savings of entropy generation or exergy loss.

Key words: Intensification; curved walls; natural convection; heatline; entropy generation; thermal management

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