Analysis of Mixing Performance and Heat Transfer Enhancement Using Chaotic Advection Caused by Simple Changes in Coiled Tube Heat Exchangers

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Abstract. *The present work proposes a novel chaotic heat exchanger to examine the effects of chaotic advection on heat transfer at low Reynolds numbers. The main mechanism generating chaotic flow is the production of spatially chaotic trajectories in an alternating Dean flow. In order to assess the enhancement of heat transfer by chaotic advection, two different heat exchanger (both of shell-and-tube type) of the same heat-transfer surface area and the same tube length were used: One is a convectional helical coil with a fixed axis which produces regular mixing, while the other one is an innovative configuration in which there is a periodic change in helical coils configuration.*

Velocity vectors and temperature field are computed. Furthermore, the Lyapunov exponents are used to identify the presence of chaotic advection in the proposed heat exchanger. By means of Lagrangian tracing of fluid particles in the flow field and sensitivity to initial condition calculations, it is shown that mixing and heat transfer is increased significantly due to change advection mechanism to chaotic advection.

Furthermore, a higher Nusselt number indicates an enhanced heat transfer and a more uniform temperature distribution for the fluid flow in the chaotic coil. The chaotic coil configuration also displays a heat transfer enhancement of 13% in terms of the fully developed Nusselt numbers compared to the straight coil with 3% change in the pressure drop.

Keywords: Chaotic mixing, Helical coiled Tube, Heat exchanger, Heat transfer