A Study of Heat Transfer and Entropy Generation Flow in Horizontally Spaced Non-Concentric Cylinders

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Abstract

Energy transfer studies in circular channels and circular cavity tubes are fundamental to understanding and optimizing thermal systems used in various engineering applications. These studies focus on analyzing the interaction between heat and fluid flow within confined circular geometries, which are common in heat exchangers, cooling systems, solar collectors, and industrial processes. The primary objectives of this study include enhancing energy utilization, maximizing energy retention or dissipation as required by the application, and reducing energy losses through improved circular cavity design. Using the finite element method, we solve the steady, incompressible Navier–Stokes and energy equations for Rayleigh numbers ranging from 10^3 to 10^7, where the eccentric dimension ranges from 0 to 1. The analysis emphasizes thermo-fluid interactions at the fluid–solid interface and the role of geometric asymmetry in shaping flow and thermal fields Under strongly convective conditions ( ), average Nusselt numbers decline by nearly 50% while local Nusselt peaks concentrate near stagnation zones, indicating uneven heat transfer across the interface. The entropy generation analysis and the Bejan number are presented for angles ranging from 0 to 360°, where the angular shift of entropy generation peaks highlights asymmetry effects up to (>30%),

Keywords

Entropy generation, Solid particles, Bejan number, Conjugate heat transfer, Conjugate heat transfer, FEM, Inner obstacle.