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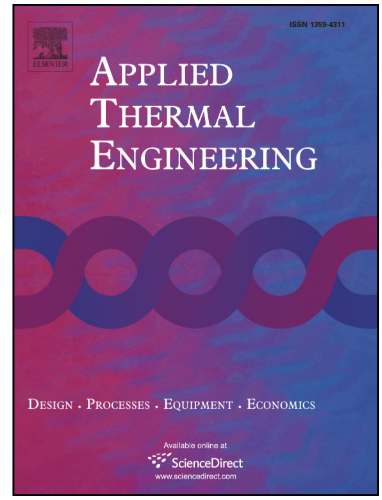

Research Paper

Combined effects of nanofluid and transverse twisted-baffles on the flow structures, heat transfer and irreversibilities inside a square duct-A numerical study

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Combined effects of nanofluid and transverse twisted-baffles on the flow structures, heat transfer and irreversibilities inside a square duct-A numerical study

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Abstract:

This paper presents a three-dimensional, numerical thermo-hydrodynamic and second low analysis of nanofluid flow inside a square duct equipped with transverse twisted-baffles. A finite volume method is employed to simulate forced convection of heat in the system with the inclusion of Brownian motion of the nanoparticles. The ultimate aim is to gain further understanding of the underlying physical processes and also to determine the optimal design and working conditions of the system. The effects of variations in the pitch intensity (γ) from 180° to 540° and volume fraction of nanoparticles (φ) from 0 to 0.05 on the nanofluid flow, heat convection and thermodynamic irreversibilities are investigated. The numerical results show that the baffle with γ=360° features the maximum value of heat transfer coefficient among all values of γ. Additionally, the baffle with γ=540° shows the minimum pressure drop for the entire range of γ. Finally, it is shown that the thermal entropy generation decreases by increasing the volume fraction of nanoparticles or inserting baffles inside the duct.

Keywords: Nanofluid; Transverse baffles; Thermo-hydrodynamics; Entropy generation; Finite volume; Square duct.

Nomenclature

Be	Bejan number (-)
c_p	Specific heat at constant pressure (J kg^{-1} K^{-1})
D	Distance between baffles (m)
D_h	Hydraulic diameter (m)
d_f	Molecular diameter of base fluid (nm)
d_p	Nanoparticle diameter (nm)
f	Friction factor (-)
H	Side of duct (m)
h	Convective heat transfer coefficient (W m^{-2} K^{-1})
k	Thermal conductivity (W m^{-1} K^{-1})