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Mixed Convection and Entropy Generation of an Ag-Water Nanofluid in an Inclined L-Shaped Channel

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Abstract: This paper investigates the mixed convection and entropy generation of an Ag-water nanofluid in an L-shaped channel fixed at an inclination angle of 30° to the horizontal axis. An isothermal heat source was positioned in the middle of the right inclined wall of the channel while the other walls were kept adiabatic. The finite volume method was used for solving the problem's governing equations. The numerical results were obtained for a range of pertinent parameters: Reynolds number, Richardson number, aspect ratio, and the nanoparticles volume fraction. These results were Re = 50–200; Ri = 0.1, 1, 10; AR = 0.5–0.8; and φ = 0.0–0.06, respectively. The results showed that both the Reynolds and the Richardson numbers enhanced the mean Nusselt number and minimized the rate of entropy generation. It was also found that when AR. increased, the mean Nusselt number was enhanced, and the rate of entropy generation decreased. The nanoparticles volume fraction was predicted to contribute to increasing both the mean Nusselt number and the rate of entropy generation.

Keywords: mixed convection; entropy generation; nanofluid; L-shaped channel; FVM

1. Introduction

Despite its active classification, mixed convection flow is still a useful tool of heat transfer augmentation. It provides efficient cooling (or heating) for many engineering applications, such as for building ventilation, cooling gas turbine blades, cooling electronic devices, cooling chemical reactors, emergency cooling systems of nuclear reactors, etc. Many studies have revealed that the mixed convection flow have different issues based on the geometry of the channel or the duct. However, most researchers compromise between the heat transfer enhancement and the associated pressure losses. Shah and London [1] have given an early and very good review of forced convection using regular duct geometry. In the early designs of a corrugated channel, the pressure drop reaches up to six times that of a smooth channel, while the heat transfer augmentation was aut 3.5 times [2]. Separation and reattachment of the flow in backward- and forward-facing steps were proven to give an improvement to efficient heat transfer [3]. Finned or ribbed wall surfaces are also implemented as a passive strategy to improve the mixing of flow and increase the area of heat transfer [4–6].

For the ventilation requirements to obtain optimal performance and space limitation, the flow in a channel can be designed into different shapes. Mezrhab et al. [7] considered the surface radiation