Mixed convective heat transfer augmentation in a backward-facing step utilizing nanofluids

S. Dhinakaran*

IBB – Institute for Biotechnology and Bioengineering, Centre of Biological Engineering, University of Minho, Campus de Gualtar, 4710–057 Braga, Portugal

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Two-dimensional mixed convection in a backward-facing step utilizing nanofluids is investigated numerically. The top wall (cold) is is maintained at a constant temperature T_C while the bottom wall & step (hot) are kept at constant temperaure T_H. The mixed-convection heat transfer in a backward-facing step has been examined numerically using suspensions of copper nanoparticles in water. Richardson number, $Ri = Gr / Re^2$ emerges as a measure of relative importance of natural and forced convection modes on the heat transfer. The governing parameters were $0.01 \leq Ri \geq 100$, Prandtl number, Grashoff number, Gr = 104, Pr = 6.2, for nanoparticle volume fractions, χ = 5%, 10%, 15% and 20% of base fluid. A finite volume method SIMPLE has been used to solve the governing equations of nanofluid flow and heat transfer numerically on a staggered grid system using a higher order upwind scheme (QUICK).

The flow pattern doesnot vary significantly when Ri << 1 while it differs significantly when Ri >> 1 with the use of nanofluids compared to conventioned fluids. These are shown by contours of streamlines velocity vectors and isotherms for different Ri for different values of χ . The plots of total Nusselt number ($\overline{Nu}$) shows that the heat trasfer increases with increase in particle volume fraction χ . A drastic increase in heat transfer occurs while utilizing nanofluids compared to conventional fluids.

In recent years, there has been an extensive research on the heat transfer in nanofluids. The forced convective flow and heat transfer in a backward-facing step utilizing different nanofluids has been studied by (?). The problem of 'mixed convection heat transfer enhancement utilizing nanofluids in a backward-facing step' has not yet been investigated to the best knowledge of the author. Separated flow as encountered in a backward-facing step occurs in various engineering applications such as combustors, heat exchangers, gas turbine blade and micro-electronic circuit boards.

References

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* Corresponding author. Tel. +351-963549500 E-mail: sdhinakaran@deb.uminho.pt