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Natural convection of nanofluids in a cavity: Criteria for enhancement of nanofluids
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Abstract
Purpose - The purpose of this study is to theoretically analyze the laminar free convection heat transfer of nanofluids in a square cavity. The sidewalls of the cavity are subject to temperature difference, whereas the bottom and top are insulated. Based on the available experimental results in the literature, two new nondimensional parameters, namely, the thermal conductivity parameter (Nc) and dynamic viscosity parameter (Nv) are introduced. These parameters indicate the augmentation of the thermal conductivity and dynamic viscosity of the nanofluid by dispersing nanoparticles. Design/methodology/approach - The governing equations are transformed into non-dimensional form using the thermo-physical properties of the base fluid. The obtained governing equations are solved numerically using the finite element method. The results are reported for the general non-dimensional form of the problem as well as case studies in the form of isotherms, streamlines and the graphs of the average Nusselt number. Using the concept of Nc and Nv, some criteria for convective enhancement of nanofluids are proposed. As practical cases, the effect of the size of nanoparticles, the shape of nanoparticles, the type of nanoparticles, the type of base fluids and working temperature on the enhancement of heat transfer are analyzed. Findings - The results show that the increase of the magnitude of the Rayleigh number increases of the efficiency of using nanofluids. The type of nanoparticles and the type of the base fluid significantly affects the enhancement of using nanofluids. Some practical cases are found, in which utilizing nanoparticles in the base fluid results in deterioration of the heat transfer. The working temperature of the nanofluid is very crucial issue. The increase of the working temperature of the nanofluid decreases the convective heat transfer, which limits the capability of nanofluids in decreasing the size of the thermal systems. Originality/value - In the present study, a separation line based on two non-dimensional parameters (i.e. Nc and Nv) are introduced. The separation line demonstrates a boundary between augmentation and deterioration of heat transfer by using nanoparticles. Indeed, by utilizing the separation lines, the convective enhancement of using nanofluid with a specified Nc and Nv can be simply estimated. © Emerald Publishing Limited.

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