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Mixed convection in superposed nanofluid and porous layers in square enclosure with inner rotating cylinder
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Abstract
In this study, numerical simulation of mixed convection in a partitioned square cavity having CuO-Water nanofluid and superposed porous medium with an adiabatic rotating cylinder is performed. The bottom horizontal wall of the cavity is heated and the top horizontal wall is cooled while the remaining vertical walls are insulated. An adiabatic rotating cylinder is located at the center of the square cavity. Galerkin weighted residual finite element method is utilized to solve the governing equations of the system. The influence of Rayleigh number (between 103 and 106), angular rotational velocity of the cylinder (between 0 and 6000), solid volume fraction of the nanoparticle (between 0 % and 0.05 %), Darcy number (between 10−5 and 10−2) and three different vertical locations of the cylinder on the fluid flow and heat transfer characteristics are numerically investigated in detail for three different cylinder sizes. It is observed that the averaged heat transfer enhances as the value of Rayleigh number, angular rotational speed of the cylinder, nanoparticle volume fraction and Darcy number increase. The effect of the angular rotational speed of the cylinder on the averaged heat transfer enhancement is more pronounced for large cylinder size and 432.55% of averaged enhancement is achieved for Ω=6000 compared to motionless cylinder case at Ω=0 using cylinder sizes of R=0.3. The averaged heat transfer enhances almost linearly with nanoparticle volume fraction for different cylinder sizes and adding solid nanoparticles to the base fluid is favorable for the locations when high values of local Nusselt number is observed. Local and averaged Nusselt number enhance as the cylinder approaches to the upper wall of the cavity. © 2017 Elsevier Ltd

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