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Conjugate natural convection in a differentially heated composite enclosure filled with a nanofluid

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Abstract
Laminar natural convection inside a square composite vertically layered cavity is studied numerically using under a successive relaxation (USR) upwind-scheme finite difference method. The cavity is set up as follows from the left: a solid wall, a porous layer, and a nanofluid layer. The porous layer is saturated with the same nanofluid. The cavity is heated isothermally from the solid wall and cooled from the right wall. The top and bottom walls are kept adiabatic. All the walls are assumed impermeable, except the interface between the porous and nanofluid layers. The Darcy-Brinkman model is invoked for the porous layer. Double-domain formulation is followed for the porous and nanofluid layers. The studied parameters are Darcy number Da (10-7-10-1), Rayleigh number Ra (103-106), wall thermal conductivity k<inf>w</inf> (0.269, 14.589 W/m. ° C), thicknesses of layers W<inf>w</inf> (0.1-0.7), W<inf>p</inf> (0.1-0.5), and the Cu nanoparticle volume fraction φ (0.0- 0.05). Alternative models for the nanofluid thermal conductivity and dynamic viscosity are used, and a comparison among different models combinations is conducted. The results show that the enhancement of natural convection is attained when the permeability (Da) of the porous medium is very low and the porous layer thickness is greater than 0.5, provided that the Rayleigh number is less than or equal to 104. The solid wall type is found to play a considerable role in the flow and heat transfer fields. It is also found that the conduction heat transfer within the solid wall is affected by the permeability of the porous layer. © 2015 by Begell House, Inc.

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