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Effect of Nanofluid Sedimentation in Natural Convection Heat Transfer

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Abstract

This report presents the development and validation of an OpenFOAM solver for investigating the effects of nanoparticle sedimentation on natural convection heat transfer in an Al_2O_3–water nanofluid enclosed within a differentially heated square cavity. The existing OpenFOAM solver, *driftFluxFoam* solver was modified to incorporate the energy equation and effective thermophysical properties, enabling the coupled simulation of nanoparticle transport and heat transfer. Simulations were performed for a nanoparticle volume fraction of 0.64% at Rayleigh numbers of 10^6, 5×10^6, and 10^7. buoyantBoussinesqPimpleFoam solver was first validated against benchmark homogeneous model natural convection results reported by Meng *et al.* Then sedimentation effects were incorporated using the non-homogeneous model in the developed solver, and the influence of nanoparticle settling on concentration distribution, flow characteristics, temperature field, and heat transfer was investigated through the variation of the average Nusselt number. This work provides a reproducible OpenFOAM framework for studying sedimentation-induced effects in nanofluids and demonstrates the importance of considering particle settling for accurate prediction of natural convection heat transfer.