Benchmark Model: Natural Convection of Water-Aluminum Oxide Nanofluids in a Square Cavity

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Abstract

Nanofluids is a new class of fluid consisting of particles in a liquid. Different base liquid has been proposed and the most common one is water. The concentration of these particles can range from 0.1% to 5% or greater. Different numerical models have been proposed to solve this interesting problem. Some scheme assumed the fluid as a single fluid and other assumed as a two phase system consisting of a liquid phase and a solid phase. Very limited experimental work has been done in this field due to the complexity of the system. Recently Ho et al [International Journal of thermal Sciences, vol 49, 2010] performed an accurate experiment dedicated to investigate whether nanofluids enhance or not the heat transfer. In this paper we will address the accuracy of the numerical model by proposing a benchmark for numerical modelling of nanofluids. First we compared our numerical results with the experimental data available by Ho et al and we have shown that our numerical model is accurate. The obtained numerical results differs from the experimental data by a 1%. Then we have solved the problem using the finite element technique (COMSOL Multiphysics® software) as well as the lattice Boltzmann approach and the finite volume method. With these three approaches we have solved the problem for a range of particle concentration from 1% to 3%. The proposed fluid is water and the proposed particle is aluminum oxide. This benchmark should serve as a guidance for researchers embarking in numerical modelling of nanofluids. Results in form of temperature and velocity variation as well as a comparison of average Nusselt number will be presented for a range of Rayleigh numbers and particle concentration.

Reference

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