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Computational Fluid Dynamics (CFD) Modeling and Simulation of Nanofluid Flow

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Abstract: Exploiting nanofluids in thermal systems is growing day by day. Nanofluids having ultrafine solid particles promise new working fluids for application in energy devices. Many studies have been conducted on thermophysical properties as well as heat and fluid flow characteristics of nanofluids in various systems to discover their advantages compared to conventional working fluids. The main aim of this study is to present the latest developments and progress in the mathematical modeling of nanofluids flow. For this purpose, a comprehensive review of different nanofluid computational fluid dynamics (CFD) approaches is carried out. This study provides detailed information about the commonly used formulations as well as techniques for mathematical modeling and CFD simulation of nanofluids.

Keywords: Nanofluid, CFD, Numerical Simulation, Mathematical Modeling, Single and Two-Phase Methods

1. Introduction

In general, the assessment of the thermal performance of a system through numerical simulations is much affordable compared to experimental studies with high expenses of material and equipment. The significance of a numerical study is highlighted when a nanofluid is utilized as the working fluid. High costs for the production of nanofluids and difficulties in preparing stable nanofluids are the main barriers to perform experiments with nanofluids. Therefore, numerical modeling of nanofluids, where a suitable approach is selected to simulate the flow, could be the best solution for problems involved with nanoparticle suspensions. However, in spite of considerable developments in computing power and methods, literature review reveals that there is no comprehensive study to conclude the best technique for the modeling of nanofluids. In particular, due to the ultrafine size of nanoparticles, the governing terms