A Computational Study on Natural Convection Phenomena

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The topic of discussion in this talk is 2D stabilized finite element simulations of heat transfer phenomena governed by natural convection equations. It is today widely acknowledged that the presence of appropriate nanoparticles in fluids is capable of improving heat transfer properties. To that end, we consider flow characteristics and heat transfer within a rectangular enclosure filled with Al_2O_3–water nanofluid. Additionally, we assume that the flowfield is subject to magnetohydrodynamic (MHD) effects. For high Hartmann numbers, since the classical numerical discretization methods suffer from several instability issues, we enhance the standard finite element method with the streamline-upwind/Petrov–Galerkin (SUPG) formulation [1, 2]. We further improve the SUPG-stabilized formulation with a residual-based shock-capturing mechanism, the so-called YZβ shock-capturing [3, 4], in order to accurately capture flow characteristics near sharp gradients due to high Hartmann numbers. Several test computations are performed using the proposed formulation and techniques under much more difficult computational conditions than those reported in the literature.

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