APPLICATION OF COGNITIVE COMPUTING TO CFD ANALYSIS OF LAMINAR AND TURBULENT NATURAL CONVECTION IN ENCLOSED CAVITIES

by

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ABSTRACT

Heat transfer analysis in enclosed cavities is important for the design of buildings, cryogenic reactors, furnaces and solar collectors. Laminar and turbulent natural convection are the guiding mechanisms for heat transfer in enclosed cavities depending on the range of Grashoff number. However the major challenge in computational fluid dynamics simulation lies in the convergence of heat transfer parameters in minimum number of iterations. This is because the simulation involves solving simultaneously the continuity, momentum, and energy equations in fluid flow and heat transfer.

In the present work fuzzy logic is used as a guiding mechanism for fast convergence in computational fluid analysis. Relaxation factors are adjusted using a pre-defined set of fuzzy rules which guide the iterative scheme towards convergence. The fuzzy controller algorithm is tested for a range of problems involving laminar and turbulent natural convection in enclosed cavities. The cavities of different aspect ratios are analyzed with and without the conjugate heat transfer in one of the walls. The orientation of the cavity with respect to the vertical axis and its impact on the heat transfer rate is investigated. The degree of complexity is increased by mounting the protruding bodies on one of the walls and the fuzzy controller is tested to determine the heat transfer rates. Parametric study of the number, aspect ratio and position of the protruding bodies on heat transfer rate is done to find the optimum condition for enhancing thermal behavior. The membership functions were adjusted to study the turbulent natural convection in high aspect ratio cavities. The work also reports the limit where the fuzzy controller algorithm fails to find a converged solution and compare with the limit of convergence for fixed relaxation factors.