Transition of double diffusive natural convection in a cavity with Cattaneo effect

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1. INTRODUCTION & OBJECTIVE

The study of double diffusive convection involves wide range of scientific and environmental fields and it has been the focus of an exhaustive research due to its importance in various engineering and geophysical problems. The objective of this study is to analyze heat and mass flow characteristics of an incompressible binary fluid filled square cavity during unsteady state for a moderately high range of Rayleigh numbers (Ra). The study is performed in a more general way by taking into account thermal and solutal relaxations.

The vertical walls of the cavity are maintained at constant temperatures and concentrations. The left vertical wall is kept at higher temperature and concentration that lead to a double-diffusive flow field within the cavity. The flow is governed by the continuity and Navier-Stokes equations. The Cattaneo-Christov formulation is used to set up the energy balance equations for both temperature and concentration. The Bousinessq approximation that includes compositional buoyancy is invoked.

2. RESULTS & HIGHLIGHTS OF IMPORTANT POINTS

Numerical solution of the governing equations is obtained through the finite volume method. The SIMPLE algorithm is used to handle the coupled equations. The convection terms are discretized by the QUICK scheme and diffusion terms are discretized by central difference scheme on a uniform staggered mesh. A 200 x 200 mesh is taken for the computational purpose.

Prandl number (Pr) is fixed at 1 throughout the computations. The study of transition from steady to chaotic state is done by fixing buoyancy ratio (Br) and varying Ra through moderately high values. We examine the results in terms of isotherms, streamlines, average Nusselt number (Nu) and average Sherwood number (Sh) when Br = 0.8 and 1.5 and compare them with the classical results. Changes in the amplitude of the resulting double diffusion and possible transition to oscillatory motion and beyond are discussed.

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