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THE COMPARISION OF THE EFFECTS OF TOP AND BOTTOM WALL HEATING ON MIXED CONVECTION OF YIELD STRESS FLUIDS IN A CYLINDRICAL CONTAINER WITH ROTATING END WALL

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ABSTRACT

Steady-state laminar mixed convection of Bingham fluids in a cylindrical enclosure has been numerically analysed based on axisymmetric incompressible flow simulations for different values Reynolds number and Richardson number ranges given by $500 \leq Re \leq 3000$ and $0 \leq Ri \leq 1$ respectively at $Pr = 100$. The aspect ratio (*i.e.* height: radius = *AR* = *H*/*R*) of the cylindrical container is considered to be unity (*i.e.* *AR* = *H*/*R* = 1). The bottom and top covers of the cylindrical enclosure are kept at different temperatures ($T_C < T_H$), while the cylindrical surface is considered to be adiabatic. The simulations for Newtonian fluids (*i.e.* $Bn = 0$) for rotating top and bottom cover configurations yield the same numerical value of the mean Nusselt number $\overline{Nu}$ when the thermal boundary conditions are kept unaltered. For this reason, only rotating top hot wall (*i.e.* CASE 1) and rotating top cold wall (*i.e.* CASE 2) configurations have been considered for this analysis. In Newtonian (*i.e.* *Bn* = 0) fluids and for small values of Bingham number, the mean Nusselt number $\overline{Nu}$ has been found to assume higher values for CASE 2 than in CASE 1. However, this difference in the mean Nusselt number $\overline{Nu}$ between CASE 1 and CASE 2 decreases with increasing *Bn* and thermal transport takes place purely due to thermal conduction for large values of Bingham number *Bn* for both CASE 1 and CASE 2. Moreover, it has been found that the variation of the mean Nusselt number with Richardson number in CASE 2 is qualitatively different from that in CASE 1. A detailed scaling analysis has been carried out to elucidate and explain the influences of Reynolds, Richardson, and Bingham numbers on the mean Nusselt number.