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Sinusoidal Roughness Elements in a Square Cavity

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Abstract : Numerical studies were conducted using Lattice Boltzmann Method (LBM) to study the natural convection in a square cavity in the presence of roughness. An algorithm basedon a single relaxation time Bhatnagar-Gross-Krook (BGK) model of Lattice Boltzmann Method (LBM) was developed. Roughness was introduced on both the hot and cold walls in the form of sinusoidal roughness elements. The study was conducted for a Newtonian fluid of Prandtl number (Pr) 1.0. The range of Ra number was explored from 103 to 106 in a laminar region. Thermal and hydrodynamic behavior of fluid was analyzed using a differentially heated square cavity with roughness elements present on both the hot and cold wall. Neumann boundary conditions were introduced on horizontal walls with vertical walls as isothermal. The roughness elements were at the same boundary condition as corresponding walls. Computational algorithm was validated against previous benchmark studies performed with different numerical methods, and a good agreement was found to exist. Results indicate that the maximum reduction in the average heat transfer was16.66 percent at Ra number 105.

Keywords : Lattice Boltzmann method, natural convection, nusselt number, rayleigh number, roughness
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