1. Role of the Fluid-Structure Interaction forMixed Convection in a Square Cavity

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Abstract

This thesis investigates numerically the role of the fluid-structure interaction (FSI) in controlling the mixed convection within a vented square cavity using flexible material.The cavity contains a flexible thin fin attached to the bottom wall. The cavity was differentially heated in such that the temperature of the left vertical wall is higher than that of the right wall. The horizontal walls kept adiabatic. The flow was assumed two dimensional, Newtonian, incompressible, laminar and the study was achieved under unsteady state condition. Water of Prandtl number 5.8 is considered as a working fluid which enters the square cavity from an opening at the lower part of the left vertical wall and exits from another opening at the upper part of the right vertical wall. The governing differential equations of the fluid mechanics and the structural mechanics, which include continuity, momentum, energy and displacement, have been solved using the Galerkin finite element method implemented in Arbitrary Eulerian-Lagrangian (ALE) approach with aid of COMSOL Multiphysics software ver. 5.2. The governing parameters of the present geometry are Cauchy number, which reflects the inertia to elastic forces, ($Ca = 10^{-12}–2\times10^{-4}$), proximity of the fin to the inlet opening ($Xf = 0.2 – 0.8$), Richardson number ($Ri = 0.1 – 100$) and the Reynolds number ($Re = 50 – 250$).

The results show that the fin shape and the average Nusselt number reach the steady periodic state at the higher values of Cauchy and Richardson numbers. This study has also revealed that the use of flexible fin improves the heat transfer, so that the enhancement in the average Nusselt number when using the flexible fin is about (10.45%) and (230%) compared with rigid fin and without fin, respectively at $Ri = 100$, $Re = 250$, $Ca = 10^{-4}$, and $Xf = 0.2$. It is also found that the average Nusselt number increases withCauchy number; however, at very high values of Richardson number, the fin material should not be very elastic.