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Ghalambaz, M., Jamesahar, E., Ismael, M.A., Chamkha, A.J.

Fluid-structure interaction study of natural convection heat transfer over a flexible oscillating fin in a square cavity
(2017) *International Journal of Thermal Sciences*, 111, pp. 256-273. Cited 36 times.

Abstract
The material of this study is a numerical formulation of a fluid-structure interaction represented by an oscillating elastic fin attached to a hot vertical wall of a square cavity. The cavity is filled with air, Pr = 0.7, and differentially heated while the horizontal walls are kept adiabatic. The finite element Galerkin method with the aid of the Arbitrary Lagrangian-Eulerian (ALE) procedure is used in the numerical analysis. The elastic fin undergoing an excitation and is subjected to buoyancy forces. The ranges of the studied parameters are the Rayleigh number Ra = 104–107, fin length L = 0.1–0.4, oscillating amplitude A = 0.001–0.1, oscillating period τ = 0.01–1, thermal conductivity ratio (fin to fluid) kr = 1–1000, and the non-dimensional Young's modulus E = 108-1013. The results show that increasing the non-dimensional amplitude the oscillating fin can significantly enhance the Nusselt number. The non-dimensional periods about τ ≈ 0.1 and higher shows better enhancement compared to lower periods. A fin length of 0.2 can be considered as the best length for heat transfer enhancement and compatible with various oscillating amplitudes.

2-s2.0-84987897240
Document Type: Article
Publication Stage: Final
Source: Scopus