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Heat Transfer Due to High Frequency Vibration: a New Approach for Achieving Thermally Optimum Geometry Under Microgravity Conditions

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This study aims to draw attention to the possibility of heat transfer enhancement under microgravity conditions. The geometry considered is a rectangular enclosure, filled with a pure fluid, heated differentially and undergoing mechanical vibration. The vibration is periodic with zero mean, and is in the limiting range of high frequency and small amplitude. The direction of vibration is perpendicular to the temperature gradient. The time-averaged formulation is adopted and the governing equations are solved by finite volume method. Numerical simulations are performed to predict the heat transfer and fluid flow characteristics of the resulting thermo-vibrational convection. Different fluid flow structures are presented and discussed. Correlations for Nusselt number and optimum configuration as a function of Rav (vibrational Rayleigh number), Pr (Prandtl number) and A (aspect ratio) are proposed. The results demonstrate the existence of an optimum geometry for which the heat transfer rate is maximal. The findings have significant applications in space industry.

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