

## Documents

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**Natural convection and entropy generation of a ferrofluid in a square enclosure under the effect of a horizontal periodic magnetic field**

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**Abstract**

The current work is concerned with the study of the impacts of a periodic magnetic field on natural convection and entropy generation of Fe<sub>3</sub>O<sub>4</sub>-water nanofluid flowing in a square enclosure. The magnetic field is applied as a sinusoidal function of the y coordinate. The Galerkin finite-element method is employed to numerically solve the model governing partial differential equations. To evaluate the correctness and accuracy of the results, comparisons have been performed between the outcomes of this work and previously published results. The governing dimensionless parameters and their corresponding ranges are the Rayleigh number ( $Ra = 103-106$ ), Hartmann number which indicates the amplitude of the periodic magnetic field ( $Ha = 0-50$ ), the period number ( $\lambda = 0.1-1.0$ ) and the nanoparticles volume fraction ( $\phi = 0-0.08$ ). The outcomes of the study are presented in the forms of streamlines, isotherms and entropy generation contours as well as the local and average Nusselt numbers. Regardless of  $Ha$  and  $\lambda$  values, the average Nusselt number  $Nu_{avg}$  and the total entropy generation  $St$  associated with the periodic magnetic field are found to be higher than those corresponding to the uniform magnetic field. Additionally, When  $\lambda = 0.25$  and  $Ra = 106$ , for  $Ha \leq 10$ , using the Fe<sub>3</sub>O<sub>4</sub> nanoparticles enhances the total entropy generation  $St$ , however, when  $Ha > 10$ , the effect of the existence of the nanoparticles on  $St$  would be inverse. © 2018 Elsevier B.V.

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