

## Documents

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**Mixed convection flow caused by an oscillating cylinder in a square cavity filled with Cu–Al<sub>2</sub>O<sub>3</sub>/water hybrid nanofluid**  
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### Abstract

The aim of this paper is to examine the effects of Cu–Al<sub>2</sub>O<sub>3</sub>/water hybrid nanofluid and Al<sub>2</sub>O<sub>3</sub>/water nanofluid on the mixed convection inside a square cavity caused by a hot oscillating cylinder. The governing equations are first transformed into dimensionless form and then discretized over a non-uniform unstructured moving grid with triangular elements. The effects of several parameters, such as the nanoparticle volume fraction, the Rayleigh number, the amplitude of the oscillation, and the period of the oscillation of the cylinder are investigated numerically. The results indicate that the motion of the oscillating cylinder toward the top and bottom walls increases the average Nusselt number when the Rayleigh number is low. Furthermore, the presence of Al<sub>2</sub>O<sub>3</sub> and Cu–Al<sub>2</sub>O<sub>3</sub> nanoparticles leads to an increase in the values of the average Nusselt number  $Nu_{avg}$  for cases of low values of the Rayleigh number. It is found that the natural convection heat transfer rate of a simple Al<sub>2</sub>O<sub>3</sub>/water nanofluid is better than that of Cu–Al<sub>2</sub>O<sub>3</sub>/water hybrid nanofluid. © 2019, Akadémiai Kiadó, Budapest, Hungary.

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