

# Abstract

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## **Influence of nanoparticles on mixed convection heat transfer in an eccentric horizontal annulus with rotating inner cylinder**

Numerical investigation of mixed convection flow and heat transfer with different nanofluids inside an eccentric horizontal annulus is presented. The nanofluids include Cu, TiO<sub>2</sub> and Al<sub>2</sub>O<sub>3</sub> nanoparticles with water as a base fluid. The inner and outer cylinders are kept at different constant temperatures with the inner at a higher magnitude than the outer. Moreover, the inner cylinder rotates to create the forced convection effect. Different scenarios are explored to clarify the effects of Richardson number, eccentricity ratio, and solid volume fraction with ranges of 0.01 (forced convection)  $\leq Ri \leq 100$  (natural convection),  $0 \leq e \leq 0.9$ , and 0.01  $\leq \phi \leq 0.05$ , respectively. Results are accomplished with Grashof number, and radius ratio, equal to  $10^4$  and 2, respectively. The generated results include the average Nusselt number, stream-lines, and isotherms. The numerical work is carried out using an in-house CFD code written in FORTRAN. Results are discussed and are found to be in good approval with preceding works. It is found that the effect of nanoparticles on the heat transfer enhancement is more pronounced at mixed convection ( $Ri = 1$ ) and natural convection regions ( $Ri > 1$ ), however at forced convection region ( $Ri \leq 0.1$ ) the nanoparticles addition has an opposite effect.