Journal of the Taiwan Institute of Chemical Engineers 63 (2016) 259–270

Contents lists available at ScienceDirect

Journal of the Taiwan Institute of Chemical Engineers

journal homepage: www.elsevier.com/locate/jtice

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

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article info

Article history:
Received 11 December 2015
Revised 17 February 2016 Accepted
8 March 2016 Available online 29
March 2016

Keywords:
Mixed convection
Eccentric annulus
Nanofluid
CFD

abstract

Numerical investigation of mixed convection flow and heat transfer with different nanofluids inside an eccentric horizontal annulus is presented. The nanofluids include Cu, TiO_2 and Al_2O_3 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), $0 \leq \varepsilon \leq 0.9$, and $0.01 \leq \lambda \leq 0.05$, 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 ef-fect 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.