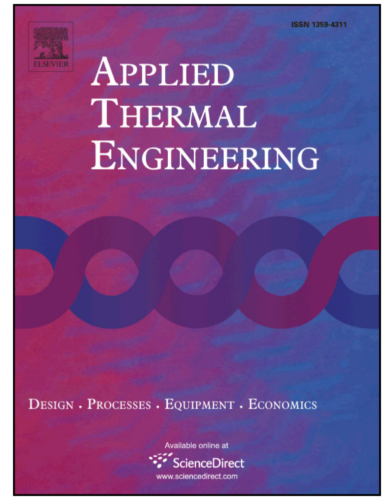


Research Paper

# Theoretical investigation of laminar flow convective heat transfer in a circular duct for a non-Newtonian nanofluid

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# Theoretical investigationof laminar flow convective heat transfer in a circular duct fora non-Newtonian nanofluid

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**Abstract**

In this study, laminar flow forced convection heat transfer of a non-Newtoniannanofluid flowing inside a circular tube that is subjected to a constant wall temperature was investigated analytically. By taking into account the effect of viscous dissipation, a new methodology based on a variational Ritz approach combined with Laplace transform technique is presented. The effects of Brinkman numbers (*Br*), power low index (*n*) and nanoparticle concentrations ($\varphi$) on the developing temperature fields and the local Nusselt number were examined. The obtained results were validated with available solutions for the special cases of conventional fluids ($\varphi$ = 0) and non-viscous dissipation effect (*Br* = 0). Bulk temperature distribution and local Nusselt number are presented graphically for *Br* =0, 0.5, 1, -0.5 and 1 for non-Newtonian fluids described by the power-law model with the flow index*n* =0.5, 1.0 and 1.5. TheNusselt numbers of nanofluids were obtained for different $Al_2O_3$ nanoparticle concentrations as well as various Peclet and Brinkman numbers.

*Keywords*:Variationalmethod; non-Newtonian fluid;Nanofluid;Circular tube;Laminar forced convection

## 1. Introduction

Knowledge of the steady stateheat transfer forced convection problem inside ducts is important inmany engineering applications, such as for the heat exchanger devices encountered in nuclear power systems, petrochemical and air conditioning equipments.

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