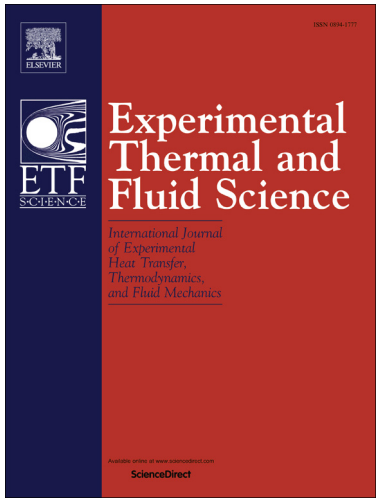

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Puja Sharma, RituGupta, Ravinder Kumar Wanchoo

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Puja Sharma[a], RituGupta[b,1],Ravinder Kumar Wanchoo[b]

[a] Energy Research Centre, Panjab University, Chandigarh 160014, India
[b] University Institute of Chemical Engineering and Technology, Panjab University, Chandigarh 160014, India

ABSTRACT
Laminar flow hydrodynamic characteristics of alumina based nanofluids (0-2.5 vol.%) flowing through straight tubes and helical coils with different combinations of curvature and pitch ratio have been studied. Two types of glycol-water based mixtures, ethylene glycol/water (EG/W) and propylene glycol/water (PG/W) in 60:40 weight ratio, were used as the base fluids. The friction factor of nanofluids was found to be higher than that of the base fluids for both the straight tube as well as helical coil geometry, which further increased with increase in nanoparticle volume concentration. At the same Reynolds number, friction factor increased with nanoparticle concentration in the base fluid, which could be due to the presence of Brownian motion and increased collision rate of nanoparticles. Two new correlations to predict the friction factor for the laminar flow of alumina nanofluids through straight tubes and helical coils have been proposed.

1. Introduction

Due to a rapid rise in energy costs, there is a great need for new types of heating & cooling medium so as to minimize the energy consumption by increasing the overall thermal efficiency. Ethylene or propylene glycol mixed with water in 60:40 weight ratio is commonly used heat transfer fluid in heat exchangers, industrial plants, automobiles etc. [1]. The main reason to use glycol mixtures is their ability to decrease the freezing point of the heat transfer medium with lower corrosivity and low volatility.

The transport properties of these fluids can further be improved by the use of additives called nanoparticles with particle size and concentration less than 100 nm and 5vol.% respectively, resulting in stable suspensions termed as nanofluids [2]. Nanofluids possess a higher thermal conductivity resulting in increased heat transfer rate as compared to that of the base fluid [3-5]. However, addition of nanoparticles also causes an increase in the density and viscosity of the fluid thereby increasing the pumping power required to pump the fluid. Baratpour et al. [6] examined the dynamic viscosity of single-wall carbon nanotubes/EG nanofluid (0.0125-0.1 vol.%) from 30^0C-60^0C. They observed that the nanofluid viscosity increased to 3.18 times that of the base fluid at 30^0C for 0.1 vol.%. Afrand et al. [7] experimentally investigated the dynamic viscosity of SiO_2-multi walled carbon nanotubes/engine oil hybrid nanofluid (0-1 vol.%) from 25^0C-60^0C. They reported a maximum enhancement of 37.4% in the viscosity of hybrid nanofluid. Some of the authors [8, 9] have studied the rheological behavior of nanofluids and reported

[1]Corresponding author.
E-mail address: rit_gupta@yahoo.com (Ritu Gupta).