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Effects of Curvature Ratio and Coil Pitch Spacing on Heat Transfer Performance of Al_2O_3/Water Nanofluid Laminar Flow through Helical Coils

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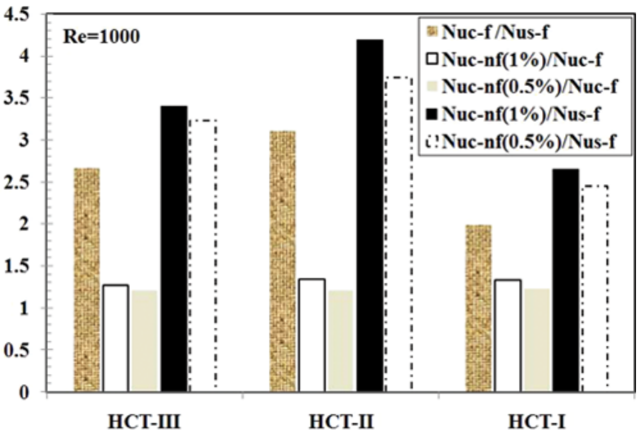
GRAPHICAL ABSTRACT



In the present work, the influence of curvature ratio and coil pitch for Al_2O_3/water nanofluid laminar flow on heat transfer behavior and pressure drop through helical coils were investigated experimentally. These experiments were performed for coils with curvature ratio 10 and 20 plus coil pitch 24 and 42. The volume fractions of nanoparticles were 0.25–1.0%. Nanofluids at all concentrations showed much higher heat transfer rate and pressure drop in comparison with distilled water, which is due to the nanoparticles present in the fluid. In addition, due to curvature of coils, significant enhancement was observed in heat transfer rate as well as pressure drop when helical coils utilize instead of straight one. Moreover, the heat transfer rate improved with the increase of pitch coils and decrease of curvature ratio. Also, the Nusselt numbers for nanofluid flow inside coils was correlated with helical number, Prandtl number, and volume concentration of nanofluid.

Keywords Al_2O_3/water nanofluid, coil pitch spacing, curvature ratio, heat transfer enhancement, helical coils

1. INTRODUCTION

The performance of heat exchangers can be improved to perform a certain heat transfer duty by heat transfer enhancement techniques. In general, these techniques can be divided into two groups: active and passive techniques. The active techniques require external forces, for example, electric field, acoustic or surface vibration, etc. The passive techniques require fluid additives or special surface geometries.[1] Due to their compact structure and high heat transfer coefficient, helical Coils have been introduced as one of the passive heat transfer enhancement techniques.

A characteristic feature of flow in helical coils is the so-called secondary flow, which is set up due to the centrifugal force. The secondary flow often consists of two symmetric counterrotating cells. The geometry of a typical helical coil is defined by the tube diameter d, coil diameter D or curvature ratio $\lambda(=D/d)$ and pitch spacing b.

Fully developed flows in helical pipes of finite pitch have numerically studied by Liu et al.[2] Manlapaz and Churchill[3] have considered the laminar convection heat

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