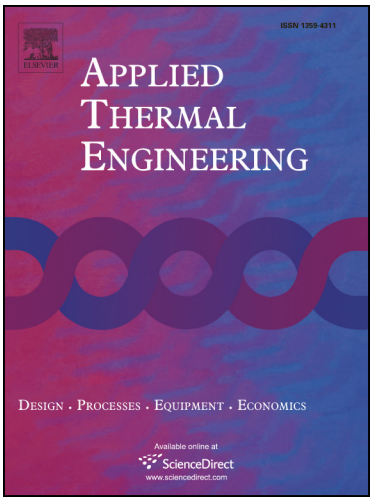

Research Paper

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Experimental study on Heat transfer enhancement characteristics of tube with cross hollow twisted tape inserts

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Abstract

This study experimentally investigates the heat transfer and friction factor (f) characteristics of a tube fitted with cross hollow twisted tape inserts of hollow widths of 6, 8 and 10 mm under uniform heat flux. Experimental data of a plain tube are compared to the standard correlations for validation. Results show that the Nusselt number (Nu) and f decrease and then increase as the hollow width increases from 6 mm to 10 mm. Nu and f for the 6 mm hollow width increase by 93%–120% and 883%–1042%, respectively, in comparison with those of the plain tube. The performance evaluation criterion(PEC) varies from 0.87 to 0.98 under a Reynolds number of 5600–18000. Correlations based on the experimental data are established to predict Nu and f under turbulent flow. These parameters match the experimental data well within 3.6% (Nu) and 2.3% (f).

Key words: cross hollow twisted tape inserts; hollow width; turbulent flow; heat transfer enhancement

1. Introduction

Industrial development has led to the need for efficient heat exchangers and their application to actual projects. Many active and passive techniques are used to improve the performance of heat exchangers. Such turbulators as small pipes [1, 2], drainage inserts [3], twisted tapes [4, 5] and vortex generators [6, 7, 8] are easy to use and effectively enhance heat transfer. These devices can improve the heat transfer coefficient considerably but usually with increased pressure drop. Dewan [9] summarised studies about twisted tape and wire coil inserts and concluded that twisted tape inserts are efficient under laminar flow and wire coils are efficient under turbulent flow. Liu [10] reviewed numerous inserts and implied that shape optimisation should be considered in insert design to reduce drag. Hasanpour [11] reviewed the development of twisted tapes and confirmed their effectiveness. Many studies [4, 5] have proposed mechanisms to enhance the heat transfer of twisted tapes, including the use of spiral steam lines. (1) The use of spiral steam lines means achieving a long flow path, which can increase heat transfer. (2) Swirls can be generated to increase the turbulence of the flow boundary layer. (3) The swirls enhance the mixing of fluids in the near-wall and central regions.

The heat transfer and friction factor (f) characteristics of enhanced tubes fitted with twisted tapes have been studied by past experimental and numerical investigations. Sicashanmugam [10] experimentally studied helical screw tape inserts under laminar flow. The same author [13, 14]