



Heat transfer and pressure drop characteristics in a circular tube fitted with and without V-cut twisted tape insert[☆]

P. Murugesan^{a,*}, K. Mayilsamy^b, S. Suresh^c, P.S.S. Srinivasan^d

^a Department of Mechanical Engineering, K.S. Rangasamy College of Technology, Tiruchengode-637215, India

^b Department of Mechanical Engineering, Institute of Road and Transport Technology, Erode-638316, India

^c Department of Mechanical Engineering, National Institute of Technology, Tiruchirappalli-620015, India

^d Department of Mechanical Engineering, Knowledge Institute of Technology, Salem-637504, India

ARTICLE INFO

Available online 10 December 2010

Keywords:

Twist ratio

V-cut

Heat transfer augmentation

Friction factor

Thermal performance factor

ABSTRACT

The effect of V-cut twisted tape insert on heat transfer, friction factor and thermal performance factor characteristics in a circular tube were investigated for three twist ratios ($\gamma = 2.0, 4.4$ and 6.0) and three different combinations of depth and width ratios ($DR = 0.34$ and $WR = 0.43$, $DR = 0.34$ and $WR = 0.34$, $DR = 0.43$ and $WR = 0.34$). The obtained results show that the mean Nusselt number and the mean friction factor in the tube with V-cut twisted tape (VTT) increase with decreasing twist ratios (γ), width ratios (WR) and increasing depth ratios (DR). Subsequently an empirical correlation also was formulated to match with experimental results with $\pm 6\%$ variation for the Nusselt number and $\pm 10\%$ for the friction factor.

© 2010 Elsevier Ltd. All rights reserved.

1. Introduction

Heat transfer augmentation techniques are widely used in areas such as heat recovery process, air conditioning and refrigeration systems, and chemical reactors. Passive and active methods of heat transfer augmentation techniques have been discussed in detail by Webb [1]. Dewan et al. [2] reviewed that passive techniques particularly twisted tape and wire coil insert are economical heat transfer augmentation tools. Eiasma-ard et al. [3–7] experimentally investigated the heat transfer and friction factor characteristics in a circular tube fitted with different tube inserts and proposed correlations for the Nusselt number and friction factor. Chang et al. [8,9] experimentally compared the heat transfer and friction factor characteristics of smooth twisted tape with broken and serrated twisted tape inserts. More information about heat transfer by means of twisted tapes fitted in a circular tube can be viewed in other reports [10–14]. Based on the available literature, it was pointed out that the modification on plain twisted tape (PTT) i.e. small cuts on the tape [6–9], gave assurance for enhancement of both heat transfer rate and thermal enhancement factor. The reason behind the high thermal enhancement factor is that those small gaps bring pressure drop in the system to the reasonable level. The objective of this paper is to study heat transfer and friction characteristics in double pipe heat exchanger fitted with PTT and VTT with twist ratios of $\gamma = 2.0, 4.4$ and 6.0 respectively and also to study the enhancement effect of V-cut with different DR and WR ratios.

2. Experimental details

The layout of experimental setup is shown in Fig. 1. It consists of two concentric tubes in which hot water flows through the inner tube and cold water flows in counter flow through annulus. In the experimentation plain twisted tapes (PTT) with twist ratios 2, 4.4 and 6.0 are shown in Fig. 2a. V-cut twisted tapes (VTT) of twist ratios 2, 4.4 and 6.0 with different DR and WR are shown in Fig. 2b.

V-Cuts are introduced in the PTT on both top and bottom alternately in the peripheral region with different dimensions of depth and width to improve the fluid mixing near the walls of the test section. The cold water was made to flow at 0.166 kg s^{-1} whereas the hot water flow rate was adjusted from 0.033 kg s^{-1} to 0.12 kg s^{-1} . As steady state conditions were reached, the inlet and outlet temperatures of hot, and cold water and the pressure drop were recorded for the case of plain tube, PTT and VTT. The details of experimental set up, all twisted tape inserts and operating conditions are summarized in Table 1.

3. Data reduction

The data reduction [3,10] of the measured results is summarized as follows:

The overall heat transfer coefficient

$$U = \frac{Q_{avg}}{A_i \Delta T_{lm}} \quad (1)$$

[☆] Communicated by A.R. Balalerishnan.

* Corresponding author.

E-mail address: pmksrct@gmail.com (P. Murugesan).