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Experimental and Numerical Study in Horizontal Tube by using Swirl Device

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Abstract: Heat exchanger performance can be basically evolved by many heat transfer enhancement techniques. The current experimental and numerical investigations disclose the use of different twisted tapes inserted in a single tube heat exchanger for better fluid mixing which produces a higher rate of heat transfer comparing to that of smooth tube. The tube is made of from copper material of 2.3 cm inner diameter and 100 cm length. The experimental work is conducted in an insulated horizontal circular tube in the laminar flow region to test the influence of tap-inserts on the heat transfer enhancement and pressure drop, under constant heat flux condition. Two configurations of twisted tapes that are also fabricated from copper material with different Twist Ratios (TR = 4 and 6) are used. The numerical study is performed using the ANSYS Fluent 15.0 based on the finite volume technique for solving the governing equations, for different values of Reynolds number with water being as a working fluid.

Key words: Heat transfer enhancement, laminar flow, circular tube, twisted tape, water, smooth

INTRODUCTION

Heat exchangers are employed as a basic element in most engineering thermal applications. The design of a heat exchanger is indeed intricate as it requires an accurate analysis of thermal and frictional performance and then the economic aspect of the equipment. Therefore, the big defy in designing such device is to produce a consolidate equipment utilizing appropriate techniques for achieving higher rates of heat transfer and lower pumping cost (Liu and Sakr, 2013).

The existing relevant literature reveals that there have been many papers reporting numerical and experimental results about heat transfer augmentation techniques using twisted tape inserts, however, most of them have been limited to simple geometries. Agarwal and Rao (1996) investigated experimental forced convection fluid flow in a horizontal circular tube using servotherm oil with Prandtl number (Pr = 195-375) and for Reynold number and Twist Ratio ranging of (Re = 70-4000) and (TR = 2.41-4.84), respectively, under uniform wall temperature heating and cooling condition. The results showed a good enhancement in Nusselt number (1.21-3.7) and (2.28-5.35) times the plain tube values on the basis of constant pumping power and constant flow rate, respectively. However, an appreciable increase in the friction factor (3.13-9.71) was found. They proposed empirical correlations for heat transfer and friction factor for practical applications.

Saha and Dutta (2001) examined experimentally convective laminar flow in a circular tube, induced by a regularly spaced twisted tape for a wide range of Renolys number (145<Re<1480) and a Twist Ratio ranging from (TR = 1.92-5.0) with water being as a working fluid (4.5<Pr<5.5). They concluded that there is a severe drop in the friction factor corresponding of the reduction in Nusselt number. They also found that at a constant pumping power, the twisted tape with multiple turns can enhance the thermal-hydraulic performance compared with that for a single turn twisted tape. Al-Fahed *et al.* (1998) conducted an experimental study to calculate the heat transfer coefficients and friction factors inside a single shell-and-tube heat exchanger fitted with microfin and with a twisted tape and compare their results with those for a plain tube. During the investigation, they used three variant twist ratios with two different widths. The

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