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Heat transfer enhancement and pressure drop of the horizontal concentric tube with twisted wires brush inserts ☆

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ABSTRACT

In the present study, the heat transfer characteristics and the pressure drop of the horizontal concentric tube with twisted wires brush inserts are investigated. The inner diameters of the inner and outer tubes are 15.78 and 25.40 mm, respectively. The twisted wire brushes are fabricated by winding a 0.2 mm diameter of the copper wires over a 2 mm diameter of two twisted iron core-rod with three different twisted wires densities of 100, 200, 300 wires per centimeter. The plain tube with full-length twisted wires brush and regularly spaced twisted wires brush with 30 cm spacer length inserts are tested. Cold and hot water are used as working fluids in shell side and tube-side, respectively. The test runs are performed at the hot water Reynolds number ranging between 6000 and 20000. The inlet cold and hot water temperatures are 15, 20 °C, and between 40 and 50 °C, respectively. Effect of twisted wires density, inlet fluid temperature, and relevant parameters on heat transfer characteristics and pressure drop are considered. Twisted wire brushes insert have a large effect on the enhancement of heat transfer, however, the pressure drops also increase.

1. Introduction

Thermal performance of heat transfer devices can be improved by heat transfer enhancement techniques. The turbulent generator with different geometrical configurations have been used as one of the passive heat transfer enhancement techniques and are the most widely used tubes in several heat transfer applications, for example, heat recovery processes, air conditioning and refrigeration systems, chemical reactors, food and dairy processes. Al-Fahed et al. [1] carried out to consider the pressure drop and heat transfer coefficients of the plain tube with twisted-tape inserts. The twisted-tapes insert with three different twist ratios each with two different widths were tested. Liao and Xin [2] performed to study the heat transfer and friction characteristics for fluids flowing in four tubes with internal extended surfaces and twisted-tape inserts. Rahai and Wong [3] investigated on the turbulent jets from round tubes with coil inserts. Hsieh et al. [4] studied on the heat transfer and flow characteristics in a horizontal circular tube with strip-type inserts. Nusselt numbers were between four and two times the bare tube values at low Reynolds number and high Reynolds number, respectively. Zimparov [5] predicted the friction factors and heat transfer coefficients for turbulent flow in corrugated tubes with twisted tape inserts. Hoang et al. [6] experimentally investigated the turbulent jets with coil inserts. Garc et al. [7,15,17] experimentally studied the laminar-transition-turbulent heat transfer enhancement and flow patterns in the tube with wire coil inserts. Experimental correlations of Fanning friction factor and Nusselt number were proposed. Naphon and Sriromruln [8,9] considered effect of coil-wire insert on heat transfer enhancement and pressure drop of the horizontal concentric plain tubes and the concentric micro-fin tubes. Non-isothermal correlations for the heat transfer coefficient and friction factor were proposed. Sivashanmugam and Suresh [10,11] experimentally studies on the heat transfer and friction factor characteristics in a circular tube fitted with regularly spaced helical screw-tape inserts. The measured data were verified with those from plain tube. Eiamsa-ard and Promvonge [12,13] studied on the heat transfer characteristics in a tube fitted with helical screw-tape with/without core-rod inserts and wire coil inserts. Chang et al. [14] considered the heat transfer and pressure drop in tube with broken twisted-tape insert. Yun et al. [16] studied on the flow boiling heat transfer characteristics of nitrogen in the stainless steel plain tube with and without wire coil inserts. Promvonge [18] experimentally investigated on the thermal enhancement in a round tube with snail entry and coiled-wire inserts. Kim and Chang [19] presented the flow-induced vibration of air-water two-phase flow in the vertical tube with wire coil inserts. Bharadwaj et al. [20] experimentally determined the heat transfer and pressure drop in a spirally grooved tube with twisted tape insert. Behabadi et al. [21] studied the heat transfer and pressure drop characteristics of forced convective evaporation in horizontal tubes with coiled-wire inserts. Sreenivasulu and Prasad [22] numerically studied the flow and heat transfer characteristics in an annulus wrapped with a helical wire for constant heat flux boundary condition. Rahimia et al. [23] experimentally and numerically studied on the flow characteristics in a

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