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# Investigation of heat transfer enhancement in a new type heat exchanger using solar parabolic trough systems

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ABSTRACT

Hydrogen production from solar energy is one of the most candidates in near future. Concentric tube heat exchangers have been used in concentrated solar power (CSP) plants such as parabolic trough system. In order to be reduced heat exchanger sizes and heat transfer enhancements, in this study, the heat transfer and friction characteristics of a concentric tube heat exchanger with different pitches of coiled wire turbulators were investigated experimentally and numerically. An experimental system was established in order to obtain experimental data. The numerical simulations were performed by using a three dimensional CFD computer code. The experimental, numerical and empirical correlation results were compared with each others for a Reynolds number range from 3000 to 17 000. The results were correlated in the form of Nusselt number as a function of Reynolds number and Prandtl number. The heat transfer enhancements using turbulators were 2.28, 2.07 and 1.95 times better than the smooth tube for pitch distances of $p = 15$, 30 and 45 mm, respectively.



## Introduction

Hydrogen can be produced from renewable energies by several ways such as electrolyze, high temperature thermochemical cycles, etc [1–3]. Especially, hydrogen production from solar energy is one of the most solutions for sustainable energy in near future [4–8]. Concentrated solar power (CSP) plants generate high temperature heat. Concentric tube heat exchangers are widely used in CSP plants such as parabolic trough system. CSP technological approaches require large areas for solar radiation collection when used to produce high temperature heat and electricity at commercial scale.

The heat transfer coefficient and pressure drop are the most important parameters to determine in reducing the size and cost of a heat exchanger using solar energy. Heat transfer enhancement techniques can be divided to two groups: active and passive methods [9,10]. Active methods require extra external power sources. Passive methods perform without additional external power, by mean of surface coating,

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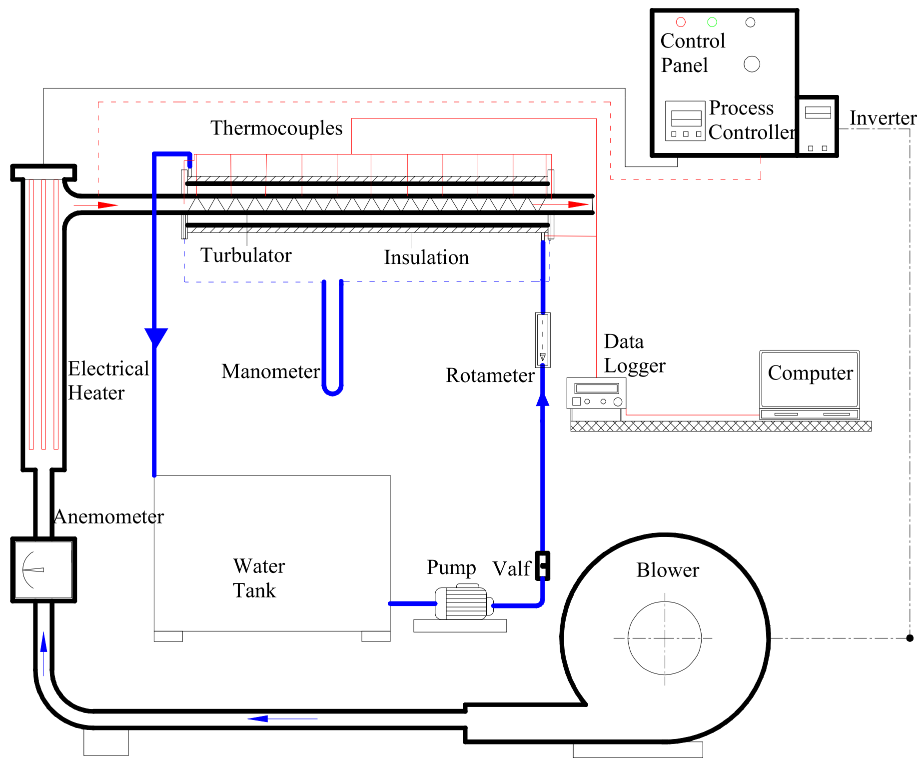


**Fig. 1 – Schematic diagram of the experimental set-up [12].**

turbulent or swirl flow devices, coiled tubes. The turbulators improve heat transfer efficiency; however they cause a pressure drop and, therefore, the system may sometimes need fan power [11].

Heat transfer enhancements and pressure drop characteristics of concentric pipe heat exchangers have been investigated experimentally and numerically using swirl flow devices based on passive method [12–17]. Some series of studies have been investigated experimentally heat transfer and friction characteristics in a circular tube with turbulators insert as swirl generators which are conical-ring, conical-nozzle, V-nozzle, twisted-tape, screw-tape [18–31].

The effects of geometrical parameters on heat transfer and pressure drop for various types of the turbulators have been investigated experimentally during recent decades [18–31]. Experimental study of heat exchangers is effective but very expensive because of the high cost of the tools involved. In the literature, some studies have been made only numerically. Compared to experimental and numerical studies have been investigated in order to select the best numerical model for suitable experimental study.

In order to be reduced heat exchanger sizes and heat transfer enhancements, the aim of this study is to determine experimentally and numerically for Re numbers ranging from

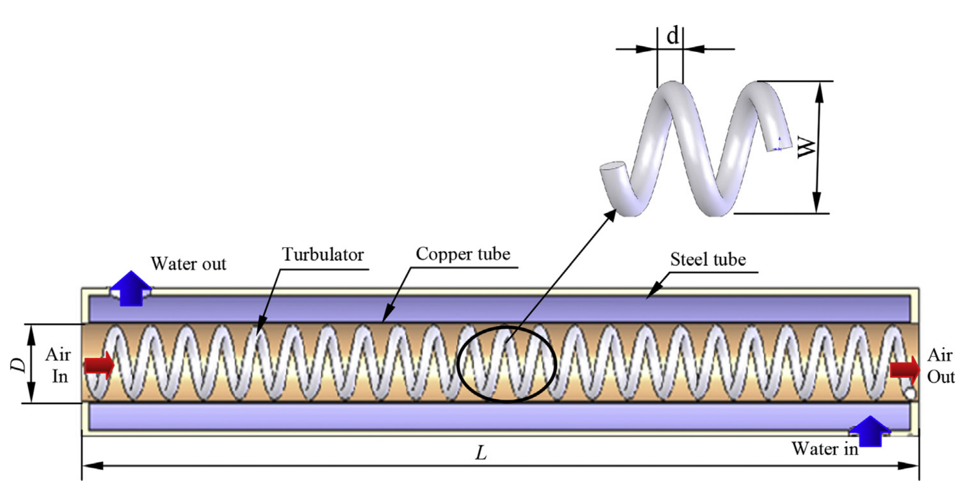


**Fig. 2 – Schematic diagram of the concentric-tube heat exchanger with turbulator.**