Saravanan et al. 2020. *Int. J. Vehicle Structures & Systems*, 12(4), 372-274
ISSN: 0975-3060 (Print), 0975-3540 (Online)
doi: 10.4273/ijvss.12.4.03

International Journal of Vehicle Structures & Systems
Available online at www.maftree.org/eja

Heat Transfer Effect of CNT and Ethylene Glycol Based Nano-Fluid in Twisted Tape Heat Exchanger with Balls

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ABSTRACT:

Heat transfer improvement is the main parameter in a heat exchanging equipment. Few methods to increase the coefficient of heat transfer is by creating the turbulence in heat exchanging elements and changing the heat transfer fluids. For current analysis of tube heat exchangers, tape inserts containing balls are implemented with nano-fluids in Carbon Nano Tubes (CNT) and ethylene glycol. 3D modelling and simulation of twisted tape heat exchanger with balls were carried out using Solidworks and ANSYS Workbench. Heat transfer rate, friction factor, temperature difference in the heat exchangers, Reynolds number and Nusselt number variations are assessed in this work.

KEYWORDS:

Heat transfer; Carbon nano tube; Ethylene glycol; Twisted tube; Bulges; Pockets

CITATION:

R. Saravanan, M. Karuppasamy, M. Chandrasekaran and V. Muthuraman. 2020. Heat Transfer Effect of CNT and Ethylene Glycol based Nano-Fluid in Twisted Tape Heat Exchanger with Balls, *Int. J. Vehicle Structures & Systems*, 12(4), 372-374. doi:10.4273/ijvss.12.4.03.

1. Introduction

Heat transfer enhancement has always been a significantly interesting topic in order to develop highly efficient, low cost, lightweight and small heat exchangers. Enhancement in heat transfer rate can be done by numerous methods in various heat exchangers. Heat exchangers are used in many places such as chemical reactors, refrigeration systems, air conditioning systems, thermal power plants, space vehicles automobiles etc [5, 8]. Nano-fluids are used in enhancing the heat transfer co-efficient because of its thermo-physical properties of nano-particles. Nano-particles are Al_2O_3, CuO, TiO_2 and NiO_2. Staged and non-staged conical inserts in a circular tube with three twist ratios (2, 3 and 5) were investigated in a laminar flow condition. Conical inserts act as tabulators for turbulent flow. Staged conical tube insert with twist ratio of 3 gives better Nussselt number and results than the other strips and plain tube [1]. Straight circular tube with and without V-cut twisted tape inserts using Al_2O_3-Cu/water hybrid nano-fluid were analysed for parameters like convective heat transfer and friction factor.

Hybrid nano-fluids increase the Nusselt number in water by 0.01% volume concentration. Copper nano is mixed with 0.4% of alumina nano-fluid, this hybrid nano-fluid increases the Reynold's number from 2580 to 11780 and it also increases the friction factor [2]. Porous media along with nano-fluids is one of the innovative ways to enhance the heat transfer co-efficient and its overall performance. Two specifications of porous media are its dissipation area which is greater than the conventional fins and the irregular motion of fluid flow around the individual beads. Porus media with nano-fluid enhances the convective heat transfer co-efficient [3]. Twisted tape inserts are used to enhance the heat transfer efficiency of heat exchangers. Twisted tape insert in shell and tube heat exchanger with Al_2O_3 nano-fluid enhances the heat transfer co-efficient. This enhances swirl flow generated by twisted tape [4]. Twisted tape inserts are more suitable for laminar flow than turbulent flow, turbulent flow leads to increase in pressure loss [5].

Nano-particles have better thermo-physical properties than the conventional fluid. TiO_2 / water nano-fluid in a uniform heated heat exchanger with modified butterfly insert was experimented for evaluating heat transfer characteristics. The volume fraction of 0.3% TiO_2 /water nano-fluid with modified butterfly insert gives better heat transfer enhancement than the conventional butterfly inserts [6]. An experiment was carried out for heat transfer characteristics and pressure drop in a uniform heated circular tube using Al_2O_3 - Cu / Water hybrid nano-fluid. Comparatively Al_2O_3 - Cu / water hybrid nano-fluid proves to have 13.56% increase in Nusselt number than the Nusselt number of water which has its Reynolds number at 1730. There is an increase in friction factor of 0.1% in a volume fraction of hybrid nano-fluid [7].

2. Materials and methods

The tube used for the analysis is made up of copper and twisted tape is made up of aluminum. The CNT concentration has a volume fraction of 1% with water. The other heat transfer fluids are water and ethylene glycol (EG). The flow properties vary at four levels. The