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PII: S0894-1777(17)30290-X
DOI: https://doi.org/10.1016/j.expthermflusci.2017.09.018
Reference: ETF 9218

To appear in: *Experimental Thermal and Fluid Science*

Received Date: 5 June 2017
Revised Date: 19 September 2017
Accepted Date: 20 September 2017

Please cite this article as: A. Hosseinian, A.H.M. Isfahani, E. Shirani, Experimental investigation of surface vibration effects on increasing the stability and heat transfer coefficient of MWCNTs-water nanofluid in a flexible double pipe heat exchanger, *Experimental Thermal and Fluid Science* (2017), doi: https://doi.org/10.1016/j.expthermflusci.2017.09.018

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Experimental investigation of surface vibration effects on increasing the stability and heat transfer coefficient of MWCNTs-water nanofluid in a flexible double pipe heat exchanger

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Abstract

Nanoparticles deposition is one of the most challenges for industrial use of nanofluids. In the present study, the heat transfer enhancement of Multi Wall Carbon Nano Tube, MWCNT-water nanofluid in a double pipe heat exchanger due to vibrating walls is examined for different mass fractions. This work is performed by a flexible double pipe heat exchanger made of PVDF. The forced vibration on the outer surface of the heat exchanger is imposed by electro-dynamic vibrators. Results demonstrate that imposing the vibrations increases the heat transfer coefficient remarkably, while decreases the nanoparticles deposition. Heat transfer increases by increasing the nanofluid temperature, mass flow rate, nano fluid mass fraction and vibration level. The most increase in heat transfer coefficient is 100% which is obtained in the test of the lowest mass fraction (0.04%) with the highest vibration level (9 m/s²) in the experiment range.

Keywords: Heat transfer enhancement; Surface vibration; flexible heat exchanger; carbon nano tube

Highlights:

1- Effect of imposing mechanical vibration on a heat exchanger with nanofluids is studied for the first time.
2- Imposing mechanical vibrations increase heat transfer coefficient while decrease nanoparticles deposition.
3- A flexible heat exchanger made of PVDF is manufactured.

1. Introduction

Heat transfer enhancement techniques essentially reduce the thermal resistance in a conventional heat exchanger by promoting higher convective heat transfer coefficient with or without surface area increases. Generally heat transfer enhancement techniques can be classified broadly as passive and active techniques. passive techniques, without requiring direct input of external power, use surface or geometrical modifications, or incorporate an insert, material, or additional device to increase heat transfer. In the case of active techniques, the addition of external power essentially facilitates the desired flow modification and the concomitant improvement in the rate of heat transfer [1, 2].

In recent years, application of nanofluids has attracted special attention in many fields such as solar energy [3-6], heat exchangers [7, 8], high efficiency lubricants [9]. Nanometer-sized particles suspended in liquids are called “nanofluids” [10]. There have been many attempts to increase heat transfer coefficient of double pipe heat exchangers by nanofluids as passive methods [11]. Use of CNT nanofluids for increasing heat transfer has been investigated in different experimental and theoretical researches. For instance, recently, Sarafraz et. al [12] performed experimental study to investigate the heat transfer coefficient and pressure drop characteristics of carbon nanotube water-based nanofluids inside the double pipe heat exchanger. To assess the thermal performance of nanofluids, forced convection experiments were conducted at laminar and turbulent flow regimes (900 < Re < 10500). Results demonstrated that carbon nanotube can enhance the thermal conductivity up to 56% at wt.% = 0.3.
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