

5th International Conference on Advances in Energy Research, ICAER 2015, 15-17 December 2015, Mumbai, India

Investigation of Solar Heat Pipe Collector Using Nanofluid and Surfactant.

Gargee.A. Pise^a, Sanjay.S.Salve^b, Ashok.T.Pise^{a,b,1*}, Amey.A.Pise^{a,b,2}

^aPG Student, Pimpri Chinchwad College of Engineering University of Pune, Pune, India-

^b Faculty of Engineering, Pimpri Chinchwad College of Engineering, University of Pune, Pune, India-

^{a,b,1} Deputy Director, Directorate of Technical Education, Mumbai, India

^{a,b,2} Student, Mechanical Department, VIT, Pune, India

Abstract

The basic aim of conducted experiments was to investigate the thermal performance of serpentine shape thermosyphon heat pipe flat plate solar collector under real operating conditions. Distil water, (Al₂O₃-water) nanofluid with varying concentrations (0.05, 0.25 and 0.5 by wt), (Al₂O₃-water) + surfactant , water + surfactant were used as working fluids. Effect of coolant rate, concentration of nanomaterial on performance of solar heat pipe collector was studied experimentally for different tilt angles. Collector wastested for tilt angles (18.53, 33.5, 40, 50 and 60°). Nanofluids of Al₂O₃ nanoparticles by wt having average size <50 nm dispersed in water with different concentrations by two step process. Two step processes comprising of magnetic string and ultra-sonication is used. From results it is observed that as the efficiency of the collector increases as coolant flow rate increases upto certain limit, then decreases. Also similar trend is observed for tilt angle and it is found maximum at 50°. Surfactant, Surfactant-Nanofluids, nanofluids as working fluid in the heat pipe collector gives better performance as compared pure water and performance enhances with increase in the concentration of the nanofluid.

© 2016 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license

(<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Peer-review under responsibility of the organizing committee of ICAER 2015

Keywords: Heat Pipe; Nanofluid; Collector; Tilt angle ;Surfactant

1.Introduction

Solar energy is widely used for providing heat to many houses. Solar water heating is an effective method of using solar energy to perform many useful tasks. In a conventional solar collector, the absorber plate is often backed

* Corresponding author. Tel.: +91-022-30233356; fax:+91-022-22692102.

E-mail address: ashokpise@yahoo.com

up with a grid or tubes containing water as working fluid in it. The solar energy is absorbed by the working fluid and transferred to the storage tank either by natural or forced circulation. The drawbacks associated with conventional solar collectors include the pump and its power requirement, more space to obtain the natural circulation of working fluid, night cooling due to reverse flow of cooled water, pipe corrosion and limited heat carrying capacity of working fluid, high heat loss factor. Heat pipes are found to provide an alternative solution to the above problems.

Heat pipes, contain small amount of vaporizable fluid, transfers heat by evaporating the working fluid in a heating zone and condensing vapor in the cooling zone. Subsequently, the return flow of condensate to the heating zone occurs through the capillary structure (wick) which lies in the inner wall of the heat pipe. However, in certain applications, the return flow of the condensate to the heating zone occurs due to the gravity force and termed as gravity assisted heat pipes, wickless heat pipes or thermosyphon. Because of its ability to transfer large quantity of heat energy, the heat pipes have been widely used in several industrial applications, namely boilers, air-conditioning system, heat exchangers and solar water heating system. The wickless heat pipes are usually integrated with flat absorber plate of the solar heating system, to enhance the thermal performance. Numerous studies have been carried out to understand the thermal performance of two phase thermosyphon used in solar water heaters. Karaghali et al. [1] obtained 38% average efficiency which is enhancement in collector efficiency with thermosyphon compared to conventional solar collector. Nada et al [2] reported the results obtained through experimental investigation of a TPCT solar collector. They investigated the performance for different coolant rate and found that collector efficiency increases with increasing flow rate from 0.0.125 kg/s to 0.0292 kg/s and further increase in coolant rate reduces the performance. The thermal performance of a two-phase thermosyphon solar collector with various refrigerants was reported by Esen and Esen [3] The thermal performance of the heat pipe with R410A as working fluid was found to be better compared to other refrigerants. The maximum collector efficiencies of solar collector throughout the day were found to be 50.84%, 49.43% and 48.72% for R410A, R407C and R-134a, respectively. The thermal performance of solar collector by using various refrigerants such as: R-134a, R12, and ethanol was reported by Enaburekhan and Yakasai [4]. The heat pipe that utilizes R-134a as working fluid exhibits maximum collection efficiency compared to other working fluids. Since thermosyphon utilizes phase change of the working fluid to transfer heat, selection of a working fluid is essential to achieve the maximum heat transfer capacity. Initially, Choi [5] had made an attempt to use nanofluid (nanofluid-suspension) in thermal engineering due to its anomalous heat transfer characteristics. The colloidal suspension of nanoparticles in the base fluid with uniform dispersion is termed as nanofluid. Because of its enhanced heat transfer characteristics, nanofluids have been used in thermosyphon to improve the thermal performance. Hung et al. [6] reported effect of concentration on heat pipe performance charge with water/ Al_2O_3 nanofluid with three different concentrations (0.5, 1.0, and 3.0 wt %), the maximum heat flux apparently increase with the increase of the mass concentration when the mass concentration is less than 1.0 wt. %. Then, they begin to decrease slowly after the mass concentration is over 1.0 wt. %, they also studied the thermal performance of a heat pipe with charged volume ratio of the working fluid (20%, 40%, 60%, and 80%). Results show that 40% charge heat pipe shows better performance. The thermal performance of the closed two-phase thermosyphon by using various nanofluids (titanium-ethanol and titanium-water suspension) was reported by Naphon et al. [7]. The heat transfer enhancement of the thermosyphon with titanium-ethanol suspension was found to be 10.6% higher compared to the heat pipe with ethanol. Moravej et al. [8] investigated the effect of aluminum oxide nanofluid on the thermal efficiency enhancement of a heat pipe. It observed that Al_2O_3 nanofluid has remarkable potential as a working fluid for heat pipe and thermosyphon of higher thermal prefates. Manimaran et al [9] has been conducted experiment on the heat pipe for various parameters such as angle of inclination and fill ratio. The thermal efficiency for DI water and nanofluid increases when the fill ratio increases and the maximum efficiency are obtained for 75% fill ratio and for an angle of 30° Chougule et al. [10] investigated the thermosyphon heat pipe for nanofluids, surfactant at different inclination angles and found that the performance of the collector increases from 20° to 50° and further increase in tilt angle reduces the performance. They compared the results of pure water with (2EH) surfactant as working fluid and found an average efficiency of 54% Jung et al. [11] evaluated the effect of 1-octanol, 1-heptanol, 3-octanol and 2-ethyl-1-hexanol (9000 ppm) on mass transfer in aqueous LiBr solution in a falling film absorber. A maximum of 20% enhancement was obtained with 2EH. Kyung and Herold [11] tested additives 2EH by varying its concentrations from 0-500 ppm. Above 80 ppm, there was no significant

Download English Version:

<https://daneshyari.com/en/article/5447106>

Download Persian Version:

<https://daneshyari.com/article/5447106>

[Daneshyari.com](https://daneshyari.com)