Singaporean Journal of Scientific Research

Journal of Selected Areas in Nanotechnology (JSAN)
Singaporean Journal of Scientific Research(SJSR)
Vol 6.No.2 2014 Pp. 132-135
available at:www.iaaet.org/sjsr
Paper Received :10-03-2014
Paper Accepted:20-03-2014
Paper Reviewed by: 1Prof.Dr.Chandra 2. Chai Cheng Yue
Editor : Dr. S.Sivanesh Rajan

A STUDY ON A FLAT PLATE TYPE OF SOLAR WATER HEATER WITH ANTHERMOSYPHON USING DIFFERENT WORKING FLUID

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ABSTRACT

This paper investigates the study of the flat absorber plate solar collector with heat pipe using two different working fluid has been experimentally investigated .TiO_2nano fluid and propanol with concentration of the nano particle and size maintained as constant 80 ml/lit and 40nm Nano fluids are stable suspensions of nano fibers and particles in fluids. latest investigation of nano fluids shows better thermal behaviour such as improved thermal conductivity and convections co-efficient in comparison to pure fluid or fluid with large size particles Performance of the heat pipe solar collector was experimentally examined the results shows that TiO_2 with DI water gives the better performance when compare to propanol.

Key words: flat plate collector, thermosyphon, TiO2nanofluid ,propyl alcohol

1. INTRODUCTION

In the energy needs of today with increasing environmental concern, alternative to these of non-renewable and polluting fossil fuels have to be investigated. One such possibility is solar energy, which has become increasingly popular in recent years. Various types of solar energy systems for agricultural and marine products have been reviewed. One of the most important components of a solar energy system is the solar collector. Solar collector is a simple, cheap and most widely used device designed to absorb incident solar radiation and to transfer the energy to fluid passing in contact with it. Solar collectors can be used for drying, space heating, solar desalination, etc. When flat plate collector integrated with heat pipe would give better performance in energy absorbtion.

A heat pipe or heat pin is a heat-transfer device that combines the principles of both thermal conduction and phase transition to manage the transfer between two solid interfaces efficiently. At the hot interface within a heat pipe, which is typically at a very low pressure, a liquid in contact with a thermally conductive solid surface turns into a vapour by absorbing heat from that surface. The vapour condenses back into a liquid at the cold interface, releasing the latent heat. The liquid then returns to the repeats the cycle. In addition, the internal pressure of the heat pipe can be set or adjusted to facilitate the phase change depending on the demands of the working conditions of the thermally managed system. Heat pipes offer effective thermal conductivities, energy efficiency, light weight, low cost and the flexibility of many different size and shape options. Heat pipe transfer heat more efficiently and evenly than solid conductors.

Extensive investigations have been carried out on the optimum design of conventional and modified solar flat plate collector, in order to search for efficient and inexpensive designs suitable for mass production for different practical applications. Flat plate solar collector using flat absorber with heat pipe was best suited for domestic solar water heater applications for its low weight, low cost and long life etc.

Asghar et al [1] simulated the model of wickless heat pipe in CFD and carried out volume of fluid technique for a different operating conditions. Also the author compared the simulated results with the experimental values. Gabriela Huminic et al [2] compared the heat transfer characteristics on basic working fluid with iron – oxide nano fluid. And the iron – oxide gives high thermal performance [3]. And that same fluid with water gives a good heat transfer [4]. Kenneth M. Armijo conducted the experiment on heat pipe with propanal in different liquid level [5]. S.Rittidech [6] investigated vertical flat thermosyphon with R123, ethanol and water as working fluid. Also author exhibit the result in different filling ratio. Bandar Fadhl et al [7] concluded that the experimental data and simulated CFD data gives good agreement.

E. Azad [8] investigate heat pipe solar collector with ethanol increase overall heat transfer. Jorge Facao et al [9] compared the experimental and simulated values in heat pipe solar collector. Lingjiao Wei et al [10] showed the efficiency of heat pipe with solar collector is 66%. When we use R134a in heat pipe solar collector gives 62% efficiency [11].

Xudong Zhao t al [12] used computer model to analysis the system. Also author investigate when the mean temperature increases the efficiency of the heat pipe solar collector was decreases. AlirezaHobbi [13] conducted the experiment in flat plate solar collector with different heat enhancement devices. And also author proved the different heat devies gives same heat flux.

. Flat plate solar collector using flat absorber with heat pipe is best suited for domestic solar water heater applications for its low weight, low cost and long life etc.Present work analysis theThermosyphon (wickless heat pipe)with flat absorber plate solar collector experimentally with Tio_2 and Propyl alcohol as working fluid for heat pipe

Experimental Study:

The experimental setup consists of Wickless heat pipe, solar collector with grooved flat absorber plate and Water storage tank. The wickless heat pipe are placed on the grooved absorber plate and tied in a flat plate solar collector. Glass wool insulation is provided below the absorber plate for reducing the conduction losses, the sides of the absorber plate are covered using thermo cool insulator for minimizing the convective losses.

The glass plate is used for reducing the radiation losses by reradiating the heat emitted by the absorber plate in the form infrared rays. Number of glass plates used are one or two, if not most of solar radiation will get refracted. The surface temperature of cylindrical heat pipe was measured using Five K-Type thermocouples, absorber plate and glass plate temperatures are measured using K-Type thermocouples. All the thermocouples were connected to the temperature indicator. The uncertainty in temperature measurement was ±0.1°C.

Flow to condenser section was controlled by rotometer and flow rate was maintained at 160ml/min. Pyranometer is used to measure the solar intensity in m.v .The experiments was conducted for six days, first three days for Tio_2 remaining days for Ethyl propyl Alcohol.

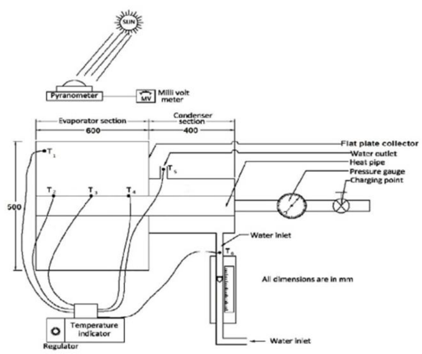

Figure 1.Sketch of flat plate solar collector using thermosyphon.

The efficiency was calculated by the ratio of heat gained by the water and total heat of the collector. Then the specimen calculation are,

$Q_t = (m.v \times 60 \times 4.187 \times 10^4) \div (5.56 \times 1000)$

$Q_c = Q_t \times A_c$

$Q_w = mCp\,(Tout - Tin)$

$\eta = (Q_w / Q_c) \times 100$

Figure 2. Experimental setup

2. RESULT AND DISCUSSION

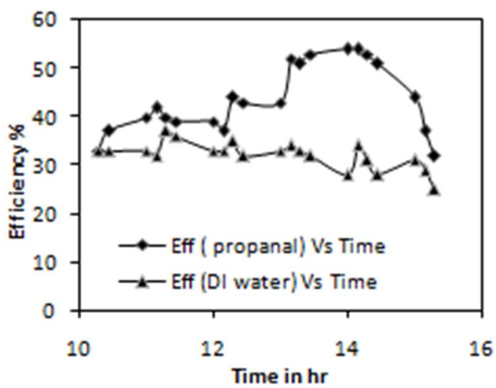

Figure 3.Efficiency improvement of flat plate solar collector using thermosyphon.

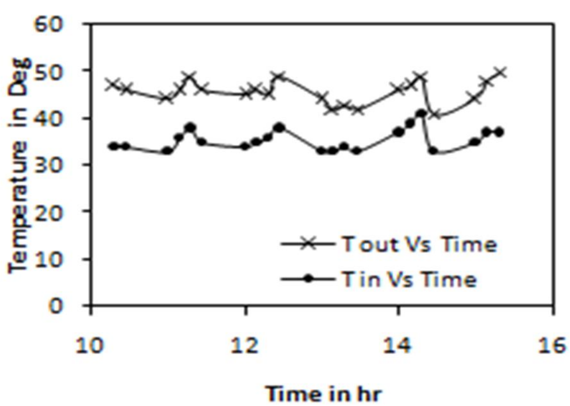

Figure 4a.

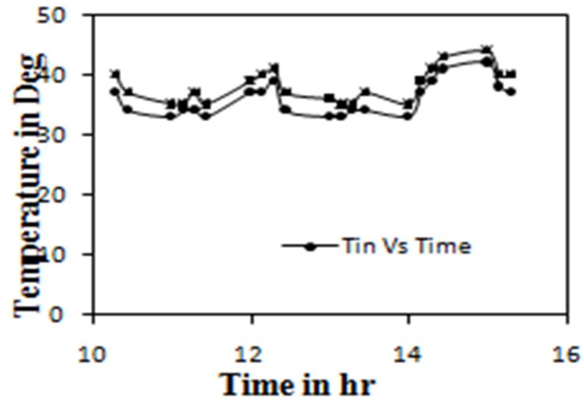

Figure 4b.

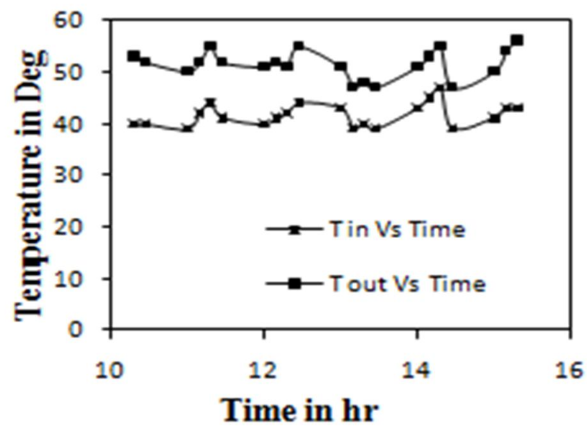

Fig 4c.

Figure 4a, 4b, 4c.shows Effect of proponal on flat plate solar collector using thermoyphon.

An experimental study was carried out to study the thermal performance of the fluid plate solar water heater with thermosyphon using two different working fluids in sunny days. All experiments were carried out between 10 am and 4 pm local time for three consecutive sunny days from 6thjan to 9thjan(with DI water) and 12thfeb to 15th (with propanal).

Fig 3 to 6 illustrates the temperature distribution of water based on DI water and propyl alcohol in typical sunny days. The maximum obtained values for 50◦C, 45◦C and 56◦C respectively. Is is also obvious that in the early hours of the day the glass temperature is slightly higher than the water because the glass is directly facing the radiation and it slowly increases the evaporator temperature of thermosyphon. Hence the thermosyphon is filled with propyl alcohol the efficiency is ....% high when compared to DI water. Similarly the temperature distribution of water at outlet is high in propyl alcohol. The temperature of glass reduces after 4pm then the evaporator temperature is also reduced due to that reason the temperature of water outlet starts to reduce gradually and efficiency also. It should be noted that the results were affected by environmental conditions such as wind speed, spatial wind barriers and ambient temperature fluctuation.

3. CONCLUSION

In this study flat plate solar water heater with thermosyphon using two working fluid have been analysed for thermal performance. The total productivity of the heated water is increased by using the thermosyphon with propyl alcohol compared to TiO_2. This is due to maragonieffet and maragoni flow. The efficiency is also high while using propyl alcohol.

REFERENCES

[1]. AsgharAlizadehdakhel[a], MasoudRahimi[a,*], Ammar Abdulaziz Alsairafi[b]. "CFD modeling of flow and heat transfer in a thermosyphon". International Communication in Heat and Mass Transfer 37(2010), 312-318.

[2]. GabrielaHuminic[*], Angel Huminic. "Heat transfer characteristics of a two-phase closed thermosyphons using nanofluids". Experimental Thermal and Fluid Science 35(2011) 550-557.

[3]. GabrielaHuminic[a,*], Angel Huminic[a], Ion Morjan[b], Florian Dumitrache[b]. "Experimental study of the thermal performance of thermosyphon heat pipe using iron oxide nanofluids". International Journal of Heat and Mass Transfer 54(2011) 656-661.

[4]. Gabriela Huminic[*], Angel Huminic[*]." Numerical study on heat transfer characteristics of thermosyphon heat pipe using nanofluid". Energy Conversion and Management 76(2013) 393-399.

[5]. Kenneth M. Armijo[*], Van P.Carey[1]." An analytical and experimental study of heat pipe performance with a working fluid exhibiting strong concentration Marangoni effects". International Journal of Heat and Mass Transfer 64(2013) 70-78.

[6]. S.Rittidech[*], W.Sriuang. " Correlation to predict heat-transfer characteristics of a vertical flat thermosyphon (VFT) at normal operating conditions". Heat and Mass Transfer 53(2010), 5984-5987.

[7]. Bandar Fadhl[1] ,LuizC.Wrobel[*], HusamJouhara. " Numerical modeling of the temperature distribution n a two – phase closed thermosyphon". Applied Thermal Engineering 60(2013) 122-131.

[8]. E.Azad. " theoretical and experimental investigation of heat pipe solar collector". Experimental Thermal and Fluid Science 32(2008) 1666-1672.

[9]. Jeorgefacãoand ArmandoC.Oliveira. "Analysis of a plat heat pipe solar collector". 28-30(2004), 1-5.

[10]. LingjiaoWei[a,b], DazhongYuan[a,*], DaweiTang[a], BangxianWu[a]. " A study on a flat – plate type of solar heat collector with an integrated heat pipe". Solar Energy 97(2013) 19-25.

[11]. S.Rittidech[*] , S. Wannapakne. "Experimental study of the performance of a solar collector by closed-end oscillating heat pipe (CEOHP)". Applied Thermal Engineering 27(2007) 1978-1985.

[12]. XudongZhao[a,*], ZhangyamWang[b], Qi Tang[b]." Theoretical investigation of the performance of a novel loop heat pipe solar water heating system for use in Beijing, China". Applied Thermal Engineering 30(2010) 2526-2536.

[13]. AlirezaHobbi[a], Kamran Siddiqui[a,b,*]. " Experimental study on the effect of heat transfer enhancement devices in flat – plate solar collectors". International Journal of Heat and Mass Transfer 52(2009) 4650-4658.