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EXPERIMENTAL ANALYSIS OF THERMAL CONDUCTIVITY OF NANO FLUIDS USING SOLAR COLLECTOR

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***Abstract*—Solar energy is one of the cleaner forms of renewable energy resources. The conventional solar collector is a well-established technology which has various applications such as water heating, space heating and cooling. However, the thermal efficiency of these collectors is limited by the absorption properties of the working fluid. Recently usage of Nano fluids, which is basically liquid Nano particle colloidal dispersion as a working fluid has been found to enhance solar flat plate collector thermal efficiency maximum by 30 percent. In this paper an effort has been made to present a comprehensive overview on thermal performance of solar flat plate collector for water heating using Titanium dioxide Nano fluids. It is reasonable to conclude then, that titanium dioxide is not a cancer-causing substance unless exposure is beyond safe limits during manufacturing using this substance. It is considered safe for use in foods, drugs, paints and cosmetics. The application of Nano fluids is to achieve the highest possible thermal properties at the smallest possible concentrations, by homogeneous dispersion and stable suspension of Nano particles in the host fluids.**

Keywords—Titanium dioxide nano fluid, Solar collector, Heat exchanger.

I. INTRODUCTION

Nano fluids have recently found relevance in applications requiring quick and effective heat transfer such as industrial applications, cooling of microchips, microscopic fluidic applications, etc. Moreover, in contrast to conventional heat transfer (for solar thermal applications) like water, ethylene glycol, and molten salts, Nano fluids are not transparent to solar radiant energy; instead, they absorb and scatter significantly the solar irradiance passing through them. Typical solar collectors use a black-surface absorber to collect the sun's heat energy which is then transferred to a fluid running in tubes embedded within. Various limitations have been discovered with these configuration and alternative concepts have been addressed. Among these, the use of Nano particles suspended in a liquid is the subject of research. Nano particle materials including aluminium, copper, carbon Nano tubes and Carbon-Nano horns have been added to different base fluids and characterized in terms of their performance for improving heat transfer efficiency. Nano fluids are potential heat transfer fluids with enhanced thermo physical properties and heat transfer performance can be applied in many devices for better performances (i.e. energy, heat transfer and other performances). In this paper, a comprehensive literature on the applications and challenges of Nano fluids have been compiled and reviewed.

II. MATERIALS AND METHODOLOGY

A. RAW MATERIAL

The materials used in this paper are Copper tube, Tio2 nano fluids, Heat exchanger, Pump & Thermometer. The flat plate wooden rectangular box contains black coated GI sheet for absorbing heat from the sun and a copper tube is winded over a GI sheet, the glass plate is covered with solar collector. The pump is used as forced circulating pump in which the titanium dioxide nano fluid is filled inside the pump tank. The copper tube is winded in heat exchanger and connected to the pump. The nano fluid is passed inside the copper tube using circulating pump through solar collector and heat exchanger as closed circuit.

B. METHODOLOGY

B.1. Preparation of nano fluid

The titanium dioxide nano particle(Fig.1) size of 20-50µm is used for converting nano fluid, in which the nano particle is taken as 1%, 2% and 3% i.e,1gms, 2gms & 3gms of tio2 is mixed with the 1000ml of distilled water.

Fig.1 Titanium Dioxide Nano Powder

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The combination of Tio2 and distilled water is taken for stirrer, first the distilled water is measured by using measuring jar before that the measuring jar is washed with acetone. The measured distilled water is poured in the 2500ml capacity of glass beaker, then the beaker is placed over the magnetic stirrer (Fig.2). The nano powder is prepared in three ratio such as 1gms of Tio2 per l litre, 2gms of Tio2 per 1 litre, 3gms of Tio2 per 1 litre are weighted in weight machine. The nano powder is handled by using spatula.

Fig.2 Magnetic Stirrer

The nano powder is poured into the beaker contained distilled water. After that the magnetic pellet is placed inside the beaker for stirrer, set an temperature as 50ºC, stirrer speed as 630 rpm and the stirrer period is 24 hours.

B.2.Properties of Titanium Dioxide particles

Density = 4.23 g/cm^3
Molar Mass = 79.9378 g/mol
Melting Point = 1,843° C
Boiling Point = 2,972° C

TiO2 nano particles are frequently used as photo catalyst due to non-toxicity, chemical stability, and the ability to possess relatively high photo catalytic activity of TiO2.

B.3.Preperation method for nano fluid (Two step method)

Two-step method is the most widely used method for preparing Nano fluids. Nano particles, Nano fibres, Nano tubes, or other Nano materials used in this method are first produced as dry powders by chemical or physical methods. Then, the Nano sized powder will be dispersed into a fluid in the second processing step with the help of intensive magnetic force agitation, ultrasonic agitation, high-shear mixing, homogenizing, and ball milling. Two-step method is the most economic method to produce Nano fluids in large scale, because Nano powder synthesis techniques have already been scaled up to industrial production levels. Due to the high surface area and surface activity, Nano particles have the tendency to aggregate. The important technique to enhance the stability of Nano particles in fluids is the use of surfactants. However, the functionality of the surfactants under high temperature is also a big concern, especially for high-temperature applications.

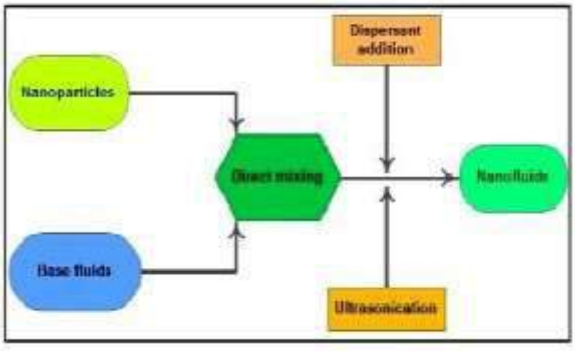

Fig.3.Two-step method

Due to the difficulty in preparing stable Nano fluids by two-step method, several advanced techniques are developed to produce Nano fluids, including one-step method. In the following part, we will introduce one-step method in detail.

B.4. Comparison between water & nano fluid

WORKING FLUID	WATER	NANOFLUID
Optical efficiency %	38.9	99.96
Thermal efficiency %	36.2	92.9
Mean output temperature °c	35.8	45.0

Table.1

B.5. Fabrication of solar water heater

The solar water heater is based on the principle of heat conduction and convection method, from which the heat absorbed from the

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collector and heat dissipated to the storage tank water. The heat energy is renewable source of energy which from sun. Solar energy is versatile. The main parts in the solar water heater are solar collector, pump, storage tank. The solar collector is the heart of the project in which it consists of rectangular wooden box, black coated GI-sheet, copper tube, visible glass plate. The black coated GI-sheet is placed inside the wooden box. The copper tube is bended and placed inside the wooden box and above the GI-sheet. The visible glass is placed surface of the wooden box and paste it.

The solar collector is placed at the angle of 45º from the surface and focused to the direction of the sun's radiation. The pump is used for circulating the nano fluids. The flow of the pump is pumped 650 per hour and placed inside the small tank capacity of 1 litre. The nano fluids is pumped by using forced circulating method in which the nano fluid from the tank is sucked and circulate through copper tubes. The storage tank contains winded copper tubes, the heated water from the solar collector is passed through the copper tubes and enter into the storage tank, the heat from the water is dissipated to the storage tank and the water from the storage tank is heated due to convection method.

III EXPERIMENTATION

The nano fluids is poured into the pump tank then it is allowed to pass the nano fluids through copper tubs winding, the nano fluids first

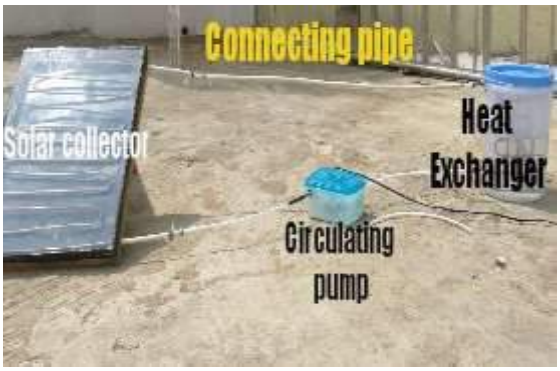

Fig.4 Experimentation

pumped to the solar collector and absorbed heat from the collector. The nano fluids have high thermal conductivity and absorbs heat from the collector then the nano fluids is passed to the water tank, in water tank the heat from nano fluids is distributed to the water tank. Due to thermal convection the heated nano fluids become slightly cooled and then it is passed to the circulating pump.

DESIGN OF COLLECTOR AND TUBES

SOLAR COLLECTOR

Box is made with a space of hollow inside it. The size of the box is 21.8 × 16.4 × 1.57 (Height × breadth × width)inch. The box is made up of wood in this project. Then the GI sheet of dimensions which is equal to the box's inside dimensions is fixed in the box. The GI sheet is coated with the black paint. The glass of size equal to the box's outside dimension is bought and then it is pasted on the box with the help of m-seal.

Fig.5 Solar Collector

COPPER TUBE

The total length of the copper tube is 9feet approx. the copper tube is cut it into two equal parts. Then the copper tube is bended into the shape of U. Each parts have three U bend in left side and two U bend in right side. The two parts of the copper tube is joined together with the help of connecting tubes. We should make sure that there is no leakage in the tubes at the place of joining.

Fig.6 Copper Tube

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IV RESULTS AND DISCUSSION

A . Working Of Solar Collector Using Ordinary Water

TIME (min) / TEMP(ºC)	T	T_n	T_a
10:00 – 11:00 AM	36.85	34.1	27.8
01:00 – 02:00 AM	39.75	34.95	35.35
03:00 – 04:00 AM	39.3	36.27	37.2

Table.2

The table.2 shows that the average temperature of Atmospheric temperature (T_a), Normal direct heat of water from sun temperature (T_n) and Heat water storage tank temperature (T). Morning (10:00 – 11:00 AM), Afternoon (01:00 – 02:00 AM) and Evening readings (03:00 – 04:00 AM) for ordinary water readings are tabulated.

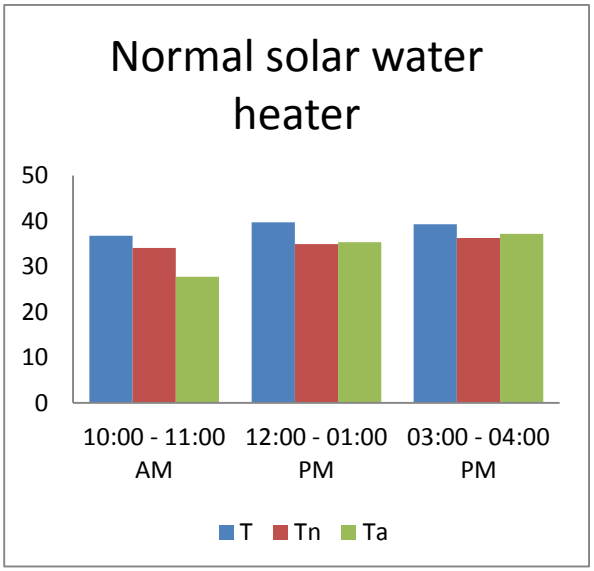

Fig.7

The above (fig.7) bar chart shows that the overall average readings for day1 & day2. The chart shows that the Atmospheric temperature (T_a), Normal direct heat of water from sun temperature (T_n) and Heat water storage tank temperature (T) of three different hours for every 15min in a comparison day.

Working Of Solar Collector Using 2gms of Tio2 Per 1000ml Of Distilled Water

TIME (min) / TEMP(ºC)	T	T_n	T_a
10:00 – 11:00 AM	42.15	37.15	27.8
01:00 – 02:00 AM	44.1	38.9	30.6
03:00 – 04:00 AM	45.3	39.3	32

Table.3

The table.3 shows that the average temperature of Atmospheric temperature (T_a), Normal direct heat of water from sun temperature (T_n) and Heat water storage tank temperature (T). Morning (10:00 – 11:00 AM), Afternoon (01:00 – 02:00 AM) and Evening readings (03:00 – 04:00 AM) for ordinary water readings are tabulated.

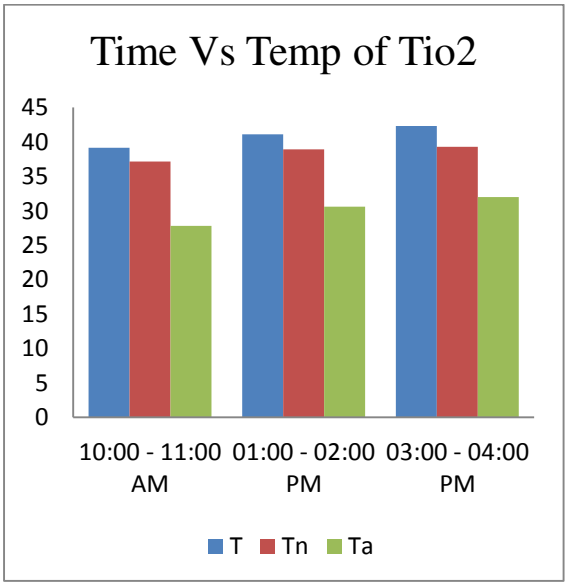

Fig.8

The above (fig.6) bar chart shows that the overall average readings for day1 & day2 of Titanium dioxide with 2gms per 1000ml of distilled water. The chart shows that the Atmospheric temperature (T_a), Normal direct heat of water from sun temperature (T_n) and Heat water storage tank

temperature (T) of three different hours for every 15min in a comparison day.

V CONCLUSION

Experimental analysis of thermal conductivity of Tio2 nano fluid using solar collector concludes that the efficiency of the solar flat plate collector at angle of 45º increase the thermal conductivity by using Tio2 nano fluids. Finally we tried to increase the efficiency of the normal solar collector by using nano fluids. Further we add the nano powder percentage to increase the efficiency of the solar water heater. This technique is more economic and useful in future. To select the best nanofluid for TiO_2, water, ethylene glycol, and propylene glycol were used as base fluids. It is reasonable to conclude, that **titanium dioxide** is not a cancer-causing substance, it is considered safe for use in **foods**, **drugs** and cosmetics. This experiment is completely pollution free one and also non toxic, simple design, less in weight, Low cost and less maintenance.

REFERENCE

1) ENatarajan& R Sathish.,(2009), Role of nanofluids in solar water heater, InternationalJournal of Advanced Manufacturing Technology.
2) Murshed S M S, Leong K C, & Yang C., (2005), Enhanced thermal conductivity of TiO2 Water based nanofluids, International Journal of Thermal Sciences, 44(4), pp 367– 373.
3) T P Otanicar& J S Golden., (2009), Comparative Environmental and Economic Analysis of conventional and Nanofluid Solar Hot Water Technologies, Environ. Sci.Techno., 43(15), pp 6082–6087.
4) Xuan Y & Li Q., (2000), Heat transfer enhancement of nanofluids, International Journal of Heat and Fluid Transfer, 21, pp 58–64.
5) Yang Y, Zhang Z G, Grulke E A, Anderson W B & Wu G., (2005), , International Journal of Heat and Mass Transfer, 48(6), pp1107–1116.
6) Azadeh Ghadimi, Ibrahim Henk Metselaar, (2013), The influence of surfactant and ultrasonic processing on improvement of stability, thermal conductivity and viscosity of titania nanofluid, International journal of Experimental Thermal and Fluid Science.
7) Sarit kumar das, Stephen u. S. Choi, Hrishikesh e. Patel, (2006), Heat Transfer in Nanofluids.
8) John Philip , P D Shima and Baldev Raj, (2008), Evidence for enhanced thermal conduction through percolating structures in nanofluids.
9) International Journal of Heat and Mass Transfer(2012), I.M. Mahbubul, R. Saidur, M.A. Amalina, Latest developments on the viscosity of nanofluids.
10) Eiyad Abu-Nada,(2007), Application of nanofluids for heat transfer enhancement of separated flows encountered in a backward facing step, International Journal Of Heat and Fluid Flow.