ISSN : 2455-9679
Impact Factor : 3.340

IJRTSM

INTERNATIONAL JOURNAL OF RECENT TECHNOLOGY SCIENCE & MANAGEMENT

"NANO FLUIDS AS A CATALYST TO ENHANCE THE EFFICIENCY OF SOLAR COLLECTOR: A REVIEW"

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ABSTRACT

Execution and proficiency of solar collectors relies on different components like collector and beneficiary material, solar radiation power, nature of working fluid and so forth. Right now properties of working fluid which courses through the collectors, significantly influences its exhibition. Right now an exertion has been made to enhance the effectiveness and improve the exhibition of solar collector by utilizing Nano fluids rather than ordinary fluid like water as working fluid. Nano fluids are the fluids that display thermal properties unrivaled than that of the regular fluid. The Reason behind utilizing of Nano fluids is to accomplish the most elevated conceivable thermal properties at the littlest potential focuses .Nano fluids contains metallic or non-metallic nanoparticles like aluminum, aluminum oxide, copper oxide and so forth. Nano-fluid based solar collector are normally utilized in territories, for example, industries, warming and cooling for local reason, thermal force plants, solar cooker, autos, and so forth. This paper contains data and technique to Enhance and improve the warmth move and execution of solar collectors utilizing Nano fluid.

Keyword: *Nano fluid, Heat transfer, solar collector, Alumina-copper.*

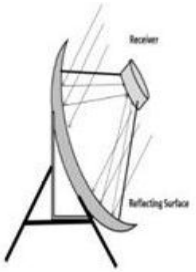
I. INTRODUCTION

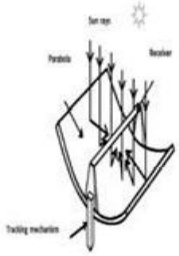
Nano-fluid is the fluid with Nano measured strong particles. The metallic or nonmetallic nano particles change the vehicle properties and warmth move qualities of the base fluid. Nano fluids are the new age heat move fluids for different mechanical and car applications on account of their astounding thermal exhibition. Solar vitality is generally utilized in applications, for example, power age, compound handling, and thermal warming because of its inexhaustible and nonpolluting nature. Most solar water warming frameworks have two principle parts: a solar collector and a capacity tank. The most well-known collector is known as a level plate collector yet these experience the ill effects of generally low proficiency. There are such a significant number of strategies acquainted with increment the productivity of the solar water warmer. Be that as it may, the novel methodology is to present the Nano fluids in solar collector rather than customary warmth transfer fluid (like water).

1. ***SOLAR THERMAL COLLECTOR:*** Solar thermal collectors can likewise be viewed as amazing dependent on the sort of warmth move fluid and their development utilized (water, non-freezing fluid, air, or warmth move fluid) and whether they are secured or revealed. Most well known sorts of solar collectors are illustrative Dish, Parabolic Trough and Power Tower framework and solar level plate. Solar level plate collectors are utilized for water warming applications and the productivity of these frameworks are around 70% which is

ISSN : 2455-9679
Impact Factor : 3.340

extremely high when contrasted with solar direct vitality change frameworks having effectiveness around 17%. These collectors are valuable for local applications, space warming and mechanical low temperature applications. Right now countless solar collectors are accessible available dependent on concentrating solar force (CSP) frameworks which use focal points or mirrors and following frameworks to center an enormous territory of daylight into a little pillar.





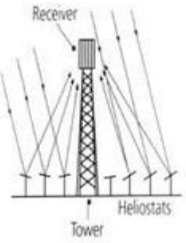


Fig-1(a) Parabolic Dish Collector **Fig-1(b) Trough Collecto** **Fig-1(c) Tower system**

2. ***SOLAR PHOTOVOLATIC EFFECT:*** French physicist Edmond Becquerel discovered how to produce electric current in a solid material with the help of sunlight as early as 1839. The photovoltaic effect cause certain materials to convert light energy into electrical energy at the atomic level, which was first studied in 1876 by Adam and Day, who made solar cell from selenium that had an efficiency of 1-2%. The photovoltaic effect was explained by Albert Einstein in 1904 via his photon theory [3]. A noteworthy breakthrough related to modern electronics was the invention of a process to produce pure crystalline silicon by Polish scientist Jan Czochralski in 1916. The efficiency of first generation silicon cells was about 6% [5], which is substantially lower than that of current solar cells (about 14-20%). Early efforts were made to make the photovoltaic cells viable for generating electricity for worldly applications were unsuccessful due to the high device costs. The lower prices of these photovoltaic cells and need for green technology gained interest in employing this technology.

3. ***NANOFLUID:*** Nano fluids demote to a solid-liquid mixture or suspensions produced by dispersing tiny metallic or nonmetallic Solid Nano particles in liquids. Nano fluids are a new class of fluids engineered by dispersing nanometer sized materials (Nano-particles, Nano-fibers, Nano-tubes, Nano-wires and Nano-rods) in base fluids. The size of nanoparticles (usually less than 100nm) in liquids mixture gives them the ability to interact with liquids at the molecular level and so conduct heat better than today's heat transfer fluids depending on nano particles. Metallic Nano fluids have been found to possess enhanced thermo physical properties such as thermal conductivity, thermal diffusivity, viscosity and convective heat transfer coefficients compared to those of base fluids like oil or water. In current years, Nano fluids established greater potential in many fields like solar collector and solar thermal storage. Even though some review articles involving the progress of Nano fluids investigations were published in the past several years , most of the reviews are concerned with the experimental and theoretical studies of the thermo physical properties or the Convective heat transfer of Nano fluids.

4. ***PREPARATION OF NANOFLUID:*** In order to carry out experimental studies with Nano fluids, their preparation is the first main step. Nano fluids are prepared by dispersing Nano sized solid particles like alumina (Al), silicon oxide (SiO), copper oxide (CuO) into base liquids such as water, ethylene glycol therminol-VP-1 etc. There are mainly two techniques used to produce Nano fluids: the single-step and the two-step method. In the present experimental work two-step method is used as this method is widely used for the preparation of Nano fluids. In this method, first the nanoparticles are obtained by different Methods and then are dispersed in an appropriate base fluid like water, oil, ethylene glycol, therminol-VP 1.

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CLASSIFICATION OF NANOFLUID :- Nano fluids can be normally classified into two categories metallic Nano fluids and non-metallic Nano fluids. The result of study about the atomic and micro scale-level characteristic behavior of Nano fluids shows that the enhancement of thermal conductivity, temperature dependent effects and significant raise in critical heat flux. Metallic Nano fluids often refer to those containing metallic nanoparticles such as (Cu, Al, Zn, Ni, Si, Fe, Ti, Au and Ag), while Nano fluids containing non-metallic nanoparticles such as aluminum oxide (Al2O3), copper oxide (CuO) and silicon carbide (SiC, ZnO, TiO are often considered as non- metallic Nano fluids, semiconductors (TiO), Carbon Nanotubes (SWCNT, DWCNT and MWCNT) and composites materials such as nanoparticles core polymer shell composites. In addition, new materials and structure are attractive for use in Nano fluids where the particle liquid interface is doped with various molecules.

REASON BEHIND USE OF NANOFLUID: - The rise in effective thermal conductivity is important in improving the heat transfer behavior of fluids. The number of other variables also plays key role, For example, for forced convection the heat transfer coefficient for tubes depends on many physical quantities related to the fluid and the geometry of the system through which the fluid is flowing. These quantities include properties of the fluid such as, its , density, viscosity, thermal conductivity, and specific heat along with extrinsic system parameters such as tube diameter and length and average fluid velocity. Therefore, it is essential to measure the heat transfer performance of Nano fluids directly under flow conditions. Researchers have shown that Nano fluids have not only better heat conductivity but also greater convective heat transfer capability than that of base fluids. The effective utilization and more usages of Nano fluids in heat exchangers as a heat transfer fluids. And there are many other advantages of Nano fluid in enhancement of heat transfer are,

- Higher thermal conductivity of Nano particles will increase the heat transfer rate.
- Successful employment of Nano fluid will lead to lighter and smaller heat exchanger.
- Heat transfer rate increases due to large surface area of the Nano particles in the base fluid.
- Nano fluids are most suitable for rapid heating and cooling systems

THERMAL PROPERTIES OF NANOFLUID: - Metallic Nano fluids clearly exhibit improved thermo-physical properties such as thermal conductivity, thermal diffusivity, viscosity, convective heat transfer coefficient, emissivity and optical absorption. The property change of Nano fluids depends on the volumetric fraction of nanoparticles, shape and size of the nanomaterial. Increased thermal conductivity of Nano fluid in comparison to base fluid by suspending particles is shown in Table 1.

Table 1, Thermal conductivity of various solids and liquids.

Material	Specification	Thermal Conductivity (W/m-K)
Metallic Solids	Copper	401
	Aluminum	237
	Silver	429
Nonmetallic Solids	Silicon	148
	Alumina	40
	CNT	2000
Nonmetallic liquids	Water	0.613
	Ethylene Glycol	0.253

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HEAT TRANSFER USING NANOFLUID:- Now a days use of Nano fluid technology instead of conventional fluids is seen as potential area where performance of solar collectors can be improved. The selection of Nano fluid is most important for using in solar collectors, Nano fluids have some limitations i.e. corrosion and erosion of components, pumping power problem, pressure drop, high cost, etc. Pressure drop enhances by employing CuO-oil based Nano fluid under laminar regime, Pressure drop enhances by enhancing volumetric concentration of TiO2water based Nano fluid under turbulent regime. So, the proper selection of Nano fluids is most important for improving the performance of solar collectors. For the high volumetric concentration of Nano fluids, viscosity is needs to be higher. The Nano fluids can be used in parabolic trough systems, photovoltaic or thermal systems, solar ponds, solar thermoelectric cells, solar cooling systems, solar absorption refrigeration systems and the combination of various different solar devices. There are many experiments was done by many different authors on solar collectors by using water and Nano fluid as working fluid, the results shows the heat transfer rate increases using Nano fluid in solar collectors.

II. EXPERIMENT AND RESULT

Experimental Setup:-

Fig-2 Parabolic trough collector system

The trial arrangement completed for testing the presentation of collector comprises of the allegorical formed collector, illustrative reflect-o-receiver tube, glass spread cylinder, 10 liter stockpiling tank, supporting structure, following instrument, channeling framework and ball valve as throttling valve. The capacity tank is situated beneath the recipient's pip level to permit the warming fluid to stream in a constrained way with siphoning framework. The capacity tank is loaded up with water/Nano fluid .The stream happens in a shut framework. The total set-up of Parabolic Trough Solar Collector is indicated figure 2.

The Parabolic trough collector framework comprises of following parts:

A Stainless steel sheet having measurements (1.21 m × 0.90 m) frames the explanatory shape. Explanatory molded mirrors are utilized as reflectors with a reflectivity of 95%. The recipient tube is created an external glass spread cylinder, a vacuum type walled in area or annular space and an inward dark painted cylinder made of copper material. In recipient tube the streaming warmth move fluid, for example, water or Nano fluid increases heat from the solar radiation originating from the reflector part. A dark painted copper tube which has higher thermal conductivity is utilized as a collector tube and is secured by a glass spread cylinder. A beneficiary cylinder has 3.5ft length with inside and outside width of 28 mm and 29 mm. glass spread cylinder has 3ft - length with inside and outside measurement of 63 mm and 65 mm. The help structure for the explanatory solar collector is made of cast iron. The choice of cast iron material for the help structure is a direct result of its more noteworthy unbending nature, hardness and greater adaptability. Primarily two kinds of following frameworks are utilized to be specific, manual following framework and programmed following framework. Right now following is utilized in light of the fact that it is modest when contrasted with programmed following as, programmed following requires an engine and a rigging system. "SUPERLON"

ISSN : 2455-9679
Impact Factor : 3.340

protection is utilized for whole channeling framework. Siphon is utilized for the dissemination of water or Nano fluid from the capacity tank to the channel of the recipient tube at some considerable tallness. Right now siphon is utilized with a most extreme stature of 6ft., 11010/hr yield and 19 W Power.

III. EXPERIMENT RESULTS

Following Fig. shows the correlation of quick productivity w.r.t. time for water and water based alumina and CuO Nano fluid with 0.01% volume fixation at 20 l/hr mass stream rate. From the diagram it is seen that the copper oxide Nano fluid shows higher proficiency from 9:30-11:30 AM and from 12:003:00 PM in correlation with alumina Nano fluid and water.

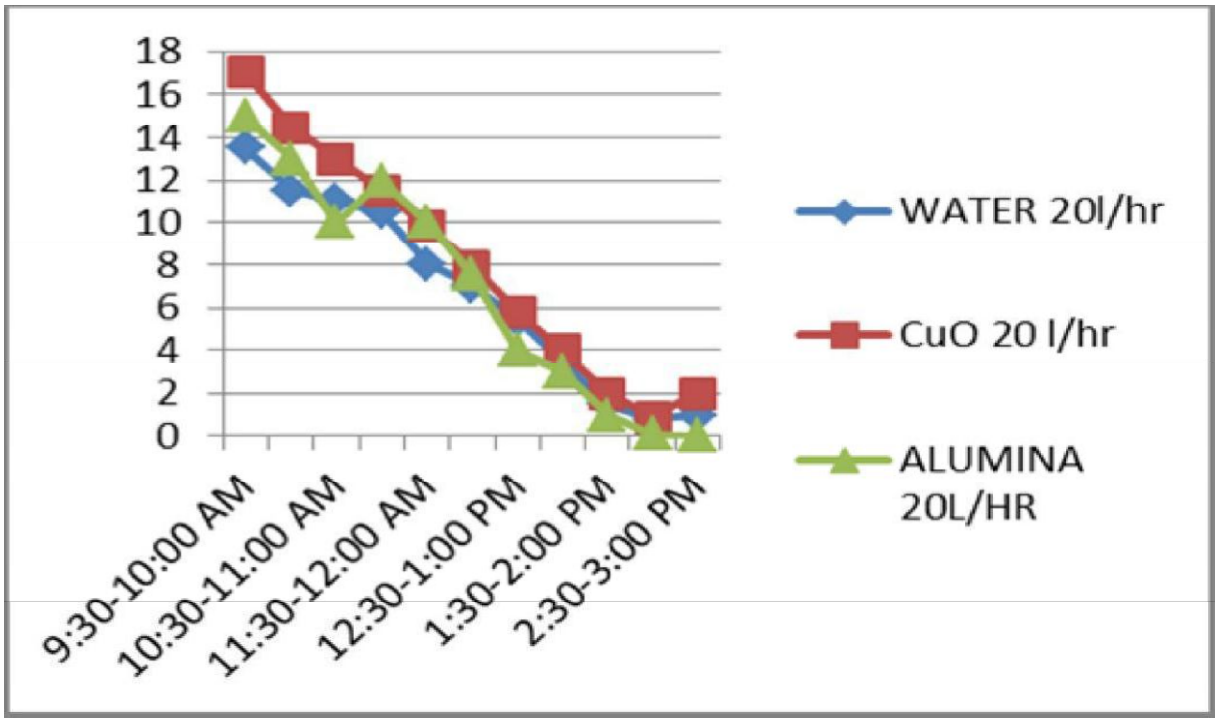

Fig-3(a) Comparison of Instantaneous Efficiency w.r.t. Time for Water & Water Based Alumina and CuO Nano fluid With (0.01%) at 20 l/hr Mass Flow Rate.

If we talk about alumina Nano fluid, it shows higher efficiency than water from 9:30 to 10:30 AM & from 11:00 AM to 12:30 PM because of higher temperature difference & lower intensity of radiations. But there is sudden drop also observes in the thermal efficiency of alumina at 10:30-11:00 AM than water because of the higher specific heat of water, as instantaneous efficiency directly depends upon specific heat. If specific heat increases efficiency increases. From 12:30-3:00 PM water has higher efficiency because of the higher specific heat & faster variation in temperature difference as compare to alumina Nano fluid.

Fig. 3(b) shows the comparison of instantaneous efficiency w.r.t. time for water & water based alumina and CuO Nano fluid with 0.01% volume concentration at 40 l/hr mass flow rate. From the graph it is observed that the copper oxide Nano fluid shows the higher efficiency at the time interval from 9:30 AM to 3:00 PM in comparison with water & alumina Nano fluid.

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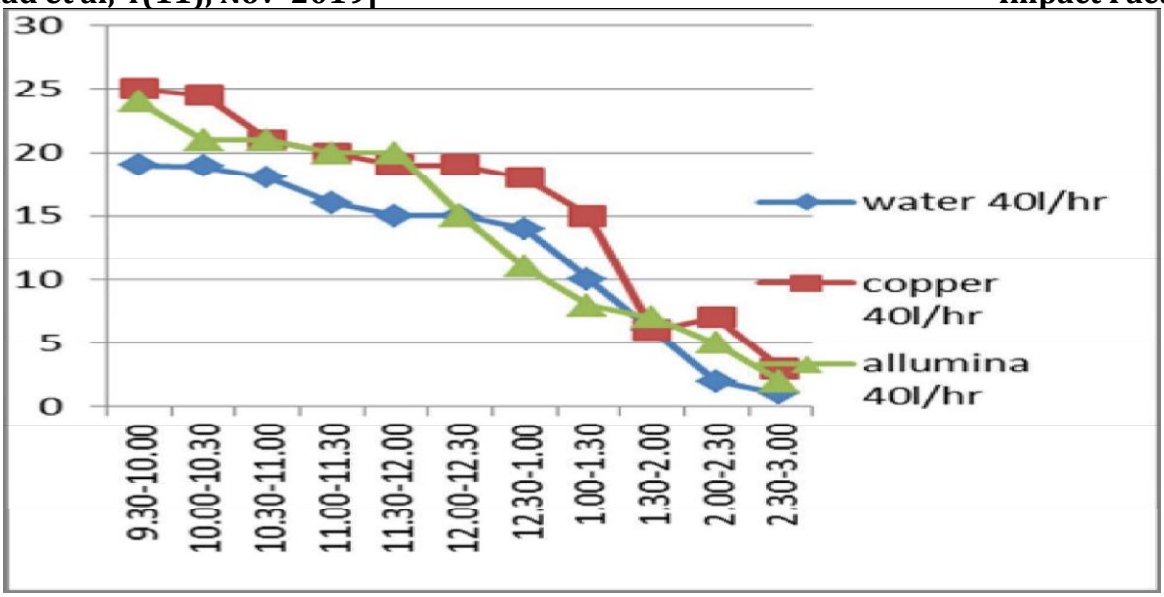

Fig. 3(b): Comparison of Instantaneous Efficiency w.r.t. Time for Water & Water Based Alumina and CuO (0.01%) Nano fluid at 40 l/hr Mass Flow Rate

On the other hand, alumina Nano fluid shows higher efficiency from 9:30 to 12:30 PM & at 2:00 to 3:00 PM in comparison with water because of higher temperature difference & lower Intensity of radiations. Water shows higher efficiency as compare to alumina Nano fluid from 12:30 to 2:00 PM because of its higher specific heat value. The overall maximum value of instantaneous efficiency for CuO is 25.17%, for alumina is 22.35% & for water is 18.91% at 9:30-10:00 AM.

IV. CONCLUSION

The purpose of this experimental work is to check the performance of parabolic concentrating solar collector by using water, water based aluminum oxide (Al2O3) & copper oxide (CuO) Nano fluid as the working fluids. Following are the conclusions drawn with copper oxide (CuO):

By using copper oxide Nano fluid as a working fluid with 0.01% concentration, collector's instantaneous efficiency has been found to be improved from 0.88 to 2.88%, 1.24 to 6.28%, for 20, 40 l/hr mass flow rates. Whereas, Collector's thermal efficiency is improved from 0.95 to 3.05%, 0.65 to 3.46%, for 20, 40 l/hr mass flow rates.

With copper oxide (CuO) Nano fluid as a working fluid with 0.01% concentration, collector's instantaneous efficiency is improved from 0.035 to 4.807%, 0.461 to 7.801%, for 20 and 40 l/hr mass flow rates. Collector's thermal efficiency is improved from 0.62 to 5.19%, 0.25 to 3.25%, for 20 and 40 l/hr mass flow rates with alumina (Al2O3):

By using alumina Nano fluid as a working fluid with 0.01% concentration, collector's instantaneous efficiency is enhanced from 0.9 to 3.3%, 0.15 to 3.4%, for 20 and 40 l/hr mass flow rates. Collector's thermal efficiency is enhanced from 1 to 2.8%, 0.1 to 1.9 for 20 and 40 & l/hr mass flow rates.

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