

Performance Studies of Heat Transfer Characteristics of High Temperature Fluids Using Parabolic Collectors- A Technical Review


P. Mathana^a, N. Vijay Ponraj^a, P. Selvakumar^a, K. Arunprasath^{a,*}

^aDepartment of Mechanical Engineering, Faculty of Engineering, PSN College of Engineering and Technology, Tirunelveli, Tamil Nadu, India.

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* Corresponding author:

K. Arunprasath 
E-mail: aruncmr12@gmail.com

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ABSTRACT

Parabolic trough collectors (PTCs) are one of the most promising technologies for solar thermal power generation. The heat transfer characteristics of the working fluid in a PTC show an important role in its thermal performance. This work includes a technical evaluation of the performance investigations of heat transfer characteristics of high temperature fluids utilizing PTCs. The heat transfer performance of a PTC is highly affected by the parameters of the working fluid. Fluids with high heat conductivity and low viscosity are desired for PTCs. This research is a review about the influencing parameters in the performance of heat transfer with high temperature fluid (HTF) in the Parabolic Trough Collector. The technical review done under the following headings. High Temperature Nano fluids and its Characteristics, Theoretical studies of Nano fluids and its Characteristics, Heat transport studies in Nano fluids, Heat Transfer in Parabolic Collectors, Heat Transfer Efficacy of Nano fluids in Parabolic Collectors, Efficiency Analysis of Parabolic Collector's Heat Transfer. The flow rate of the working fluid also has a substantial impact on the heat transfer performance. A higher flow rate often leads to improved heat transfer performance. The design of the receiver is also critical for the heat transfer performance of a PTC. Receivers with a greater surface area and better heat transfer coefficients can achieve higher thermal efficiency. Nano fluids have been shown to progress the heat transfer performance of Parabolic Trough Collectors. However, the use of nano fluids also brings significant obstacles, such as the agglomeration of nano particles and the clogging of the receiver tubes. New heat transfer enhancement techniques, such as swirl flow and vortex generators, have been developed for PTCs. These strategies can considerably increase the heat transfer performance of PTCs. This comparison study provides the information about the properties, characteristics, and applications of the high temperature fluids in various heat transfer applications.

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1. INTRODUCTION

Since the sun is the source of all energy on Earth, it should come as no surprise that solar energy is a rising star among renewable sources of power; nonetheless, there is still room for improvement and innovation in this field [1]. Many experimental research has been reported on the topic of thermal conductivity because it is the most essential parameter responsible for improved heat transmission. The most famous procedure is the transient hot wire technique. It is trying to straightforwardly apply the standard transient hot-wire way to deal with nano fluids since they are electrically conductive [2].

Water and HE200 oil serve as the bases for Al₂O₃, CuO, and Cu nanoparticles, respectively. The expansion of only 5% of nanoparticles brought about a 60% increment in warm conductivity contrasted with the comparable base liquids. Two separate base liquids, water and ethylene glycol (EG), were joined with the nanoparticles CuO is 18.6 nm and Al₂O₃ was 23.6 nm to make four unique blends of nanofluids such as CuO in water, CuO in EG, Al₂O₃ in water, and Al₂O₃ in EG [3]. The exploratory outcomes showed that the warm conductivity improvement became bigger with expanding nanotube stacking and shrank with developing base liquid warm conductivity. Various arrangements of MWCNTs, CuO, SiO₂, and ethylene glycol are introduced. MWCNT nanofluid was found to have a warm conductivity that was 11.3% higher than the control at 1% volume fixation a wide range of nanofluids [3,4].

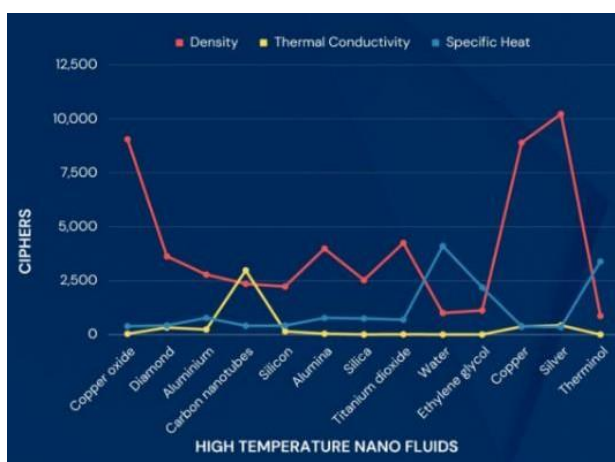


Fig. 1. Experimental characteristics of high temperature nano fluids properties.

To work on the proficiency of explanatory box gatherers in a great many business settings. The exploration set off on a mission to get more familiar with how illustrative box gatherer frameworks could profit from utilizing engineered fragrant liquids containing cross breed nanoparticles to upgrade warm proficiency and intensity transmission [5]. Figure. 1 shows the experimental characteristics of high temperature nano fluids properties.

2. THEORETICAL STUDIES OF NANOFLUIDS AND ITS CHARACTERISTICS

Supercritical CO₂ (s-CO₂) as an intensity move liquid substitute can possibly help the exhibition and usefulness of sun powered Explanatory Box Gatherer. The connections have been analyzed to decide if they can appropriately gauge the typical Nusselt values when s-CO₂ goes about as the Intensity Move Liquid in a sun powered Explanatory Through Gatherer [6]. Consistently, under various climatic conditions, the mix of an Explanatory Box Gatherer with different power cycles was examined regarding Energy, Exergy, Financial matters, and Ecological. Execution examinations of the Steam Rankine Cycle, Natural Rankine Cycle, and Kalina Cycle were attempted on a yearly premise using changed liquids and blends. As well as genuinely showing occurrence point's advantage over direct typical illumination [6,7].

The most by and large recognized technique for utilizing boundless energy is the illustrative sun powered box gatherer. The current examination provided a LS-2 model of an explanatory box gatherer with differing pivoting flower supplements and three particles-based nanofluids as intensity conveying medium. By blending aluminum oxide, copper oxide, and graphene oxide with water as the establishment liquid, half breed nanofluids with 1% vol. content are created [8, 9].

Liquid salts were utilized as working liquids since they made prevalent warm conductivity, limited consumption, and tried not to stop up in the collector cylinder's part areas. The UV-visible region has a relatively high rate of absorptivity as well. For non-emptied recipients, particular coatings of dark chrome or dark nickel are used inferable from their cost and effortlessness [10]. Figure 2 describes the theoretical studies of the Nano fluids.

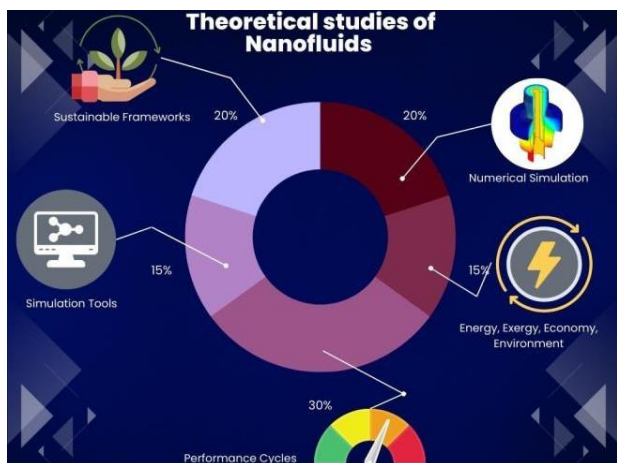


Fig. 2. Theoretical studies of Nano fluids.

3. HEAT TRANSPORT STUDIES IN NANOFLUIDS

Three intensity move liquids like water, therminol VP-1, Al₂O₃ based warm oil nanofluid. The RNG k-disturbance model was used, as well as ANSYS Familiar programming utilizing a limited volume procedure. The computational discoveries were contrasted with existing observational and trial information, and there was an extensive level of understanding, affirming the rightness and constancy [11, 12].

Temperature field inside the safeguard cylinder and intensity move liquid zone using the TPM are bigger than that of SPM. Greatest PEC for SiC/EG-water and EG-water nanofluid are 1.67 and 1.70, individually, for sinusoidal-wavy small channel with a nanoparticle volume level of 4%, nano particles measurement of 90 nm, and Reynolds number of 15,001.3. Besides, EG-water as base liquid with a nano particle width of 90 nm gives preferable energy effectiveness over water [13]. The solar oriented dryer included cleared tubes with warm capacity unitary intensity pipe sun powered authority. An original intensity pipe game plan was planned and introduced inside the gatherer by joining the evaporator bits of the intensity pipe with a solitary intensity pipe condenser section connected to a chamber that might deal with various types of nuclear power stockpiling media [14].

The assortment and dryer framework has a greatest energy proficiency of 29 % and 24 % correspondingly. The Benzoic corrosive put away a limit of 3069 kJ energy while therminol- 55 put

away a limit of 1881 kJ. Drying tests done using therminol-55 as the warm stockpiling medium took 16 h to dry 1 kilogram of apple to 45 g, while Benzoic corrosive demanded 17 h of drying investment. The drying strategy worked really with therminol-55 [15]. Figure 3 show the heat transport studies on Nano fluids.

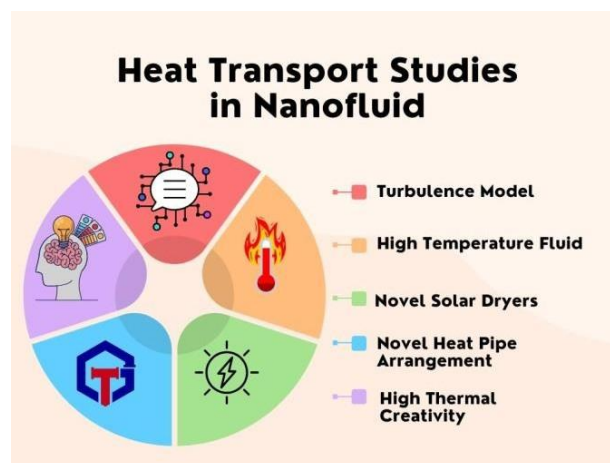


Fig. 3. Heat Transport in Nano fluids.

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4. HEAT TRANSFER IN PARABOLIC COLLECTORS

At the point when the temperature dissemination between the evaporator information and exit is insignificant, the cooling limit is diminished. Moreover, expanding load diminishes the energy and exergy Co-productive of Execution. The reduction in cooling load as limit increments adversely affects effectiveness [16].

The mathematical and trial results range between 3.17% to 5.6%. The viability and execution of the recently developed model were researched by shifting the volumetric stream pace of 20, 40, 60, and 80 L/h and the water input temperatures of 300, 315, and 330 K [17].

Heat pipes matched with these gatherers have shown a more extensive temperature range and further developed execution. Since developed

and modern innovation for delivering power by changing over nuclear power is presently popular, a concentrated sunlight based energy unit coordinating box gatherer parts is a financially savvy speculation. The mechanical headway of the office with was stressed. The need of intensity move spreading procedures was underlined [18, 19].

Solar powered concentrators are arranged into four sorts in light of getting innovation and center calculation: illustrative dish gatherers, straight Fresnel authorities, and heliostat field authorities. Besides, bountiful functional, mature innovation, positive worth added use, and the capacity to couple with non- regular and petroleum products are a portion of the variables that gain mechanical headway with Illustrative Box Gatherer more conservative [20]. Figure 4 shows the effect of heat transfer in parabolic trough collectors.



Fig. 4. Effect of Heat Transfer in Parabolic Trough Collectors.

5. HEAT TRANSFER EFFICACY OF NANO FLUIDS IN PARABOLIC COLLECTORS

The solar based controlled joined intensity and power framework is a successful and harmless to the ecosystem answer for far off energy requests. In this undertaking, a two- tank liquid salt warm stockpiling framework is joined with sun based illustrative box gatherers to drive and warm a natural Rankine unit [21]. Moreover, some water content is viewed as by cross-tainting in the power block's steam generator. The level of similarity between a triphasic framework made out of sodium nitrate and potassium nitrate salts (60:40), heat move

liquid, and water when presented to 390 °C for 312 hours [22].

In an Explanatory Box Gatherer, an exceptionally reflecting reflector formed like a bended box is utilized to concentration and concentrate solar oriented energy onto a direct beneficiary. It is basic to keep the functioning liquid in a box exactly lined up with the point of convergence of the reflector for effective warming. The Allegorical Box Authority centers daylight 70-100 times, raising the temperature by 350-550 degrees Celsius [23].

The substance of Copper Oxide and Alumina in the nanofluids was kept at 0.01%. At two particular mass stream rates, 0.0112 Kg/s and 0.0224 Kg/s, the effectiveness of the Allegorical Box Gatherer is assessed. The best effectiveness for aluminum oxide as nanofluids is 13.01 and 13.1% at 0.0112 Kg/s and 0.0224 Kg/s stream rates, individually, though copper oxide has a productivity of 13.92% and 14.79% at a similar stream rates. The temperature dissemination conduct of safeguard tube materials like steel, copper, and aluminum [24, 25].

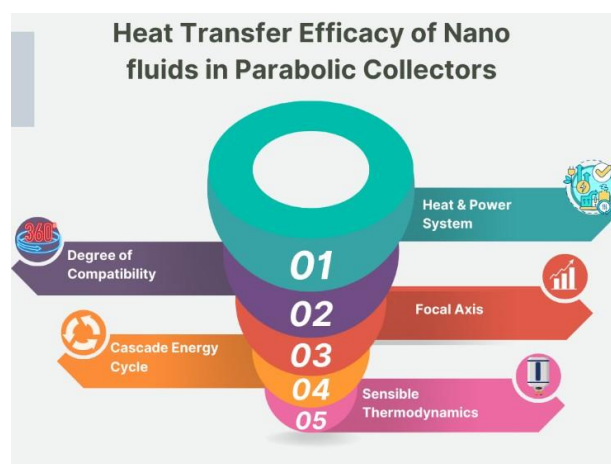


Fig. 5. Heat transfer efficacy of Nano fluids in parabolic collectors.

6. EFFICIENCY ANALYSIS OF PARABOLIC COLLECTOR'S HEAT TRANSFER

The SIMPLEC method and the Limited Volume procedure are utilized to settle the three-layered consistent stream, fierce stream, and intensity move administering conditions. Moreover, the outcomes recommend that rising the extent of nanoparticle volume upgrades the typical Nusselt number [26]. Reflect reflectivity is the

underlying optical misfortune and is impacted by various elements including mirror readiness method, reflect material, and surface quality. Reflect reflection, then again, is basic to the warm proficiency of the Explanatory Box Authority. Because of generally significant optical misfortunes, research uncovered that the warm productivity of a PDC with a twisting pit recipient was generally 35% [27].

The testing discoveries showed that the occasional cluster course of action of the metal froth inside the cylinder further develops warm productivity the most. Warm effectiveness is expanded by 14% in this arrangement [28]. The outcomes exhibit that when the beneficiary is totally emptied and the three concentric chambers' most reduced distances across are utilized, the energy and exergy proficiency reach 65.3 and 40.3%, separately [29].

A definite mathematical investigation of the warm water driven and thermodynamic execution conduct of a high- fixation proportion framework in vaporious and supercritical stages with CO₂ as the functioning liquid, including heat move capacity, temperature slope variety, beneficiary intensity misfortune, siphoning influence prerequisite, gatherer productivity, and irreversibilities [30]. Figure 6 show the heat transfer efficiency analysis of parabolic collector.

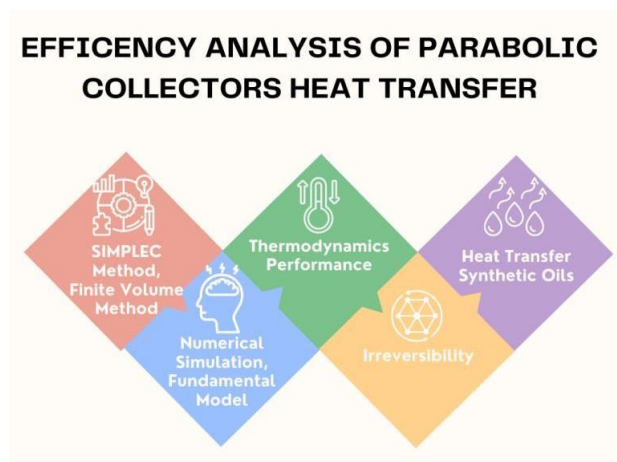


Fig. 6. Efficiency Analysis of Parabolic Collector's Heat Transfer.

7. CONCLUSION

The conclusion of this review paper was drawn as a result of the technical data collection with information available is as follows as:

- Heat transfer execution examinations of high temperature liquids utilizing explanatory gatherers have shown that the functioning liquid boundaries, stream rate, and beneficiary plan all fundamentally affect the intensity move execution of a PTC.
- PTCs require liquids with high intensity conductivity and low consistency. The functioning liquid stream rate likewise impacts heat move execution. A more noteworthy stream rate regularly prompts better intensity move execution. The beneficiary's plan is likewise significant for a PTC's intensity move execution.
- Beneficiaries with a bigger surface region and better intensity move coefficients can accomplish higher warm proficiency. PTC heat move execution has been shown to be further developed utilizing nanofluids. In any case, the use of nanofluids presents significant difficulties, for example, nanoparticle collection and collector tube blockage.
- PTCs have profited from new intensity move expansion procedures, for example, twirl stream and vortex generators. These arrangements can altogether further develop PTC heat move execution. Lately, huge advancement has been accomplished in the exhibition examination of intensity move properties of high temperature liquids utilizing allegorical gatherers. Figure 7 show the performance studies of heat transfer in high temperature fluids using in PTC.

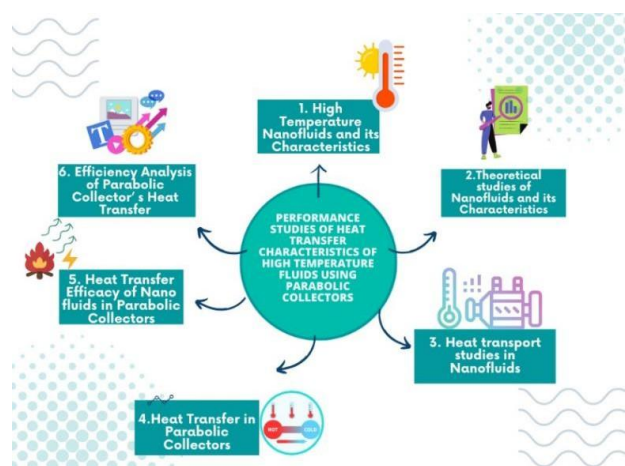


Fig. 7. Performance studies of heat transfer in high temperature fluids using in PTC

The advancement of solar thermal power production technologies, industrial process heat, water desalination, and tiny solar power plants is dependent on ongoing research and development in this sector.

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