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"A REVIEW ON DIRECT ABSORPTION SOLAR COLLECTOR"

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ABSTRACT

A review on applications of nanofluids and nanocomposites shows the desired improvement in thermal and optical properties of solar energy conversion systems from the efficiency and reliability points of view. Solar energy conversion systems play a very important role in the solar energy field, which includes concentrated and non-concentrated systems that convert solar energy into electricity or thermal power. The conversion efficiencies of these systems can possibly be enhanced by using a nanofluid as the heat transfer medium and a nanocomposite as the selective coating.

Key Words: *Solar energy, Nanofluids, Nanocomposites, Selective coating.*

I. INTRODUCTION

The Worldwide energy demand is always growing. Nowadays, over 80% of primary energy demand is covered by fossil fuels. Excessive fossil fuel expenditure is causes lot of undesirable phenomena such as environmental and atmospheric pollution, consequently global warming, greenhouse effect, climatic change, Ozone layer depletion and acid rain. Sustainable energy generation is one of the most important challenges for our society. Electrical energy consumption is increasing year by year and its generation is the most important problem for all the industry. In the entire World, most of the energy can be shared by electricity. The electricity usage will grow faster than liquid fuel, coal& natural gas. Fossil fuels such as coal, natural gas and petroleum are used for produce steam in boilers of power plants. Burning of fossil fuel release greenhouse gases such as carbon dioxide, nitrous oxide and carbon monoxide, these gases allows the high intensity solar radiation to the earth. These various air pollutants emitted into the atmosphere act as green house gases, which allows the incoming short wave solar radiation but does not allow the long wave outgoing terrestrial infrared radiation to escape and thus help in keeping the earth‟s surface warmer. Burning of such fossil fuels causes the air pollution; it has been the main issue for the inventers, government, researchers and environmentalists. Sun-based gatherers are gadgets which as their name gather sun or in a practical sense a piece of the sun's radiation transmitted for the day. Presently this radiation is changed over into heat and is used in alternate manners either straightforwardly or by moving it to some other medium. Truth be told sun oriented authorities regularly allude to the motors of any sun-based warming frameworks. It is to be remembered that the radiation need not be extreme however the typical everyday radiation will do the trick for any sun-based authorities. The sun-powered authority is grouped by the temperature that is achieved by temperature. They are characterized by the temperatures that are accomplished by the sun-based collector. Solar Energy is the most seasoned wellspring of energy utilized by Algae, Plants, and so on There are in everyday 3 different ways:-

1. Photovoltaic cells

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2. Solar warm innovation

3. Passive sun oriented warming

The fundamental deterrent is the cutoff on efficiency. Although the sun transmits a huge measure of radiation yet we can just use a Fraction of it. The materials are not almost productive nor are the imperatives of science helping correctly. For instance, the environment mirrors an impressive piece of the radiation, the air diffuses the radiation by dissipating the light because of the little particles in it. At that point comes the productivity of the moving gadgets including the lines of metal the glass with not 100% Permeability. This outcome is extremely low effectiveness.

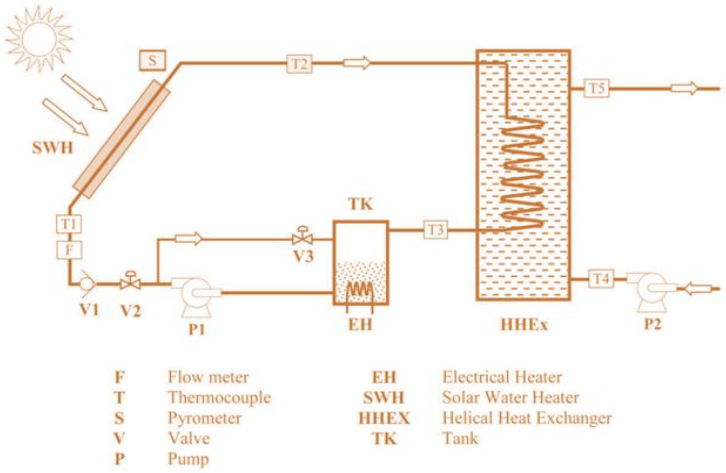

Figure 1. Schematic of experimental set-up

II. LITERATURE REVIEW

Natarajan and Sathish [2009] tentatively researched the warmth move properties of MWCNT-H2 O nanofluid and contrasted it and water as the customary warmth move liquid. sodium dodecyl sulfate (SDS) was utilized as a surfactant (1.0 wt%) for the planning of a settled nanofluid. The warm conductivity improvement of MWCNT nanofluid was seen up to 41% for a volume part of 1.0%. The warm conductivity improvement was discovered to rely on the volume part of the molecule, the warm conductivity of the molecule, and the base liquid. Nanofluid was discovered to be more powerful for a functioning liquid having lower warm conductivity. Along these lines, MWCNT-H2O was discovered to be an appropriate possibility for the exhibition improvement of a sunlight-based collector.[1]

Otanicar et al. [2010] considered the effectiveness of the immediate ingestion sunlight-based authority utilizing nanofluids. The arrangement was having an element of 3 × 5 cm2, with a channel profundity of 150 μm (Fig. 27.). Three distinctive sorts of nanoparticles were utilized for the examination specifically Graphite (30 nm dia.), carbon nanotube (6–20 nm breadth and 1000–5000 length), and Silver (20 and 40 nm width). The readings were taken either by changing molecule size or volume portion. They tracked down that the changeability in size, shape, volume part can prompt the greatest ghostly retention. There was an upgrade in warm conductivity given the expansion of the nanoparticle. The effectiveness improvement of up to 5% was seen utilizing the nanofluid. The exploratory and mathematical outcomes both portrayed an underlying quick expansion in effectiveness with expansion in volume part. [2]

Yousefi et al. [2012] tentatively explored the impact of pH variety of MWCNT-H2O nanofluid on the productivity of a level plate sunlight-based gatherer. The assimilation region considered was 1.51 m2 and the normal nanoparticle width was 10–30 nm. The tests were done at 0.2 wt% and Triton X-100 was utilized as the surfactant. The pH worth of the MWCNT nanofluid considered was 3.5, 6.5, and 9.5. It was seen that for temperature distinction higher than mean

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temperature contrast the effectiveness of gatherer for Ph = 3.5 is higher than for ph = 9.5 and for temperature distinction lower than mean temperature contrast the proficiency for ph = 9.5 was higher than that for ph = 3.5. Accordingly, the outcomes called attention to that the higher the distinction between the ph of nanofluid and ph of the isoelectric point higher will be the improvement in the warm proficiency of the authority. Fig. 23 shows the variety of gatherer productivity as an element of temperature distinction complete rundown of examinations of nanofluid in a level plate sun-based authority.

Ladjevardi et al. [2013] dissected the impact of utilizing nanofluid in sun-based radiation ingestion effectiveness. Direct assimilation sun-oriented gatherer utilizing graphite nanofluid was mimicked for getting the suitable worth of nanoparticle volume portion and width to boost the energy retention effectiveness. Radiative vehicle condition, mass, and energy preservation condition were tackled to get the working qualities of DASC. The impact of nanoparticle breadth and volume portion on termination coefficient were contemplated and contrasted and the trial information. There was an upgrade in eradication coefficient from 0.4 to 1.0 for an increment in nanoparticle size from 50 nm to 300 nm. They likewise discovered that for a volume part of 0.000025% it was feasible to assimilate over half of the occurrence radiation while unadulterated water could retain around 27% of episode radiation. [4]

Karami et al. [2013] contemplated the daylight retaining capability of carbon nanoball water and Ethylene glycol-based nanofluid in a DASC. sodium dodecyl sulfate (SDS) was utilized as a surfactant and nanofluid with various fixations (10–300 ppm) were ready. The optical properties as an element of volume division were contemplated. From the ghostly transmission, carbo nanoball (CNB) assumes a significant part in raising the optical properties of the liquid because of the upgrade of annihilation coefficient even at low volume fixation. They found that by utilizing 300 ppm carbon nanoball the annihilation coefficient of water was improved by 3.9 cm−1 and that of ethylene glycol by 3.4 cm−1[5]

Mahina et al. [2014] concentrated logically the entropy age and warmth move because of Al O2 3/water nanofluid stream in a level plate sunlight-based gatherer. The molecule size considered was 25, 50, 75, and 100 nm volume fixation was fluctuated up to 4% and the mass stream rate differed from 0.1 to 0.8 kg/s. The impact of cylinder harshness, molecule size, and different thermophysical properties on Russell number, heat move coefficient, entropy generation, outlet temperature, and Bejan number were contemplated. The impact of sun-based radiation and surrounding temperature on entropy age were additionally examined. Nusselt number was found to diminish with expansion in volume portion and was found to increment with the increment in nanoparticle size. Warmth move coefficient had a contrary pattern in contrast with the Russell number for various molecule size and volume division. With the increment in volume part of nanoparticle entropy age decreases and outlet temperature rises. The significance of harshness was more unmistakable when the sun-oriented radiation and encompassing temperature decreases.[6]

Karami et al. [2014] tentatively contemplated the thermo-optical properties of low-temperature direct assimilation sunlight-based gatherer utilizing CuO/H O EG 2 − nanofluid (Fig. 24). The nanoparticle distance across considered for the examination was under 40 nm.The tests were performed at various temperatures and for various volume portion (0.005%, 0.0075%, 0.01%). It was tracked down that warm conductivity of CuO nanofluid increments non-straightly with expansion in volume part of CuO nanoparticle. For CuO nanofluid of volume part of 25 ppm, the warm conductivity expanded from 1.3% at 25 °C to 3.2% at 60° C. It was discovered that CuO nanofluid was having lower conveyance or higher absorbance than the base liquid for the frequency scope of 200–1400 nm. The dynamic consistency of the CuO nanofluid was found to increment with the increment in the volume part of nanofluid and was found to diminish dramatically with expanding temperature(because of Brownian movement enhancement). Thus high warm conductivity, low thickness, in this way better thermophysical properties at high temperature along with improved optical properties make the nanofluid a superior contender to be utilized in sun-powered authority. [7]

Karami et al. [2014] tentatively contemplated the improvement in thermophysical and optical properties for a low-temperature direct assimilation sun-powered gatherer utilizing carbon nanotube (CNT) liquid. Refined water and CNT (MWNT 10 nm in dia. what's more, 5–10 μm long) were utilized to plan nanofluid. They considered the scattering steadiness and optical properties. The light couldn't go through the answer for volume portion more than 150 ppm off-

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CNT in water so seven territories volume division (S1:0, S2:5, S3:10, S4:25, S5:50, S6:100, S7:150 ppm) were taken. A drawn-out steadiness for around one month was guaranteed to utilize f-CNT. It was discovered that f-CNT has a significant job in raising the optical properties of liquid as a result of the progress of light termination level even at low volume division. The warm conductivity of the nanofluid was found to increment with expanding vol. portion and temperature with reliance on the temperature being abundantly articulated. The most extreme improvement in warm conductivity was found in S7 about 32.2% than water at 25 °C. [8]

Gupta et al. [2015] tentatively researched the impact of Al O2 3-H2O nanofluid stream rate on the effectiveness of direct assimilation of sunlight-based collectors. The authority size considered for this investigation was 1.54 m × 0.9 m and the molecule size is taken as 20–30 nm. ultrasonic vibration blender was utilized for the readiness of the nanofluid for least conglomeration and improved scattering. The effectiveness of the authority was determined for a volume part of 0.005% at three distinctive stream paces of 1.5, 2.0, and 2.5 pm. Authority productivity was discovered to be expanding for all worth of stream rate in contrast with the water. Proficiency improvement of 8.1% and 4.2% was noticed for the 1.5 and 2 pm stream pace of nanofluid. The ideal stream rate which gives the most extreme proficiency was discovered to be 2.5 and 2 pm for water and nanofluid separately. Fig. 28 addresses the productivity of FPSC as a component of temperature distinction for different nanofluids.[9]

Parvin et al. [2016] mathematically examined the warmth move execution and entropy age examination of constrained convection for an immediate ingestion sun-based gatherer utilizing cu-water Nano liquid. The mean width of the nanoparticle considered was 5 nm and the authority region considered was 0.3 × 0.3 m. The sectional view and schematic chart of DASC are portrayed in Figs. 25 and 26 individually. The impact of the nanoparticle volume division and the Reynolds number on the isotherm, heat lines, mean Russell number, Bejan number, mean entropy age, and authority effectiveness were considered. The overseeing conditions were settled utilizing Galerkin limited component method. From the investigations, the Nusselt number(Nu) and efficiency(η) were connected with Reynolds no. ($200 < Re < 1000$) and volume part ($0\% < \phi < 3\%$) for Pr = 6.6 utilizing Eqs. (8) and (9). The isotherm and headlines were discovered to be fundamentally relying on Re and ϕ. Mean entropy age was discovered to be higher for the bigger worth of Re and ϕ. Higher Reynolds number and ϕ = 3% ended up being more successful for upgrading the exhibition of warmth move rate. For nanofluid with a higher Reynolds number, the Bejan number was discovered to be drawing nearer to 1. Nu (3.442 0.157) (Re) = + ϕ 0.1528 (8) η = + (2.488 0.3276) (Re) ϕ 0.4684 (9) . [10] Delfina et al. [2016] studied the performance characteristics of MWCNTs nano-fluid-based direct absorption solar collectors experimentally and numerically. Nanofluid was made to flow between two parallel walls, the top wall made of glass with transmissivity 90% and the bottom wall being insulated (Fig. 29). For numerical analysis, radiative transport equation and energy equation were solved to investigate the performance analysis, of DASC. Carboxyl (COOH) functionalized MWCNT (10–20 nm in dia. and 10–30 µm in length) nanofluid of different volume fraction were prepared by suspending it in Water-Ethylene glycol mixture (70%: 30%). The thermo-optical properties of the nanofluid were determined using the experimental method. The thermal conductivity was found to increase with the increase in volume fraction and temperature thus enhancing heat transfer rate and collector efficiency. The tests were performed at different flow rates (0.015–0.025 kg/s) and two different bottom surfaces (black & reflective). The collector outlet temperature as a function of internal emissivity of the bottom wall, collector height, volume fraction, and mass flow rate was studied. The numerical result was found to be accurate within ± 5% of the experimental result. The collector efficiency for 0.025 kg/s and 100 ppm volume fraction was found to be 29% more than that of using base fluid rather than nanofluid. Fig. 30 depicts extinction coefficient variation.[11]

No java S, [2017] The plug-in electric vehicles and hydrogen storage systems containing electrolyzer, stored hydrogen tanks, and fuel cell as energy storage systems can bring various flexibilities to the energy management problem. In this paper, the selling price determination and energy management problem of an electricity retailer in the smart grid under uncertainties has been proposed. Multiple energy procurement sources containing pool market, bilateral contracts, distributed generation units, renewable energy sources (photovoltaic system and wind turbine), plug-in electric vehicles, and hydrogen storage systems are considered. The scenario-based stochastic method is used for uncertainty modeling of pool market prices, consumer demand, temperature, irradiation, and wind speed. In the proposed model, the selling price is determined and compared by the retailer in the smart grid in three cases containing fixed pricing, time-of-use pricing, and real-time pricing. It is shown that the selling price determination based on real-time pricing

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and flexibilities of plug-in electric vehicles and hydrogen storage systems leads to higher expected profit. The proposed model is formulated as mixed-integer linear programming that can be solved under General Algebraic Modeling System. To validate the proposed model, three types of selling price determination under four case studies are utilized and the results are compared.[12]

Pankaj Raj et al [2018] With increasing energy demands worldwide, the consumption of fossil fuels has increased unprecedently which is scarce. This has led to environmental degradation and global warming which is a matter of concern. These factors lead to the rise in the renewable energy sector in the last decade. Among various renewable energy sources, solar energy is most exclusively used because of its ease of availability and least impact on the environment. Flat plate solar collector is the most widely used solar collector but is less efficient (low capability to convert solar energy to thermal energy). The use of nanofluid (fluid obtained by mixing nanoparticles in base fluid) in place of base fluid has an improved effect on thermophysical properties such as thermal conductivity. The use of nanofluid on flat plate solar collectors (FPSC) & direct absorption solar collector (DASC) can be identified as an effective way to enhance the performance of solar collectors. With the advancement in nanotechnology and growing thrust over increasing the performance of solar devices a lot of work has been done in this regard. The purpose of this literature review is to summarize the various research work done on the application of nanofluid in solar thermal devices. This review paper identifies the effect of various parameters and the optimum working condition. This paper also identifies the probable challenges we ought to face while developing thermal collectors using nanofluids thus identifying the opportunities for future research.[13]

Radzi Abdul Rasih et al [2019] Recently, solar energy research popularity has been growing rapidly due to its pollutant-free renewable energy source. As alternative energy to the existing conventional fossil resources, solar energy is projected to drive future research to a new level in the renewable energy field. One of the methods to harvest solar energy is through the solar thermal collector, which utilizes heat transfer fluid to capture the solar radiation. In this paper, the recent development of application using concentrated direct absorption solar collectors on nanofluids is comprehensively discussed. Our emphasis is on concentrating solar collectors including parabolic trough, parabolic dish, heliostat field collector, and Fresnel solar collector. To accomplish this, an inclusive review of the analytical, numerical, and experimental studies in this field is prepared. Finally, some issues related to the concentrated direct absorption solar collector using nanofluid are also presented.[14]

Arun K Behuraa et al [2020] Effective absorption and utilization of incident solar thermal energy in the present basic solar collector is the primary concern for energy-efficient and optimum design due to heat absorption on the surface and indirect transfer of heat to the fluid medium. Poor absorption ability and transport properties of generally used conventional heat transfer fluid such as water, also limit the heat absorption and transfer efficiency of solar collectors. Recently, Stable suspension of nanoparticles into conventional base fluids has been used that improves the light absorption and thermophysical characteristics of the base fluid which also results in an upside in the effectiveness of the solar collector. This novel fluid can be utilized for efficient absorption and heat transfer in a solar collector. The present paper introduces the idea and design of Direct Absorption Solar Collector (DASC) and the use of nanofluid as heat-carrying fluid to experimentally analyze the developed DASC. The paper also discusses the experimental performance study on this new type of direct absorption solar collector for evaluating the effects of different Alumina nanoparticles concentration in Al2O3-water nanofluid used as a heat-carrying fluid. Experimental instantaneous efficiency was calculated for three varying concentrations of Alumina nanoparticles, 10 ppm, 50 ppm, and 100 ppm in actual outdoor conditions. The results indicated the enhanced efficiency of DASC with Al2O3 nanofluid in comparison to base fluid water. The efficiency enhancement was 22.1%, 39.6%, and 24.6% for 10 ppm, 50 ppm, and 100 ppm concentrations respectively. The promising results will provide potential development of nanofluid-based DASC for efficient utilization of solar energy than a conventional solar collector.[15]

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III. CONCLUSION

Nanofluids are advanced fluids having a colloidal solution of nano-sized particle of metallic or non-metallic material in another fluid. Nanofluids are being used in solar energy systems as working fluids, as storage medium in thermal storage systems or as a coolant in the micro-channel of electronic equipment. Experimental and numerical analysis has been done and shows that addition of nanoparticle enhances the thermophysical and thermal transport properties of nanofluids such as thermal conductivityand heat capacity. Also the nanofluid concentration (volume %/weight %) has a large effect on heat transfer enhancement; therefore, the optimum volume fraction should be tested. It is also seen that nanoparticle size has an effect on the efficiency of the solar collector, so experimental work should be carried out to observe the effect of nanoparticle size on efficiency. But the most important challenge in front of us is the cost of nanoparticles, their synthesis, instability and agglomeration problem, which may cause increase in pumping power.

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