Enhancement of Solar Flate Plate Heater: A Review

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Abstract- *The upward energy demand along with the depletion of conventional energy sources demands improved utilization of renewable energy resources. Among many energy resources, solar energy is the most appropriate alternative to conventional energy sources owing to its inexhaustibility and green property. Solar collectors are the devices which convert the solar radiation into heat or energy. Solar collector's efficiency should be improved by nanofluids. The importance and significance of nanofluid on the performance of solar collectors especially on thermal properties are extensively described here. Six types of solar collector's viz. flat plate, evacuated tube, direct absorber, parabolic trough, solar dish, and photovoltaic thermal solar collector performance has been extensively reviewed here. The nanomaterials such as TiO2, CuO, ZnO, Al2O3, and MWCNTS in base fluids with polymer dispersant or surfactants forming nanofluids for the mentioned types of solar collectors are compiled. Further, the quantification of the improvement in solar collector performance utilizing these nanofluids as working fluid is compiled. Recent problems of these nanofluids performance in the solar collectors are included and a future recommendation of research based on these problems is also covered.*

Keywords- Solar collector ,Nanofluids, Thermal conductivity, Out let temperature.

I. INTRODUCTION

World population and its modern everyday requirements. More than 80% of the global generation of electricity is currently based on fossil fuels [1,2].This would lead to a further rise in atmospheric carbon levels due to global Smarter consumption of resources is needed due to the exponential growth in the warming. Rather than diminishing their use, their use of fossil fuel is increasing (mainly 2% each year)[3]Consequently, green renewables with higher efficiencies, such as solar, are preferred[4.5] to address the aforesaid drawbacks of fossil fuels.In order to meet global energy demand, research and development on state-of-the-art energy conversion techniques must be done[6,7].Renewables are generally derived from infinite natural resources and can be recovered in a small space of time. There are various forms of green energy such as solar energy, hydropower, wind, water, tidal energy, bioenergy and geothermal energy. In most parts of the world solar energy is clean, comprehensive and abundant. Solar power is completely eco-friendly and readily available[8,9].Three high-tech processes like chemical, electrical, and thermal energy can be transformed into solar energy . In addition, solar radiation, including water steam and wind, can be turned into mechanical energy [10,11].Solar collectors (SC) is an extraordinary form of heat exchanger that transforms solar radiation direct in photovoltaic applications into two forms of electricity, thermal energy in solar thermal applications and fuel. As used thermally, solar systems absorb the incident of solar radiation energy on its surface, convert it into warmth and transmit the heat to the fluid that runs through it [12,13].This paper provides an exhaustive description of the thermal efficiency and the application process in various solar collectors of solar collectors using nanoflows. Various literature styles are uninteresting for learning about the relevance and importance of nanofluids in solar energy collecting systems.Last but not least, were built on the basis of the important literature results.

II. BACKROUND OF STUDY

Suspensions of liquid and nano-sized solid particles are known as the nanofluid. Farhana, K. Kadirgama, M. M.M. Rahman et al./ Nano-Structures & Nano-Objects 18(2019) 100276 is such as water, tar, ethylene glycol, molten salts. While a partition size rangeis1–100nmandliquidK. Metal, non-metallic and carbon nanotubes that were first identified by Choi in 1995 could be stable particles. Al2O3, Cuo, Cu, Al, Fe, TiO2 and SiO2[14,15] were the most common nanoparticles. Metal has greater thermal conductivity than any fluid, which is generally noteworthy. For example, the thermal capacity of copper at room temperature is approximately 700 times higher than any fluid[16].The thermal conductivity of nanoparticles has increased because of various physical factors such as Brown's movement of fluid particles, a liquid coating at the interface to liquid component, the grouping of nanoparticles in the base fluid, the concentration of nanoparticles in the base fluid, the scale of nanoparticles and the migration of particles[17,18].In addition, the radiational absorption property of nanoparticles is excellent [19]. Not only is one of the key reasons to conduct its performances a nanoparticle synthesis process [20].The SC is the major component of the set of solar energy and water heating system. SC may be described as a thermal energy conversion and electrical converter.Thus, the greater the fluid heat transfer, the more temperature outlet and therefore the better efficiency of the collector. CS are various types of mobile phone, smoke-equipped, photovoltaic, hybrid, hybrid, photovoltaic thermal, etc.

Many scientists are studying the collector performance improvement by adjusting various components or equipment or configuration and by setting up solar collectors.However, nanofluids in solar collectors, as work fluids in place of traditional fluids, are the most powerful approach and the newest technologies. Nano fluids do much better than traditional fluids for heat transfer[25,26].

Much work on the study of the thermal comportamiento of nanofluids in solar collectors was numerically and experimentively focused[27,28]. The thermal conductivity results of solar collectors were analysed using nanofluid capacities by Natarajan and Sathish[29].Chen, Liu[30] studied the efficiency of direct solar collector absorption thermal transfer with nanofluids distributed with reduced oxide. This paper demonstrated solar collector's photothermal conversion efficiency with 96.93% nanofluid increase at 30 umcels and 52% increase at 75 umcels, which is very promising working fluids for low-temperature solar collectors.

The heat transfer property of SiO2/water nanofluid in the vacuum solar collector tube was numerically and experimentally examined by Yan, Wang[32]. With increasing mass fractions, the experiment performed at another mass fraction of nanoparticles and the thermal conductivity were improved.And numerical analysis results in increased temperature and speed and processes of heat transfer. Nasrin, Parvin [32] studied heat transfer numerically and forced convective convection by different nano-fluids by means of flatsolars.

Nanofluids include Ag/Water, Cu/Water, Al2O3 and CuO/Water. The authors reported that the highest rate of heat transfer performed by Ag/water nanofluids, as well as the highest quality collectors, for Cu/water nanofluids, increased by 65 to 85% with an interval volume of 0-5%. The volumetrical collector efficiency of graphene platelets/deionized water nanofluid was studied by Vakilli, Hosseinalipour[33] experimentally.

The nanofluid was applied at three mass flow speeds in a separate weight fraction. The authors documented the ability of graphene nanofluids to absorb solar power well and can increase the volumetric solar collector performance. The effect on the heat output of the cylindrical solar pipeline collector, as well as the effect of CuO/water nanofluid and purified water, was investigated experimentally by Goudarzi, Shojaeizadeh[34]. The efficiency of the collector was improved by 25.6 per cent at concentrations in volume of 0.1 wt percent and the mass flow rate of 0.0083 kg/s.

Top performance of SDS surfactant rose by 24.2%. Tomy, Ahammed [35] analysed with the aid of an artificial neural network in MATLAB the output of flat plate solar collectors using silver/water nanofluid.In different conditions and rates the authors reported a very clear understanding of the values observed and predicted. Compared to experiment results from the flat plate solar collector, the results demonstrated fair precision. In Gupta, Agrawal [36], a study of the impact on the efficacy of direct solar absorption by Al2O3/water nanofluid flow rate was carried out.The volume portion of Al2O3 nanoparticles was 0.005% of the 20nm scale. The authors showed optimum efficiency of both pure water and nanofluids at varying flow speeds. At 1.5 and 2 inch nanofluid flow rate, the performance of the collector increased by 8.1 percent and 4.2 percent respectively.

III. NANOFLUID PROPERTIES

The diffusion of nanoparticles in the base fluid is directly affected by nanofluid thermophysical properties such as thermal conductivity, viscosity, density and heat (Angayarkanni and Philip, 2015). This segment discusses briefly the thermo-physical characteristics of various nano fluid forms. The improvement of nanofluid's thermal conductivity plays a key role in increasing their convective thermal transfer properties. Many variables such as nanoparticle type, base fluid type, form of the nanoparticles, nanoparticle size, concentration of nanoparticles and temperature are affecting the thermally conductivity of Nanofluids (Gorji and Ranjbar; 2017).

Nanofluid thermophysical properties including thermic conductivity, viscosity, density and heat influence the diffusion of nanoparticles in the base fluid directly (Angayarkanni and Philip, 2015). The thermal-physical features of different nano-fluid types are briefly discussed in this chapter. Increasing thermal conductivity of nanofluids plays an important role in increasing the convective thermal transmission properties. Many variables, including nanoparticle type, basic fluids type, nanoparticle shape, nanoparticle scale, nanoparticles concentration, and temperature affect nanofluid thermal conductivity (Gorji and Ranjbar; 2017).

The inherent heat conductivity of nanoparticle compared to water may be due to enhanced efficiency. Furthermore, due to powered water molecules and nanoparticles the thermal conductivity increases with an increase in temperature. In addition, nanofluid viscosity was found to grow as the weight portion of a nanoparticle grew. This is attributed to an increase in the frictional resistance between the nanoparticles and the neighbouring layers of the base fluid and the forming of an intermolecular barrier between the nanoparticles themselves.

Density also inflammates the efficiency of the heat transfer of nanofluids, as it directly affects the Nusselt and Reynold quantities, the loss of pressure and the friction factor. Relevant heater is an important feature of the Nanofluid, though, because it is a critical element in the process of thermal transmission and thermal storage.

Every theoretical study of thermal processes, such as heat transfer, energy analysis and energy analysis is also very important (Park et al., 2014). Verma et al (2017) also demonstrates the experimental findings that the nanofluid density rises as the concentration of nanoparticles is clearly .
However, with the the accumulation of nano-partments, the specific heat of nanofluids decreases which is beneficial to the increased absorption and heat transfer ability of nanofluids. The thermophysical characteristics are summarised in different nanoparticles and essential fluids.

3.1. CALLENEGES IDENDIFIED BASED ON THE REVIEW

Nanofluids, which are still in the test process, are new emerging complex fluids than functional applications. The researchers, however, are continuing their feasibility analysis of nanofluids and solar collectors for better performance in the various applications. In various studies of nanofluid properties and their use in solar collectors, several complex issues are listed.

3.1.1. STABILITY OF NANOFLUDS

Long-term stability is the main and basic necessity for nanofluids. Improving nanofluid stability leads to a strong increase in thermal conductivity (183). Therefore, it is theoretically difficult to prepare a homogeneous suspension of nanofluids since the nanofluids are very tightly aggregated by van der Waals[184]. Therefore, one of the most critical prerequisites of solar thermal systems[185,186] is stable and improved dispersing of nanofluids .

3.1.2. BEHAVIOR SURFACTANT USAGE

One form of obstacle is to use a suitable surfactant in the preparation of nanofluids for solar collectors. Several laboratory studies have shown that nanoparticles are useful in improving the scatter of the working fluids and in decreasing their aggregation behavior[187,188]. The paper investigated the usage of various surfactants in various sun collectors for the enhancement of suspension parameters and nanofluid stability [22,89,157].

Nanofluids' stability and solar thermal adsorption properties are influenced by different forms of nanofluid surfactants such as Choi,Jang[189]examined MWCNTs/water nanofluids for their stability and thermal solar adsorption characteristics by incorporating various surfactant groups (SDBS, CTAB, SDS, and TX-100). These types of surfactants used for the preparation of nanofluids greatly influence the stability of the dispersion and the absorptive properties. Of the four surfactants, SDBS has shown the highest efficiency and recommended for use both in DASC and in other thermal receivers.

3.1.3. NANOPARCTICLE SIZE AND VOLUME CONCENTRATION

The scale and mass concentration of nanoparticles is also the basis for solar systems [86]. In Asaeian, Eshghi[190] published further studies on the impact on solar thermal systems of nanoparticles. Khullar, Tyagi[115] further pointed out that the necessary nanoparticles in size and quantity are needed to maximise the solar collector's maximal outlet temperature and thermal performance. That particle size doesn't affect the solar collector's performance considerably.

3.1.4. VICOSITY OF NANOFLUIDS

Nanofluid viscosity is increasing at the same time as the amount of nanofluid concentrations is rising and decreasing at the same rate in solar energy with rising temperature[191].

In addition to the concentration of particulate mass, it should not be limitless[192]. Said that Sajid [193] researched on the solar platform collector and registered a high volume, temperature and basis fluids for viscosity of Al_2O_3/water ethylene, and Al_2O_3/water nanofluids. Viscosity increases with increased mass fractions of nanoparticles and higher temperatures of water-based nanofluids. In contrast, nanofluids dependent on water ethylene glycoma demonstrate Newtonian behaviour.

3.1.5.PUMPING POWER AND PRESSURE DROP

With higher density and nanofluid viscosity, the pressure drop increases[194]. The Mahian analysed that pressure decreases are calculated by the friction factor in Kianifar [195]. In addition, pressure decline and nanofluid density decide the solar heat loss. Faizal, Saidur[66] experimentally tested the rise in pressure decrease as a result of the increased flow rate and increase in nanoparticles into the basic fluids.

For pumping force, which is associated with a drop in pressure and a mass fluid fluid rate. In-solar collector's pumping capacity is improved by the the mass proportion of nanoparticles in the working fluid as the density and pressure decrease in working fluids has increased[196]. Nanofluids are a source of increased pressure and pumping capacity by approximately 30 percent at the full volume fraction of nanowaters in the solar collector, Shamshirgaran, Assadi[197] numerically analysed in plate solar collector and Cu/Water Nano fluids.

3.1.6. COST OF NANOFLUIDS

Increased nanofluid suspension development due to production problems[198] is a key potential challenge to the use of nanofluids in solar collectors. Nanofluids are generally produced in one or two stages [199]. In order to generate nanofluid using these techniques, specialised and elaborate apparatus are therefore required.

The costs for nanofluids used in the field of heat exchanger[200] and microchannels[201] in thermal engineering systems are underlined as a disadvantage. Mahian, Kianifar[202] stated that higher performance in solar thermal systems constitutes the first potential obstacle for nanofluids.

3.1.7.EROSION AND CORROSION OF NANOFLUIDS

Working fluid nanoparticles can induce surface erosion or corrrosion of any long-term thermal devices such as Bubbico, and TiO_2, Al_2O_3, SiC, and ZrO_2 nanofluid sensitivity on metal surface can be investigated by experimental Celata[203]. They showed that nanoparticles have caused surface damage by chemical corrosion and almost insignificant mechanical erosion.

In another trial, Fotowat, Askar [204] carried out experiments on copper, aluminium and stainless steel, degradation and corrosion effect of the Al_2O_3 nanofluids. The authors found that nanofluids influence aluminium and copper considerably, while in stainless steel they were much less effective.

IV. FLATE PLATE SOLAR COLLECTOR

In an application such as water heating, heating, home use, commercial use and industrial use[37] the recently developed concept for a flat-solar collector (FPSC) is relatively simple and broad. It is famous for its lowest cost and easy to manufacture, instal and maintain. The surface of the flat-plate solar collector absorbing solar radiation is generally almost as wide as the collector. It is classified as a liquid collector in which the liquid is a liquid transfer fluid and a heat transfer fluid collector for air [38,39].

Hottel & Woertz was the most primitive solar plate collector, and first worked on a platform solar collector in 1958.[40] Afterwards many researchers studied the collector's thermal efficiency, analysing it and improving it. It is made up of glass, absorber, pipes for riser and header, isolator, a back layer, aluminium rails. The sunlight through to the absorber is used to protect the absorber, which is clear and reinforced glass.

The absorber is made out of aluminium and ultrasonically soldered to the working fluid with a riser tube. A harpsick heat exchanger is formed by the riser pipe and header pipe that the working fluid can circulate through it [41]. In order to improve the efficiency of structurally structured platform solar panels, the front and back of the collector can minimise radiative and convective heat loss[42].

The flat solar collector's usual flat plate. Recent research has demonstrated, by means of polymers, a thermosetting microchannel, nano fluid as heat transfer fluid, an absorber plate design, the use of PCM and the use of improvement instruments, that flatsolar collectors have a better efficiency. In addition, the analysis has begun at the beginning of the 2012 calendar year, particularly with regards to heat transfer coefficients[60]. flat platform solar collector efficiency. Said,Saidur[61]concluded that Al_2O_3/water nanofluid treated with PH improves the collector's thermal ability.

Chadji, Ajabshirchi[65] has been studying to improve the performance of TiO_2/Water nanofluid solar collectors. Different concentrates and the mass flow rate are used in this analysis. The efficacy of nanoparticles is increased between 2.6% and 7% compared to basic fluid. The collector output was reduced by the sedimentation of nanoparticles at the maximum flow rate (108 l/m), however, relative to the 36 and 72 l/m flow rate. Faizal, Saidur[66] has studied a SiO_2/Water Nanocollector experiment to examine the efficiency of the solar collector.

The findings showed an energy savings of about 280 Mj relative to water and a reduction in the emissions of CO_2

in the atmosphere of about 170 kg. The efficiency of flat platform solar collectors using silver nanofluids as working fluid was investigated by Polvongsri and Kiatsiriroat[67]. Silver nanopart's sizes in this area were 20 nm, the concentration of volume was 1,000 ppm, and the temperature at input was 10000 ppm and 5–35 ppm. In comparison to pure water, the authors observed substantial changes in collector efficiency at 1000 ppm vol.

The efficiency also grew as the volume concentration increased. The collector output with silver nanofluid could also be improved at higher inlet temperatures. the overview of several previous major studies focused upon an experimental approach to the efficiency increase of flat plate solar collectors using nanofluids.

4.1.EVACUATED TUBE SOLOR COLLECTOR

The key element of the solar collector evacuated tube is the parallel evacuated tube (ETSC). The outer tube is a very solid glass tube, while the inner tube is made of glass, but is covered by a special selective layer, with outstanding solar radiation and minimum reflective characteristics. The air between these pipes is removed to provide a vacuum that removes conductive and convective thermal loss. The plate is often made of copper or aluminum.

A high-level heat pipe is generally made of copper and is welded to a plate. The plates are then inserted into the interior tube[68].Fig.4isolar tube solar collector photographic-evacuated. Ayompe, Duffy[69] experimentally studies the energy efficiency of flat and evacuated tube solar collectors throughout the whole of the year under similar conditions. ETSC is much better than FPSC's flat quality.

ETSC is now improving in various respects such as output, efficiency, thermal conductivity, coefficient of heat transfer, energy storage, coefficient of convective heat transfer by changing the arrangements, configurations, equipment, architecture, installation [70–78]. Furthermore, Lu, Liu[79] studied the potential first study of nanofluid to increase performance, as used in the evacuated solar tube collector.
CuO/deionized water is used for this analysis as nanofluid. The outcome revealed that the evaporator was filled optimally with 60 percent and thermosyphon thermal efficiency improved as operating temperature was increased. Compared to deionized evaporator water, the heat transfer coefficient was increased by 30%; the mass concentration was 1,2% at full heat temperature rise.

Al-MashatandHasan[80] has tested, for Baghdad from April until the end of March 2012, the tilting Angle Direction of the evacuated solar pipe collector using Al2O2/Water nanofluid. They noted that the best angle of inclination for ETSC was 41 cents per annum and observed an improvement in collector efficiency of 28,4% with 1%, 6,8% with 0,6% and 0,3% without a sensitive result. The utility of the collector of ZrO2/water and Ag/water nanofluids was analysed by Hussain Jawad[81].

Both nanofluids showed that the solar collector improved efficiency compared to water, especially at high inlet temperatures. However, nanofluid performance with Ag/water was higher than nanofluid with ZrO2/water. the increased effectivity with experimental method of the solar tube collector evacuated by nanofluids. Theoretical research in Kim, Ham was carried out on the output of a MWCNT, Al2O3, TiO2, SiO2 U-pipe solar collector. Nanoparticles from Cu O were suspended in 20 percent of pillar eglycol-water base fluid, and the increased thermal conductivity was observed.

MWCNT nanofluid shows higher efficiency and quality at a concentration of 0.2% by a factor of 62.8%. In 1841,6–2083, they also published. The output should be decreased annually, if 50 ETSCs should be used on a given period, 1 biskgCO2 and 6.0–6.7 biskgSO2 should be produced.

4.2.DIRECT ABSORPTION SOLAR COLLECTOR

The direct absorption solar collector (DASC) was created in 1970, the first time solar systems were to capture solar energy directly into the fluid volume to improve the performance of solar cell [83,84]. At the end of the collector there is no absorbing layer. The volume of solar radiation directly absorbed by the working fluids concentrate depends on the fluid type, the fluid solar absorption properties and the recipient tube dimensions[85,86].

However, DASC's performance is restricted since the solar spectrum of typical working fluids has extremely poor absorption properties[87]. Typical schematic of solar collector direct absorption. Micro-sized particulate matter has been incorporated into the base liquid to increase DASC energy efficiency; however, this has created issues, such as blockage of the channel, degradation, abrasion, corrosion, low stability and sedimentation [85,88].

Nanotech recently offers an incentive for the drastic improvement of DASC's energy performance by nanoparticles with advanced technologies. [103-105], in French. The applicability of graphite nanofluids in DASC was tested in Ladjevardi, Asnaghi[106].

In comparison to pure water, these authors showed an improvement of $0.045/L in the expense of nanofluid rises the outlet dimension temperature between 0.27 and 0.915 compared with pure water. The thermal conductivity of DASC was investigated by Natarajan and Sathish[29] using CNT nanofluids and nanoparticles were found to be potential for radiative properties enhancement of the fluids.

The authors also pointed out that DASC increased performance. The graphene graph for low-temperatural DASC used for 0.00025, 0.0005 and 0.005 wt.% of nanoparticles was experimentally researched by Vakili, Hosseinalipour [107]. They showed improved absorption and conductivity with a weight percentage increase.

The collector has improved overall capacity. Via the use of factory architecture using response surface methodology, Gorji and Ranjbar[83] theoretically investigated the thermal efficiency and entropy production in nanofluid DASC. Here, the 30 nm graphite 0.1 vol percent nanoparticles in water used as working fluid are suspended. Maximum thermal efficiency and low entropy production was achieved and recommended in accordance with multiple reaction optimisation.

Parvin, Nasrin[108] studied the creation of entropy through the directly absorbed solar collector filled with nanofluids and the working fluid was Cu/water at different fraction of solid volume. The most powerful heat transfer coefficient increase is the Cu/water nanofluid with the largest number of Reynolds and 3 percent volume fraction; collectory efficiency is increased more than twice. The importance and importance of direct solar absorption by nanofluids .

4.3. PARABOLIC TROUGH SOLAR COLLECTOR

The PTSC is a kind of mature solar concentrate that is curved as a parabolic and positioned in a straight line with a matrix of mirrors that forms a parabolic reflector, as well a focal length receptor and aligned with the laser beam[109]. Due to its capability to provide a high temperature load and a range of 100-500 µC, synthetic oil is used as the heat transfer fluid. PTSC is the linear solar collector concentrate[110].

The recipient receives the energy reflected from the sun. This absorbed radiation heats the fluid moving into the tunnel, which converts the radiation into thermal energy. It is the most frequent high-temperature collector [111,112]. Typical solar collector parabolic trough. Increased thermal conductivity in flow and increased heat transfer rate from warm to working fluid can be attributed to nanoparticles. Higher coefficient of thermal transport, leading to lower absorber temperatures and lower thermal losses[113]. Mwesigye, Huan[114] examined thermodynamic analysis of PTSC using an entropy minimising process, whereas synthetic oil Al2O3 is used by the receptor tube as a heat transfer fluid. Due to the present presence of nanofluid, the output of the heat transfer system was up to 76%, while the volume fraction increased by 54% and 35% by 0%, 0% to 6% and 0% to 4% and even thermal efficiency rises to 7,6%. Khullar, Tyagi [115] studied nanoparticles that used in therminol oil (Therminol VP1) as a work fluid in PTSC could increase their performance by some 5-10%.shows the performance of parabolic trough collector using nanofluids.

De Risi, Milan [116] has numerically examined the possibility of gas based nanofluids in PTSC and simulations have shown a maximum efficiency of 62.5%. The pilot team at Kasaeian, Daviran[117] explored new concepts and convenience. Complete productivity of trough collectors was increased by approximately 4 –5% and 5 –7%, where nanofluid is used as a pure oil by 0.2% and 0.3% by MWCNT/mineral oils. Table 6 demonstrates the efficiency of the nanofluid parabolic drum collector.

4.4. SOLAR DISHES

Solar dish collector (SD) shaped by focusing technology with a ratio of approx. 3000 geometric levels[118]. There is a two-axis monitoring device into the concentrators to guarantee that the plates match the light. It is ideal for higher temperature receivers such as Stirling engine heating, Brayton cycle gas receiver, Thermo chemical Reactor and other applications of heavy concentrat radiation.

Higher working temperature empowers higher performance [119,120]. Temperature and pressure bar are usually increasing by about 700–750 percentage points of C and 200 bar respectively[121]. The diameter of the plating usually ranges from 5 to 10 m and is about 40 to 120 m2 with reflective surfaces[122]. A plastic or glass secured sliver or aluminium to make the surface glittery. Iron may be used to increase the reflective characteristics of the surface by a fraction. Power generation capacities of Solar dish concentrator range from 0.01 to 0.5 MW[119,123].

In addition, solar platform concentrators for methanol reform[124], wastewater desalination[125] were used. Thanks to their high thermal performance in medium and high temperatures, the concentrate solar collectors gained greater interest. Due to their high concentrateur ratios for high temperature applications [126,127], solar plates demonstrate great interest among different types of concentraters. A lot of study has, thus, been carried out on its architecture in order to achieve high therial efficiencies, higher production temperatures and thus to increase the thermal efficiency of solar panels[128] through the nanofluid technology. Improving solar plates' thermal efficiency using nanofluids.

4.5.POTOVOLTAIC THERMAL COLLECTOR

Solar irradiation is recently converted combinations of electricity and heat power into one single photovoltaic (PTV) system[130] similar to photovoltaic and solar thermal components[131], using the most qualified solar technologies. This system's fundamental principle is to generate the heat from the photovoltaic modules, and solar thermal systems are used separately from this heat generated. In the 1970s [132], the concept was developed.

The PVT system's simple model[133]. Due to this type of PVT system, energy efficiency is higher than traditional solar and photovoltaic systems [134]. Various working fluids such as water and air are used for cooling in the PVT system [135]. Nanofluids can increase the overall efficiency of the PVT collector without altering the structural architecture substantially by using them as fluids[136]. Many computational and experimental studies for the energy efficiency of PVT using nanofluids are carried out .

4.6. COMPOUND PARABOLIC COLLECTOR

Winston has been developed first for the Compound Parabolic Collector (CPC). It consists of a receiver in the centre of the parabolic form concentrate with a flat or tubular form. This collector requires various parabola components, and is therefore referred to as "compound" This CPC is a non-imagery concentrated community that does not emphasise the image of the sun. The usual ratio of focusers is from 2 to 3. The focuser ratio of about 6 can be used however and hence the greater surface area cannot be used[23,138]. [23,139].
The use of nanofluids in the CPC method has been tested in limited literature. The thermal efficiency of CuO/water nanofluid in the collector was experimentally studied by Lu and Liu[79]. The authors stated that nanofluid transmission is very restricted in the highest heat transference in a CPC system so further studies were required to investigate CPC output with different 200 l/min nanofluids and the entry temperature was the same. The investigators find that therapeutic efficiencies improved from 0.22 to 0.78% with 32 to 49% pumping. The coefficient of heat transmission rose by almost 30% – 35%.

V. CONCLUSION

Flat plates, direct absorption, evacuate tube, parabolic trough, solar dish, and photovoltaic thermal solar collector's energy efficiency changed rapidly when nanofluids applied as the working fluid. In case of FPSC, SiO_2, MWCNTs, CuO, Cu, SiC, MgO, TiO_2 and Al_2O_3 nanofluids affect significantly on the thermal performance of collector. For evacuated tube solar collector, nanofluids such as CNTs, CuO, TiO_2, and Al_2O_3 exhibit significant improvement of thermal performance. In term of direct absorption solar collector, Magnetite, MWCNTs, SiC, CuO, Al_2O_3 nanofluids play an important role on the thermal performance of collector. Illustrates the thermal performances of nanofluids in DASC arranged. Similarly, for parabolic trough solar collector, nanofluid such as TiO_2, ZnO, SiO_2, Fe_2O_3, Cu, Al_2O_3 and MWCNTs perform interestingly in the collector. Thermal performances of nanofluids in PTSC respectively based on the thermal performance of solar dishes and photovoltaic thermal solar collector. These all present that thermal conductivity, heat transfer coefficient, convective heat transfer coefficient, output temperature, energy efficiency, and energy efficiency enhanced dramatically. Finally, the thermal conductivity and outlet temperature performance of nanofluids in solar collectors respectively. According to flat plate solar collector presents the highest thermal conductivity enhancement by 76.6% than others. The collision between nanoparticles reinforces to surge the Brownian diffusion which leads to enhancing the thermal conductivity of nanofluids.

REFERANCE

[1] B. Petroleum, BP Statistical Review of World Energy June 2015, 2015, British Petroleum Google Scholar, London, UK, 2015.
[2] R. Viral, D. Khatod, Optimal planning of distributed generation systems in distribution system: A review, Renew. Sustain. Energy Rev. 16 (7) (2012) 5146–5165.
[3] G.E. Assessment, Global Energy Assessment—Toward a Sustainable Future, Cambridge University Press and the International Institute for Applied Systems Analysis, Cambridge, UK, and Laxenburg, Austria, 2012.
[4] R.K. Pachauri, et al., Climate change 2014: synthesis report. Contribution of Working Groups I, II and III to the fifth assessment report of the Intergovernmental Panel on Climate Change. 2014, IPCC.
[5] R. Brini, M. Amara, H. Jemmali, Renewable energy consumption, International trade, oil price and economic growth inter-linkages: The case of tunisia, Renew. Sustain. Energy Rev. 76 (2017) 620–627.
[6] B.N.E.F. FS-UNEP, Global trends in renewable energy investment (2015), in: Frankfurt School-UNEP

Collaborating Centre for Climate & Sustainable Energy Finance, United Nations Environment Programme, 2015.

[7] M. Ranjbar-Mohammadi, et al., Gum tragacanth/poly(l-lactic acid) nanofibrous scaffolds for application in regeneration of peripheral nerve damage, Carbohydr. Polym. 140 (2016) 104–112.

[8] M. Mussard, Solar energy under cold climatic conditions: A review, Renew. Sustain. Energy Rev. 74 (2017) 733–745.

[9] Z. Elum, A. Momodu, Climate change mitigation and renewable energy for sustainable development in Nigeria: A discourse approach, Renew. Sustain. Energy Rev. 76 (2017) 72–80.

[10] G.N. Tiwari, Solar Energy: Fundamentals, Design, Modelling, Applications, Alpha Science Int'l Ltd, 2002.

[11] F. Liu, et al., Working principles of solar and other energy conversion cells, Nanomater. Energy (2012).

[12] H. Chang, et al., Modeling study on the thermal performance of a modified cavity receiver with glass window and secondary reflector, Energy Convers. Manage. 106 (2015) 1362–1369.

[13] T. Melchior, et al., A cavity-receiver containing a tubular absorber for high-temperature thermochemical processing using concentrated solar energy, Int. J. Therm. Sci. 47 (11) (2008) 1496–1503.

[14] G. Bhosale, S. Borse, Pool boiling CHF enhancement with Al2 o 3-Cuo/H2 o Hybrid Nan fluid, Int. J. Eng. Res. Technol. IJERT (2013).

[15] S. Chol, Enhancing Thermal Conductivity of Fluids with Nanoparticles, Vol. 231, ASME-Publications-Fed, 1995, pp. 99–106.

[16] A. Bejan, A.D. Kraus, Heat Transfer Handbook, John Wiley & Sons, Inc, Hoboken, New Jersey, 2003.

[17] M. Serebryakova, et al., Thermal conductivity of nanofluids based on hollow γ-Al 2 O 3 nanoparticles, and the influence of interfacial thermal resistance, Int. J. Heat Mass Transfer 108 (2017) 1314–1319.

[18] S. Angayarkanni, J. Philip, Review on thermal properties of nanofluids: recent developments, Adv. Colloid Interface Sci. 225 (2015) 146–176.

[19] J. Hone, Carbon nanotubes: thermal properties, J. Nanosci. Nanotechnol 6 (2004) 603–610.

[20] S. Morandi, et al., Shedding light on precursor and thermal treatment effects on the nanostructure of electrospun TiO2 fibers, Nano-Struct. Nano-Objects 7 (2016) 49–55.

[21] A.K. Hussein, Applications of nanotechnology to improve the performance of solar collectors–Recent advances and overview, Renew. Sustain. Energy Rev. 62 (2016) 767–792.

[22] J. Ghaderian, et al., Performance of Copper Oxide/distilled water nanofluid in evacuated tube solar collector (ETSC) water heater with internal coil under thermosyphon system circulations, Appl. Therm. Eng. (2017).

[23] G. Tiwari, A. Tiwari, Handbook of Solar Energy: Theory, Analysis and Applications: 2016, Springer Verlag, Singapore, Singapore, Singapore, 2016.

[24] Ž. Jesko, Classification of solar collectors, rN 1 (21) (2008) 21.

[25] J. Eastman, et al., Enhanced thermal conductivity through the development of nanofluids, in: MRS proceedings, Cambridge Univ Press, 1996.

[26] İ.H. Yılmaz, M.S. Söylemez, Thermo-mathematical modeling of parabolic trough collector, Energy Convers. Manage. 88 (2014) 768–784.

[27] P. Visconti, et al., Measurement and control system for thermosolar plant and performance comparison between traditional and nanofluid solar thermal collectors, Int. J. Smart Sensing Intell. Syst. 9 (3) (2016).

[28] G. Colangelo, M. Milanese, A. De Risi, Numerical simulation of thermal efficiency of an innovative Al2o3 nanofluid solar thermal collector, Therm Sci 21 (2017) 2769–2779.

[29] E. Natarajan, R. Sathish, Role of nanofluids in solar water heater, Int. J. Adv. Manuf. Technol. (2009) 1–5.

[30] L. Chen, et al., Reduced graphene oxide dispersed nanofluids with improved photo-thermal conversion performance for direct absorption solar collectors, Sol. Energy Mater. Sol. Cells 163 (2017) 125–133.

[31] [31] S. Yan, et al., Heat transfer property of SiO 2/water nanofluid flow inside solar collector vacuum tubes, Appl. Therm. Eng. 118 (2017) 385–391.

[32] R. Nasrin, S. Parvin, M. Alim, Heat transfer by nanofluids through a flat plate solar collector, Procedia Eng. 90 (2014) 364–370.

[33] M. Vakili, et al., Experimental investigation of graphene nanoplatelets nanofluid-based volumetric solar collector for domestic hot water systems, Sol. Energy 131 (2016) 119–130.

[34] K. Goudarzi, E. Shojaeizadeh, F. Nejati, An experimental investigation on the simultaneous effect of CuO–H 2 O nanofluid and receiver helical pipe on the thermal efficiency of a cylindrical solar collector, Appl. Therm. Eng. 73 (1) (2014) 1236–1243.

[35] A.M. Tomy, et al., Analysing the performance of a flat plate solar collector with silver/water nanofluid using artificial neural network, Procedia Comput. Sci. 93 (2016) 33–40.

[36] H.K. Gupta, G.D. Agrawal, J. Mathur, Investigations for effect of Al 2 O 3–H 2 O nanofluid flow rate on the efficiency of direct absorption solar collector, Case Stud. Therm. Eng. 5 (2015) 70–78.

[37] F. Struckmann, Analysis of a flat-plate solar collector. Heat and Mass Transport, Project Report, 2008MVK160, 2008.

[38] A. Klevinskis, V. Bucinskas, Analysis of a flat-plate solar collector, Mokslas: Lietuvos Ateitis 3 (6) (2011) 39.

[39] S.K. Amrutkar, S. Ghodke, K. Patil, Solar flat plate collector analysis, IOSR J. Eng. 2 (2) (2012) 207–213.

[40] H. Hottel, A. Whillier, Evaluation of Flat Plate Collector Performance'. in Transactions of the Conference on the Use of Solar Energy.

[41] M. Jamil, N.C. Sidik, M.M. Yazid, Thermal performance of thermosyphon evacuated tube solar collector using TiO2/water nanofluid, J. Adv. Res. Fluid Mech. Therm. Sci. 20 (1) (2016) 12–29.

[42] M. Madhusudan, et al., Optimization of heat losses in normal and reverse flat-plate collector configurations: Analysis and performance, Energy Convers. Manage. 21 (3) (1981) 191–198.

[43] K.M. Pandey, R. Chaurasiya, A review on analysis and development of solar flat plate collector, Renew. Sustain. Energy Rev. 67 (2017) 641–650.

[44] W. Kong, et al., A new laplace transformation method for dynamic testing of solar collectors, Renew. Energy 75 (2015) 448–458.

[45] H. Hottel, B. Woertz, Performance of flat-plate solar-heat collectors, Trans. ASME (Am. Soc. Mech. Eng.) (1942) 64, (United States).

[46] D. Njomo, M. Daguenet, Sensitivity analysis of thermal performances of flat plate solar air heaters, Heat Mass Transfer 42 (12) (2006) 1065–1081.

[47] J.A. Duffie, W.A. Beckman, Solar Engineering of Thermal Processes, 1980.

[48] N. Madhukeshwara, E. Prakash, An investigation on the performance characteristics of solar flat plate collector with different selective surface coatings, Int. J. Energy Environ. 3 (1) (2012).

[49] B.J. Prakash, B. Vishnupasad, V.V. Ramana, Performance Study on Effect of Nano Coatings on Liquid Flat Plate Collector: An Experimental Approach, 2013.

[50] N. Akhtar, S. Mullick, Effect of absorption of solar radiation in glasscover (s) on heat transfer coefficients in upward heat flow in single and double glazed flat-plate collectors, Int. J. Heat Mass Transfer 55 (1) (2012) 125–132.

[51] E. Amer, J. Nayak, G. Sharma, Transient method for testing flat-plate solar collectors, Energy Convers. Manage. 39 (7) (1998) 549–558.

[52] A. Shariah, B. Shalabi, Optimal design for a thermosyphon solar water heater, Renew. Energy 11 (3) (1997) 351–361.

[53] G. Martinopoulos, et al., CFD Modeling of a polymer solar collector, Renew. Energy 35 (7) (2010) 1499–1508.

[54] T. Sultana, G.L. Morrison, G. Rosengarten, Thermal performance of a novel rooftop solar micro-concentrating collector, Sol. Energy 86 (7) (2012) 1992–2000.

[55] M. Selmi, M.J. Al-Khawaja, A. Marafia, Validation of CFD simulation for flat plate solar energy collector, Renew. Energy 33 (3) (2008) 383–387.

[56] K. Gertzos, S. Pnevmatikakis, Y. Caouris, Experimental and numerical study of heat transfer phenomena, inside a flat-plate integrated collector storage solar water heater (ICSSWH), with indirect heat withdrawal, Energy Convers. Manage. 49 (11) (2008) 3104–3115.