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The heat produced by reducing the cell temperature should be invested and used in several applications

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***Abstract*---**In this research, a comprehensive review of the methods of reducing the cell temperature and study of these methods in depth was focused on the type of fluid that cool the cell. The results obtained were focused on the economic feasibility of financial costs and their consumption of electricity. The aim of the study is to find out all the good ways to reduce the temperature of the cell and its benefits and the difference between each way and the advantages and disadvantages of each method. This paper has revealed that it also focused on determining which technologies are appropriate and easy to use and give good results. The study recommends the need for independent research on the economic feasibility of cells for cooling photovoltaic cells. The choice of good technique to reduce the temperature of PV cell is the right way to obtain the best results that lead to increasing the cell lifetime, increase its efficiency and achieve a clear increase in the performance of the cell, which reduces the possibility of cell destruction. The heat produced by reducing the cell temperature should be invested and used in several applications, including heating and drying and to other applications.

***Keywords*---**Cooling photovoltaic cells, Reduce the temperature, Cell destruction, Independent research.

Introduction

As a result of the increasing population and affecting the environment through the increase of emissions of fossil fuels, making the use of renewable energy more need and more widespread in the world. Renewable energy applications are many and varied, but the most widespread and more important is the solar energy for its sustainability and its abundance. Solar energy has attracted great attention from researchers and studies and has entered into many applications in the world [1]. Electrical energy and thermal energy can be produced by Solar energy, but

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the biggest need is to produce electricity and dispense with fossil fuel stations where electricity can be produced using photovoltaic (PV) cells Photovoltaic (PV) modules are a strong state cell that converts Solar radiation, the most plenteous vitality source on the planet, specifically into power without an interceding heat motor or turning hardware PV cell has no moving parts and, accordingly, Requires little maintenance and has a long lifespan. Energy is produced without any emissions and impact on the environment or some other gases and its task is for all intents and purposes quiet. Photovoltaic frameworks can be worked in for all intents and purposes any size, extending from mill watt megawatt, and the frameworks are particular, i.e., more boards can be effortlessly added to build yield. Photovoltaic frameworks are very solid and require little upkeep. They can likewise be set up as independent frameworks [2]. Photovoltaic cells are the most widely used for their advantages, especially it is conversion of solar energy to electrical energy without affecting the environment in any emissions of waste gas, but these cells are affected by a range of environmental factors such as temperature and solar radiation, soil and others where environmental factors affect the efficiency And performance of photovoltaic cells [3]. The efficiency of the photovoltaic cell is mainly affected by cell temperature in addition to the power of solar radiation [4]. Photovoltaic panels convert part of the falling solar radiation into electrical energy, while the rest is converted to heat. Where heat represents wasted energy to the surrounding environment from the front surface and the air gap in the back surface through convection and radiation this heat raising the operating temperature of the photovoltaic cell and decreasing the performance of the photovoltaic cell and electron transfer properties. The increase in the operating temperature of the photovoltaic cell results in a decrease in the production of photovoltaic panels [5]. For example, crystalline silicon solar cells have a typical power temperature coefficient of -0.5% for every 1ºC a rise in operating temperature [6]. Another study The efficiency of the photovoltaic cell decreases by 0.5% when the cell surface temperature increases one degree [7]. The standard conditions in which photovoltaic cells are typically analyzed are (STC: 1000 W / m2, 25° C temperature, and global 1.5 AM spectra). The main effect of the process of converting solar energy into electrical energy in PV is the solar PV cell temperature [8]. Increasing the temperature of the photovoltaic cell will increases the current and will low voltage, which confirms that the production of electricity from photovoltaic cells is directly affected by cell temperature [9]. Which normally for each and every 1°C increment of PV module temperature, there is a~0.45% diminish of PV module proficiency for crystalline silicon. P-V properties are a relationship. We can illustrate the operation of solar/photovoltaic system When the solar radiation falls on the photovoltaic cell and When through the P-N junction, the cell absorbs the photon, and through the photon, junction becomes a potential difference. A photovoltaic current (IPV) is produced when the charging vectors flow. This current corresponds to a diode called P-N the temperature effect on the photovoltaic cell can be calculated by using the following mathematical equations.

$$\eta pv = \eta pv \,[1 - \beta R\,(TC - TR\,) + \gamma \log10\ IPV] \quad (1)$$

Where: ηPV is the efficiency of the photovoltaic cell which is calculated at standard conditions temperature; TR (25° C). βR is the temperature coefficient of the cell efficiency (usually 0.004-0.005/ °C) [10]. IPV is the average hourly radiation incident on the PV module at nominal operating temperature; NT. TC is the temperature of the PV module, and Y is the radiation intensity cell efficiency coefficient. The equation above is usually reduced by a value of ϒ is zero [11,12] and will be the equation of calculating the effect of temperature on the photovoltaic will cell to:

$$\eta pv = \eta TR\ [1 - \beta R\ (TC - TR\ )] \qquad (2)[13]$$

Between the energy produced and the voltage, while the mean temperature [Tm] of the PV, and solar radiation, [E], is maintained. For the most part, sun-oriented PV module ingested sunlight based radiation yet not changed over to power but rather aim to build the heat and diminishing the electrical proficiency [14]. Despite the fact that photovoltaic cell productivity ranges from about 5% to 20% due to the effect of temperature and various components, they remain better than the efficiency and performance of other units, such as wind and biomass. Since photovoltaic cells are specifically affected by cell temperature where the efficiency rate drops from 0.25% to 0.5% for each degree depending on the type of material for the cell used [15]. Because of the huge decrease in the effectiveness of photovoltaic cells, which some of the time extend from 9% to 12%, over 80% of the falling sunlight based radiation isn't changed over into electrical energy, yet is reflected or changed over to undesirable warmth energy and this is lost energy since the warmth produced prompts an expansion in cell temperature and subsequently influence the execution and productivity of the cell [16]. For the purpose of making PV cells more suitable in alternative energy applications and technologies, it is necessary to work and think of solutions that are feasible, simple and applicable and do not require more maintenance. These solutions can solve the problem of increasing the temperature of the cell and thus improve and increase the efficiency and performance of the PV cell. It is necessary to study all possible techniques to improve the efficiency of photovoltaic cells and study the most important factors that affect the performance of photovoltaic cells there are previous studies and useful work for many of the authors and researchers, which will present the most important studies in this paper to lessen the board temperature, cooling of the PV boards is generally done which enhances the electrical execution of the module and lessens the warm burdens creating in the module. A few kinds of warm models have been created for computing the temperature of PV cells as an element of sunlight based radiation and the ecological conditions. *Siecker and et al.* [17] Studied the previous literature on the system of cooling techniques of photovoltaic cells to find a general understanding of the techniques used and compare them and clarify the advantages and disadvantages of each technology and any preferred technology. while the review paper of *Haitham M.S. Bahaidarah and et al.* [18] Focused on the importance of cooling standardized of photoelectric and the economic and environmental impact on cooling techniques by discussing the cooling of photovoltaic systems through a comparative case study between standard and non-standard cooling methods. They found that the immersing PV technique was to reduce the temperature of PV to 20-45 ° C for CPV systems. The heat pipe technique can lower the temperature to 32 ° C with the best non-uniform temperature of 3°C. While the study of *Tiwari GNN and et al.* [19] Recommended that the cooling should maintain the mean temperature of the cell where the behaviour of the solar cell shows a decrease in electrical efficiency by increasing the temperature as shown in the figure. (1).

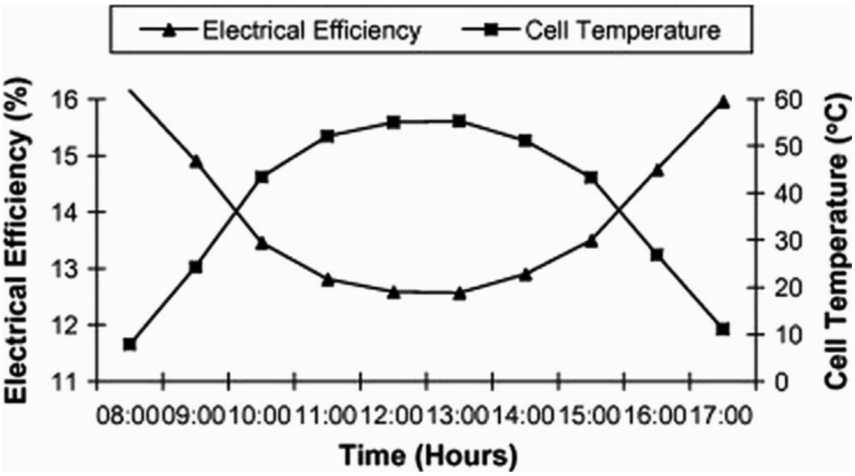

Fig. 1: behaviour of electrical efficiency and cell temperature for a typical summer day[19]

Table (1) focuses on the most important studies related to previous studies of photovoltaic cooling techniques. For the best use of photovoltaic cells, cooling techniques are necessary and important to increase efficiency by reducing the temperature of the base and can take the heat of waste energy for heating and drying the most important and useful methods of cooling used in the cooling of photovoltaic cells was discussed and the number from recent papers on the subject of cooling of photovoltaic cells has been studied and the names of authors and scientific journals that have been published were all referred to in the technology used to cool the photovoltaic. To illustrate each technique a table was prepared with the advantages and disadvantages of each technique. The cooling of photovoltaic techniques will be discussed and analyzed through this following study:

1) Photovoltaic cooling technique by using forced air
2) Photovoltaic cooling technique by using water spraying
3) Photovoltaic cooling technique by circulation forced water
4) Photovoltaic cooling technique by a heat sink
5) Photovoltaic cooling technique by use of a phase-change substance
6) Photovoltaic cooling technique by immersion in water
7) Photovoltaic cooling technique by coating transparent
8) Photovoltaic cooling technique by thermoelectric cooling
9) Photovoltaic cooling technique by floating tracking concentrating cooling system (FTCC).

Table (1) Focuses On the Latest Papers That a Literary Review of All Photovoltaic Cell Cooling *Techniques*

Author	The Focus About
Haitham M.S. Bahaidarah and et al [18]	studied the effect of temperature irregularity on cell performance, and the effect of shading on the cell and divided the cooling techniques to 8 techniques as shown in fig(2) (heat pipe cooling, microchannels, liquid immersion cooling, improved heat exchangers, heat sinks, Impingement jet cooling and Hybrid microchannels and impingement jet (cooling and phase change material systems) and study the comparison between this technique The research included a study of the uniform cooling system with a review of a practical study of the functioning of the cell under the influence of the uniform cooling.
A. RezaeeJordehi[13]	This research includes study different models of cells and different strategies are analyzed to solve the problem of photovoltaic cell temperature and review the solution from a different point of view. Review strategies for estimating the various elements that affect the photovoltaic cell and studying some practical suggestions and solutions for the development of photovoltaic cells.
*Swar*a. Zubeer and et al [20]	This paper looks at three kinds of cooling methods: air cooling, water cooling and fin cooling technique This paper inspect three sorts of cooling procedures: air cooling, water cooling and in cooling and spotlights on enhancing the execution of photovoltaic frameworks for little residential use by keeping the cell temperature as low and uniform as would be prudent. A pilot and specialized investigation of the impact of cell temperature on Electrical and warm execution of photovoltaic frameworks, and spotlights on enhancing the execution of photovoltaic frameworks for little residential use by keeping the cell temperature as low and uniform as could reasonably be expected. A pilot and specialized investigation of the impact of cell temperature on Electrical and warm execution of photovoltaic frameworks.
M. Hasanuzzaman and et al.[21]	This paper focused on the most vital papers dealing with photovoltaic cells and gave a mathematical analysis of the thermal equations of the cell. Most research plans to enhance cell implementation and increase productivity and give it a long life. The investigation focused on the ways of separate cooling frames to reach a moderate and normal temperature of the photovoltaic cell as the electric efficiency progressed and developed at a lower rate of 15.5%.
Tushar M. Sathe and et al[22]	A concentrated and inside and out an investigation of the scope of research considers inspected the development of photovoltaic cells through cooling and achieving a moderate temperature. This paper centers around air and

Author	The Focus About
	water cooling and give an investigation of the most recent advancements and improvement with refrigeration advances and have given an order of PVT framework dependent on warmth exchange advances and a combination of PVTframeworks with various foundation.
]32[S.S. Chandel and Tanya Agarwal	This study focused on research that cool photovoltaic cell by phasechange materials PCM for the purpose of achieving a high-efficient, low-cost technology, increasing the cell's performance. The results showed that phase-change materials PCM increase the electrical efficiency of the cell by 5% with PV systems. And effective efficiency increase, but it does need financial losses are large and therefore fail in terms of a feasibility study and it is can Succeed in areas of high disturbance in climatically throughout the year. The problem of PCM is a weakness of its thermal conductivity and its high financial cost. There are no studies on the economic feasibility of this type. In this paper, some gaps were identified during the cooling process. PCM cooling technology is not feasible for its high cost and the availability of these materials is not easy. In this paper, other cooling technologies were discussed and compared with PCM.
Raja, M and Sarath Kumar, P[24]	A recent review of research in previous years has used cell cooling technology by adding phase change agents called PCM. The paper was divided into two important aspects: the research was carried out practically in the laboratory and obtained results through PCM. The other side was numerical research by simulations. The results of the review showed that although few researchers did practical research by using PCM, most of the research did not address the process of solidification at the time of heat discharged at night. This research recommends that the properties of the material PCM must be tested before it is used because most of these materials are low thermal conductivity and recommends packaging the material container for the purpose of non-leakage, PCM leakage leads to loss of material properties and there should be tests of the ability of these materials PCM to reduce the temperature before use in the process of cooling the photovoltaic cells And under high temperatures

Fig. 2: classify of photovoltaic cooling technologies [18]

This paper provides a detailed explanation of the most important cooling techniques for photovoltaic cells depending on the type of fluid used in the cooling of PV, which will summarize the nine techniques mentioned above into three sections:

1. Studies that relate to use of air as working fluid in cooling.
2. Studies that relate to use of water as working fluid in cooling.
3. Studies that relate to the use of phase-changing materials and other techniques.

Depending on the latest paper and researchers who wrote about them and what their results from magazines and scientific sources and then a table of all the techniques and the difference between each technology and its advantages and disadvantages.

Studies That Relate To Use Of Air as Work Fluid in Cooling

The use of air in the cooling is common and useful for its thermal specifications. There are many types of research that focused on the development of the technology of cooling the photovoltaic cells in the air starting from the free cooling and then the forced cooling and others and the attempts and researches continue to develop this technique and get the highest heat transfer convection coefficient During by air cooling where this technique is one of the most important techniques that can be used to cool photovoltaic cells by reducing the temperature of the photovoltaic cell for the purpose of increasing electrical efficiency through air circulation through forced convection. The system is composed in addition to the photovoltaic cell which that installed on a steel duct to the air flow from it. The air (which is the cooling fluid) is pushed through the channel through a fan that consumption energy from the photovoltaic cell and increasing its energy consumption as it increases its speed, to increase heat exchange and cooling the photovoltaic cell base. Cell dimensions affect the rate of heat transfer. Heat transfer to photovoltaic cell cooling through forced convection and there are numerous studies to improve cooling through the use of air for air abundance and it is without effect on the photovoltaic cell and its cost-free use. And from the advantages of this technique, it is simple and Can get air easily and economical And generally, yield satisfactory results leading to increased efficiency and can use the hot air which results from the cooling process in buildings within HVAC systems where the air has low corrosion.

J. K. Tonui and Y. Tripanagnostopoulos [25] study ''Performance improvement of PV/T solar collectors with natural air flow operation'' by provide air cooling to the photovoltaic PV module, which is formed as a solar collector for the PV / T air through natural flow, where there are two low-cost Modification techniques are examined to promote the transfer of heat to the air stream in the air duct. The methods studied are composed of thin Metal sheets suspended in the center or fins connected to the rear wall of the airway to improve heat extraction from the unit, A digital model has been developed and verified against experimental data obtained from external testing campaigns for glazed The models of PV / T models are plated. The validation results show a good agreement between expected values and measured data thus can be used to analytically study the performance of these PV / T collectors' air in relation to many design and operation Parameters. Modified systems offer better performance than usual and will help improve integrated performance photovoltaic systems for applications of natural ventilation in buildings, both in terms of cooling and heating.

C. Misiopecki and et al [26] discusses the effect of free convection cooling on PV cell where practical results and 3D simulation results show a problem in choosing the size of the air gap for air passage as its smallness increases the temperature and requires a sufficient attenuation force to overcome the air force and makes the airway channel vulnerable to breakage.

A. S. Káiser and B. Zamora [27] used air as a working fluid for cooling either by natural convection or forced by means a fan to characterize the electrical behavior of solar panels in order to improve the design PV installations placed in roof applications that ensure low operating temperatures that will correct and the effect on the efficiency is produced by high temperature and up to the electrical power of the plate convection forced higher obtained by natural convection. Improvements in the photovoltaic cell reach to 15% in electric power because the temperature lowered about 15°C and they are shown that the depth of the flow channel under photovoltaic cells has a great effect on passive cooling as shown in fig (3).

A. D. Nebbali and et al [28] Verify cooled PV by air and determine the highest fan consumption through which the air flow can be carried out on the base of the cell. A numerical simulation of the CFD program was performed. The results indicated that the optimum air mass is 8 g / s, giving an increase in electrical efficiency of 1.35%.

E. A. Sweelem and et al [29] examines the design of the PV cell cooling system by using forced air technology for its availability, simplicity and low cost through a DC fan. The experimental results showed an increase in energy by 2% compared to the cooling cell. The study recommended that to increase the capacity and efficiency of the PV cell, the fan capacity should be controlled and controlled with the lowest possible capacity.

A. Crăciunescu and et al [30] study the effect of cooling by using forced air on the photovoltaic panel where the study found that the voltage decreases in the case without cooling from the beginning of the exposure the cell to the solar radiation and the voltage increase in the case of cooling and the study found that the temperature of the cell increase whenever the cell exposed to solar radiation and this negatively affect the performance of the cell, therefore, the cooling systems very important to PV.

H. M. Maghrabie and et al [31] cooled PV by forced air where the air blower to rectangular channel installed on the back of the cell. The results showed a decrease in cell temperature by 11% when the air passes on the back of the cell and the cell temperature drops by 10% when the air passes on the front of the cell. The rate of increase in cell efficiency is 3.7 %.

Fig. 3: illustration of the pv cell cooling system by using forced air [27]

G. Ömero [32] study the effectiveness, order and the number of the fins that installed on the base of photovoltaic cells was verified and verify their effect on the process of making turbulent air which transmits heat from the PV cell base. Fins are manufactured from cheap and easy-made materials. The air was pushed through two 10 watts of fans. The result of the CFD program showed that increasing the number of fins leads to a significant increase in thermal efficiency and a slight increase in electrical efficiency.

Air cooling technology has been developed by use heat sink technique as well as thermal units (TE) as shown in fig(4) [33]. Where the heat generated on the surface of the photovoltaic cell generated by the photons containing the largest amount of energy is withdrawn and absorbed through the use of the electro thermal unit (TE). The thermal unit is inserted on the back panel of the PV cell and equipped with resistors, one on the top of the unit and the other surrounding the unit. These resistors installed in the ocean and the highest thermal-electrical unit on the back of the photovoltaic cell has a different by the increasing temperatures that result when the photovoltaic cell receives the solar radiation. The difference in the temperature of the resistors at the top and the perimeter of the thermo electric unit because of the diffusion property within the unit material. The waste heat of the photovoltaic cell is put away in a battery in the wake of being released by the resistors Along these lines, the photovoltaic cell is cooled by warmth dispersal from the cell surface by means of a heat sink[34].

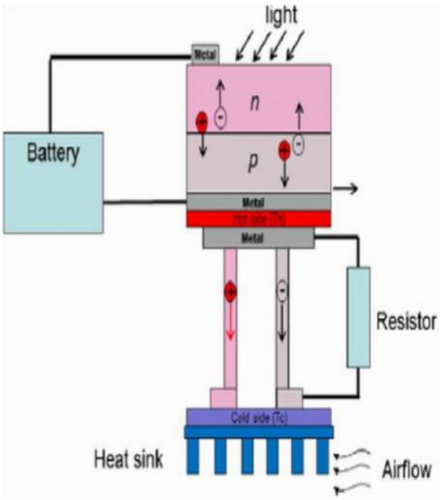

Fig. 4: illustration of the cooling technique by using a heat sink [33]

Studies That Relate To Use Of Water as Work Fluid in Cooling

Water is characterized by high capacity and good heat transfer coefficient. The water cooling technology is characterized by the high efficiency of cooling technology, which improves the conversion efficiency of the photovoltaic cell. It is possible to take advantage of the hot water resulting from the cooling process can use in many applications, but the disadvantages of this technology high cost to made the general system and the possibility of freezing coolant and consume high electrical energy from the pump and the possibility of damage and leakage in the system and other defects. The technique of water cooling has developed in many ways and it is possible to summarize some the types of this technique cooling through forced water. The Spray water cooling technology uses a centrifugal pump for pumping the water by the nozzles spraying from the tank through the towing tube. The suction pipe consists of a non-return valve and a filter to avoid absorption of large particles and protection of the centrifugal pump After transferring the water filter to the spray nozzles to reduce the temperature of the photovoltaic cell by spraying the water with a spray on the cell and this method is efficient as it reduces the proportion of water use and the Electrical efficiency increases as a result of spraying water on the surface of the photovoltaic cell, which reduces the temperature of the cell [35]. There are many studies and researchers who have discussed the cooling of photovoltaic cells by using water spraying technology.

M.Abdolzadeh and et al [36] study, the ability to improve the performance of the photovoltaic pumping system was investigated. This is done by spraying water over photovoltaic cells. Results are compared with conventional systems. The experimental results show that cell energy is increased by spraying water on photovoltaic cells. This is can greatly increase system efficiency, subsystem and pump flow rate at operation under different heads. Indicated that the water spray improves the optical system performance Loss of efficiency due to the high temperature of photovoltaic arrays can be reduced by removing the heat from the front surface in the water spray across cells that absorb heat generated from cells during the day.

This study is using 225W of the water pumping system with water spray on Mahan recognized *R. Hosseini And et al* [37] used the water to cool the photovoltaic cell by using water spray technology and the effectiveness of this technique was studied instead of using water continuously Above PV. Results from 8 am to 5 pm in the summer showed an increase in the electrical efficiency of the cell by 17% without taking the force of the pump. After the procedure Reset for water pump system for continuous production water flow on the PV surface. The results showed a 26% increase in electrical productivity.

K.A. Moharram and et al [38] used the water to cool PV cells by spraying water. The purpose of this paper is to reduce the amount of water used in the PV cell cooling plant. The cooling model was developed based on water spray for the photovoltaic cell. The cooling process is completed when it reaches a temperature of 35 °C. The result obtained from this research is that the highest power can be obtained from the photovoltaic cell if cooling begins at 45 °C where he managed to calculate the maximum. The temperature allowed by the PV panel (45 °C) by which cooling by spraying should begin to improve overall power output. Note that the system needs at least X minutes to complete the cooling procedure as shown in fig (5).

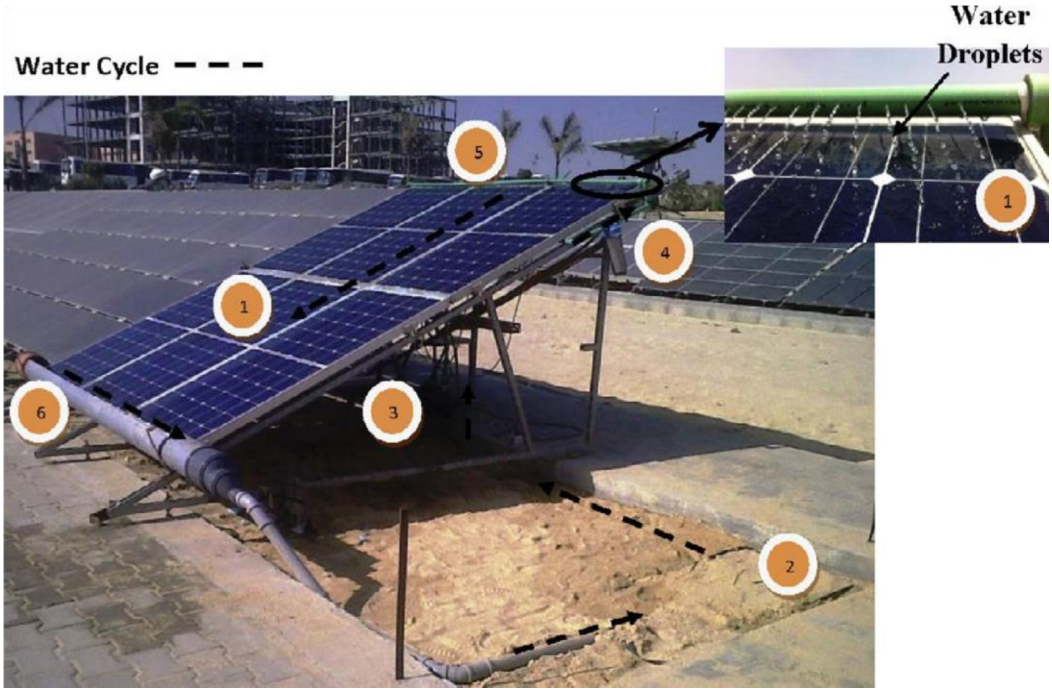

Fig.5: illustration of the PV cooling system by using the water [38]

Experimental Setup

1) PV module,
2) Tank,
3) Pump,
4) Filter,
5) Nozzle and
6) 6) Drainpipe.

M. Salih and et al [39] presents an experimental method of water spray technology to improve the efficiency of the photovoltaic (PV) Enhanced net energy saving. To improve the electrical efficiency of solar energy Panels work in non-ideal conditions, active water. The cooling system was built on the top of the PV spray group (Pump) cool water in front of the painting surface, to pull Away from the heat, keep the plate cool and keep the plate inside specific temperatures. The technique of forced water spraying and cooling with a constant water flow rate on the PV array the surface is designed and implemented. The rate of decrease in temperature of the plate surface is directly proportional with PV efficiency. At the same time, hot water produced is very useful for homes, buildings, etc., such as a water heating system, specifically in remote areas. The electrical performance of the PV group was studied. The cooling rate of plate surface5minutes = 4 in the middle of the day. The electrical performance of the PV classes was also studied. As a final point, the economic results were the result is achieved by increasing the power supply 7w / degree in the middle of the day.

S. G. Grubisić-Čabo and et al [40]used spray water technique to cool the PV panel, where the sides of the photoelectric panel were cooled simultaneously The experimental results showed that is possible to achieve a total increase of 16.3% (effective 7.7%) in electricity production and an overall increase of %1..1 (effective 5.9%) in the electrical efficiency of the PV panel using the cooling spray water spray in the conditions of the peak of solar irradiation The plate temperature of the average of 54 °C (unpowered PV panel) was reached to 24 ° C in this case simultaneously. In this technique, the back side or the front surface of the PV cell is cooled by pouring water directly on it. It maintains a low temperature and is also used to clean the photovoltaic cell.

O. Abdellatif [41] used three cooling system: film water cooling, direct contact back water cooling and combining film - back cooling are view and analyze using an infrared camera used to obtain the surface temperature distribution of the module and experimental measurements of the three cooling experiments indicate that the temperature of the photovoltaic unit is lower until 16, 18, 25° c for film cooling unit, direct contact back water cooling and combining film-back cooling, respectively compared to the noncooling module causes an increase in module output power and photovoltaic efficiency. The results showed that photovoltaic efficiency increased to 22%, 29.8% and 35% for film cooling, back cooling and combining the film-back cooling unit, respectively, compared to the non-cooled unit.

L. Dorobanțu and M. O. Popescu [42] increase the efficiency of PV cell by using a device that makes a water film that is placed on the surface of the photovoltaic cell where the temperature is reduced and the photovoltaic cell is added at one time which increases the conversion efficiency. The thermal camera is used to monitor the temperature throughout the operating period of the cell with the water film placed on the surface and another cell without the water film. This method achieved an increase in electric output by about 9.5% by cooling the PV front surface using a thin film from the water. The advantages of cooling using this method are that the photovoltaic temperature gradually decreases with increased electrical efficiency and reduces reflection loss.

S. A. Abdulgafar and et al [43] increasing the efficiency of the photovoltaic cell by immersing it in distilled water and studying the effect of different depths. The results showed that increased efficiency with increasing water depth had an effect and the appropriate depth was determined where an increase of 11% was obtained from the plating efficiency at a depth of 6cm. The efficiency was then reduced due to the electrolytic reaction on the electrodes or photovoltaic connections under the depth more than 6cm.

A. A. Hachicha and et al [44] investigated the effect of different types of water cooling techniques on the performance of the photovoltaic cell in the United Arab Emirates and The effect of the high-temperature of photovoltaic cells on The voltage and efficiency of photovoltaic cells. In this work Water cooling has been developed to enhance PV performance Modules where using different water cooling techniques: front, rear and double cooling. The spray technology is used for front cooling and direct contact water technology is used for rear cooling the results were compared with a non-cooling cell to determine the performance of the

PV cell in different water cooling techniques and to find the best ones. The result is the front type is More effective than the rear cooling where can reduce the temperature of the PV module is larger.

J. F. Musthafa [45] use the water through a sponge installed on the back side of the photovoltaic panels. The wet state is maintained by rotating the water droplets through the sponge to reduce the temperature of the solar cells in order to increase the efficiency of the electrical transformation and confirmed through the study a linear relationship between efficiency and temperature. Where it reached through the search to a temperature low by 40 degrees Celsius, during which the efficiency of solar cells increased by 12%.

Z. Syafiqah and et al [46] using air and water at the same time to COLL the PV cell where the air passes through a channel installed at the back of the photovoltaic cell and water is made in front of the cell. The results were analyzed through the ANSYS simulation program. The results showed a decrease in air cooling temperature of 19% and 53.2% by cooling water where the temperature of the cell without cooling (66.3 ° C).

Studies That Relate To the Use of Phase-Changing Materials and Other Techniques

The latest studies for PV coolers present development of PV cell cooling techniques, so it is necessary to discover the aspects that have not been focused on most papers and researchers, as well as the impact of each technique to reach the best results that contribute to the development of photovoltaic cells and a review of the possibility of cooling with the phase-changing technology (PCM) and in its ability to reduce the temperature of the photovoltaic cell as shown in fig (6).

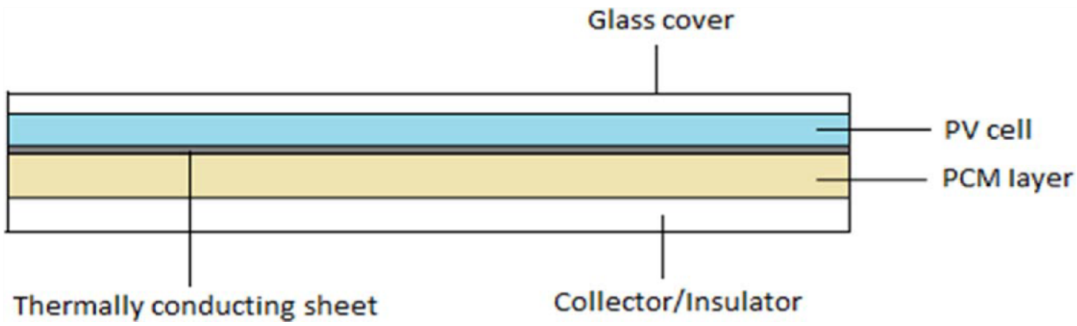

Fig. 6: integration of the PCM layer on the backside of the PV module for cooling [23]

Research on photovoltaic cooling techniques shows that when using phase - change materials (PCM) with other cooling technologies, the temperature of the cell decreases and thus reduces the cost of PV production projects and increases their performance[47] Research on cooling technology with change phase (PCM) materials is low, but we will focus on the most important thing that enriches the subject with information and these researches were carried out in practice, and the other through simulations by a numerical program.

This technology is able to keep the temperature of the cell low at a certain point for a long period of time from 25–30 °C and does not increase the temperature even after a long period of time and also reduce the consumption of electricity and does not need to maintenance and modification and work silently without noise and can used The thermal energy that is stored within the material phase of the change as these materials maintain the thermal energy for a longer period However, the disadvantage of this technique is the initial cost of processing materials change phase is very high and is characterized by a lack of stability over time and it has low thermal conductivity where difficult to discharge and dispersion thermal energy [48].

P. H. Biwole and et al [49] study and simulation to analysis Navier-Stokes equations by modify buoyancy term to be zero when PCM solid by adding term force at velocity with boundary condition transit convection and conduction at same time where the solve by finite element program at fixed grid .the objective from this study to maintain the temperature of the photovoltaic cell close to the ocean where a non-pure phase change material SP/PCM was added to the base of the cell in the back of the cell. The results showed that the presence of this change-phase material SP/PCM was able at solar radiation to keep the cell temperature under 40 °C for 80 minutes.

M. C. Browne and et al [50] enhance the performance of a photovoltaic cell by used phase-change material and its comparison with another, without PCM. the PCM type Capric-palmitic acid with the point of melting is 22.4 ° C and The heat stored in the variable phase material, which is absorbed from the photovoltaic cell, is used to heat the water through pipes passing through the variable phase material Results showed that cell performance with the change phase, material (PCM) has doubled for two times than the cell without (PCM) and the utilization of waste heat for the base of the cell is available significantly to heat the water more than twice compared to the cell without the substance.

L. Tan [51] improving the performance of the photoelectric cell by reducing the temperature of the cell cooling technology by use phase-change materials (PCM) type RT27 material and melt at 27 ° C and the thermal capacity of 184 kJ / kg.Where the results showed a decrease in cell temperature by five degrees compared to a cell without the PCM, which led to an increase in electrical efficiency by 1% can increase this efficiency by increasing the amount of material.

M. Khaled and et al [52] used Petroleum jelly as a phase change material PCM to cool the photovoltaic cell where the Petroleum jelly PCM absorb the heat from the cell base to cool the cell and compare it with cell without Petroleum jelly PCM. the result shown is by using the pure PCM can decrease the temperature of PV 6.5 °C with an average of 2.7 °C and then increase the electrical efficiency by an average of 5 % and by using the combined PCM can decrease temperature of PV 6.3 °C with an average of 5.6 °C and then increase the electrical efficiency by an average of 10%. And it is a modern technology that is in use and research is the use of nanotechnology to cool photovoltaic cells.

A. Younis and et al [53] used nanotechnology to cool the photovoltaic cell by a dynamic test and analysis of several different nanotubes was carried out to confirm their effect on improving heat transfer from the base of the cell and reducing the temperature by practical methods and simulation. The fluid used in the tested is water, and Al2O3-ZnO-H2 is mixed with Nan fluid Ethylene glycol as shown in fig (7) The ratio of nanoparticles was 0.05% by weight Al2O3 With particle size of 5nm The ZNO 0.05 has a wavy ratio and particle size of 10-30 nm the results showed that compared to water As the absorption medium and Nanofluid mentioned, the thermal efficiency increase and the overall efficiency of the system Was recorded for the final absorption scenario, although the concentrations of nanoparticles were considered Is relatively low and there is an increase in ambient temperature and for 0.05% by weight of the molecular mass of nanoparticles, the average increase in total efficiency was 4.1% Energy efficiency was 4.6%

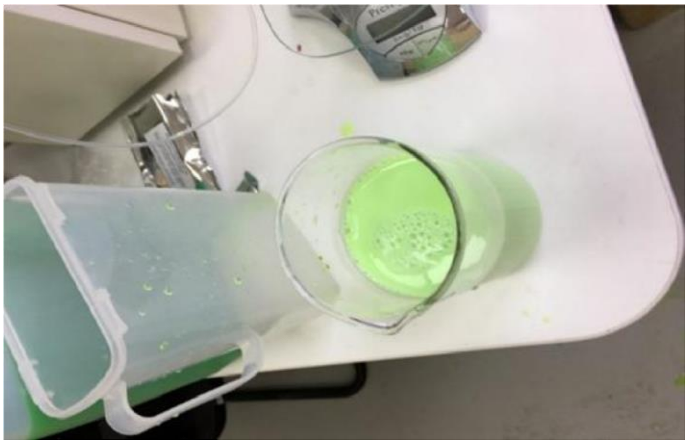

Fig.7: illustration of nanofluid with some distilled water droplets 2o3-zno using nanyl glycol nanofluid

Discussion

A comprehensive review of cooling techniques was conducted, depending on the type of material used to reduce the temperature. It is therefore very important to describe and clarify the results reached. The advantages and disadvantages of each method were discussed in detail in the previous sections of each technique. For the purpose benefit the researchers in the future who work in the field of cooling the photovoltaic cells in proportion to the procedure, that wants to do and lead to reduce the temperature of the cell and increase the efficiency of electricity. We recommend that it is best to invest heat generated by the cooling process in simple household applications.

Cooling by used air strategies, including compelled air stream, are astoundingly suitable especially for good climatic conditions and The heat sink advancement is incredible and gainful yet the furious air makes the heat sink temperamental. Regardless, waste heat can be used to grow the electrical proficiency of the cell.

The utilization of water by methods for cell cooling systems in all courses by constrained water stream and flooding of the cell with water, showering, and so on to a critical increment in electrical proficiency because of the adequacy of water temperature decrease, yet it needs to alter the stream rate as per the temperature change and the association needs nonstop upkeep.

The utilization of phase change materials in photovoltaic cell cooling can lessen cell temperature and increment the effectiveness of the cell due to the high assimilation properties of these materials and it is can save the warmth created by the cooling procedure to use it by several applications. Nonetheless, there are various troubles referenced by this paper have diminished the utilization of this strategy, including that these substances won't give great outcomes in high-temperature climate and high cool conditions.

Conclusion

In this paper, an accurate literature review of the different cooling techniques used in the cooling of photovoltaic cells was carried out. The use of images, tables, comparisons and mathematical equations was based on recent literature reviews and scientific research in the field of cell cooling. The successful and preferred cooling technology, which increases the efficiency of the cell (electric and thermal) at the lowest cost and low consumption of energy and the fastest reduction of the temperature of the cell where the results of cooling for the long life of the cell and prevent cell destruction and make the cell perform the most efficient. Below is a summary of the different refrigeration techniques that are usually used in photovoltaic cell cooling where they have been extracted by reviewing a variety of modern research and sources related to photovoltaic cooling. The easiest and available method that does not require constant maintenance and does not damage parts of the system those use the air in the cooling of photovoltaic cells.

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