International Journal of Future Generation Communication and Networking
Vol. 13, No. 4, (2020), pp. 4324–4329

Review on Solar Photovoltaic Thermal Power System

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ABSTRACT

For the sustainable development of any country, electricity is the basic need for current civilization. Without hampering the environment, generation of electricity is very essential. Solar energy is completely natural, it is considered as clean energy source. Solar energy is one of the most promising renewable sources of energy for the present needs. Solar Photovoltaic Thermal (PVT) system is a hybrid system used to produce both thermal and electrical energy. Moreover PVT collector does not cause any pollution during its operation and does not have any moving parts in it. This helps increasing the reliability and durability of the equipment. In this paper, we have studied the different types of solar hybrid photovoltaic thermal collectors with different cooling channel cross sections were analyzed to study the effect of air and water cooling on the performance of solar hybrid photovoltaic thermal system.

KEYWORDS: S*olar Energy, Solar Photovoltaic Thermal (PVT) System, Cooling System, Solar Hybrid Photovoltaic Thermal System.*

1. INTRODUCTION

The access to electricity determines the living standard of humans. One must realize that around 1.2 billion out of the 7 billion people worldwide still do not have access to the electricity grid the electricity worldwide is mainly generated from all coal, gas, nuclear and hydro power [1]. The more advance in the use of solar energy, the brighter our future can be. Earth receives large amounts of energy directly from the sun. With the help of technology it can be utilized efficiently. It can be converted into other useful forms of energy. For example we can convert solar energy into electrical energy and then we can convert electrical energy and to heat energy, kinetic energy, potential energy, etc. Solar energy reaches the earth as light travels in the form of waves. One meter square area of the atmosphere receives 1.4 kilowatt energy which is also known as a solar constant. It means the solar energy absorption of our atmosphere is one point four kilowatt per meter square.

We can convert solar energy into electrical energy through the use of semiconductor devices like silicon and these are called as solar cells. They are also called as photo voltaic (PV) cells made up of silicon electrons. The silicon gained energy from the sunlight to create the voltage. Each solar cell produces a very small amount of voltage. The high voltages can be derived from a large number of such solar cells are connected in series forming a solar panel.

The applications of solar energy can be used power satellites having large solar panels which are keep facing the Sun. Solar watches and solar calculators are also in use nowadays solar energy is used in industrial zones for power generations. Nowadays, different developed countries have introduced cars that are completely running on solar energy. The solar energy is renewable energy which we can use again and again solar energy is environment-friendly source of energy. It means solar energy doesn't pollute our environment because it doesn't produce pollutant gas like carbon dioxide, sulphur dioxide, etc. Finally, solar energy is the energy of the Sun which we can use in different ways for long period of time without environmental hazards. That is why developed countries like China have invested billion dollars in renewable sources of energy.

Solar energy is a renewable energy that will not cause any pollution in the environment. It is an energy extracted from the sun using solar power plants. Sun is the richest source of light energy and never has any scarcity. Approximately the energy delivered by the sun on the earth is more than sufficient to the energy requirement of the world for a year. Lack of sufficient electricity is always an immense problem in any developing country. So it is an efficient practice to store this energy instead of deriving it from non-renewable energy sources oil, gas, coal, etc. Shortage of electricity can be

ISSN: 2233-7857 IJFGCN

considered as the major problem in the developing and undeveloped countries. The utilization of energy from non-renewable energy resources will be expensive and exhaustive as they are limited in the nature. The efficient solution to this problem can be achieved by switching to the generation of energy from sunlight. Solar energy is always an effective option to generate the electricity due to its in-exhaustive and eco-friendly nature. Several countries have already adopted this technology to replace the crude oil in many industries. It is mainly due to the high cost of crude oil and its disastrous impact on environment. In the solar type of renewable energy, we use the photovoltaic (PV) cells as the primary and essential elements to efficiently convert the sunlight into electrical current, without any other form of mechanical or thermal interlink.

One key point which makes renewable energy systems attractive is low transmission losses because these are distributed in nature however the other losses present in these systems make them less efficient so it is important to minimize these losses in order to improve performance .Irradiation is the boosting parameter for the performance of solar photovoltaic systems while temperature is a buck parameter i.e. efficiency of solar cell drops with increase in module temperature. Many researchers have contributed in this area and developed the relatationship for temperature dependent electrical efficiency and concluded that 5% to 15 % thermal losses present in solar photovoltaic systems, which degrades the performance of the system. These losses can be minimized or utilized by converting them in another form of energy.

In current scenario, the PV systems of large ratings are installed but due to these high temperature losses, the size of PV system is over estimated hence long payback period is observed. Researchers continued their focus in this area and found that cooling behind the module brings down module temperature; good efficiency can be achieved even in low irradiance regions. Another side hot air if collected can be utilized for drying purpose i.e. Same module generates electrical and thermal energy. Thus cooling boost the performance by decreasing the module temperature, hence improves efficiency and performance by decreasing thermal losses.

2. OBJECTIVES OF THE RESEARCH

Energy is significant not only for the financial development of the nation yet additionally to fulfill the increased need because of the populace growth. The urban development is one of the major factors for increased usage of energy in any society. Renewable energies will be principle substitute for non-renewable energy sources in the confessing all quality. Energy emergency and CO2 contaminations are the significant danger confronting the humanity today. Photovoltaic Thermal Systems (PVT) can have a job on the above emergency. PVT systems in private applications can add to the decrease of energy utilization for warming cooling and a similar time limiting the absolute surface region of the framework. It takes a shot at quiet condition and don't create any undesirable waste like radioactive materials. Low upkeep cost with life length of 20-30 years is the appealing highlights for the house-hold applications.

Objective of this research is to conduct experimental or analytical work on the developed PV/T model. By the completion of this objective, a study will be done by collecting data during the experimentation to determine the different energy efficiency output of the device.

3. LITERATURE REVIEW

Due to interest of electrical power is expanding step by step because of urbanization, development of populace and industrialization, etc. The Non-conventional sources of energy are being used all over the world because of its variety of advantages. These advantages contain sustainability,ascend in financial development, work openings, escalate human government assistance just as commitment towards atmosphere safe future and so on [2]. The utilization of fossil fuels brings about the discharge of ozone harming substances that builds the unnatural weather change, jeopardizing future humanity. The asset available non-conventional sources are Wind energy, solar energy, and hybrid system of solar, Wind, Hydro, and Fuel Cells so on. Although in the available sources (wind, solar,

ISSN: 2233-7857 IJFGCN

hydro) the solar power is a contamination without any cost, encouraging & solid pollution free source of energy to fulfill the developing energy need [3]. It has additionally less impact on green house. By using solar photovoltaic cell light energy form the sun can be converted in to electricity. In solar photovoltaic system with the help of photovoltaic impact daylight changes into electrical energy. Whenlight is falls on Photovoltaic cell then photon energy is converted in to the flow of charge. These charges break intopositive (hole) & negative charge (electrons)because of electric field effect across the junction. As a result of this a current is start flowing in the circuit when a load is connected.

Michaelo et al [4] developed a technique to improve solar panel life span. The authors mentioned that the overheating of solar panel can form electric arcs which melts the metal fixtures and burns away its insulating materials. Michaelo used the hollow fibre(hallow tubes of 1mm diameter attached behind solar PV panel) cooling system. But in these results were observed at temperature of 50°C. It is too high ie 38°C is STC(Standard Testing Temperature). Xiao Tang et al [5] developed a novelty in their work to cool solar panels using micro heat pipe array. The air-cooling and water-cooling methods under nature convection condition were discussed in this paper. But they conclude that water cooling is the best technique to improve Solar PV panel efficiency [6].

Sandeep Koundinya et al [7] proposed a technique to improve the efficiency of PV panel. They have discussed that reflections from the top surface and the absorption of heat from the other parts of panel can reduce its efficiency. Also they have attempted to lessen the panel's temperature by cooling it with finned heat pipe. Computational Fluid Dynamics methods were adopted to design the solar panel model and its finned heat pipe assembly. This method decreases the temperature by a maximum of 20K. Assembling of finned heat pipe is a complicated one. B.Koteswararao et al [8] experimented a work to improve efficiency of solar system. Although we have the large amount of solar energy but we coudn't use it adequately because of its temperature variations in every while. In their research they found that the constant power was generated with the help of cooling. Also they have compared different cooling methods for solar panel. The water cooling method uses the cross and parallel flows of water. When the panels are overheated then the thermal sensors will automatically switches on the motor to start the water cooling process. Then the parameters like efficiency and Fill Factor were calculated. Finally they have concluded that cooling system is compulsory one to improve PV panel efficiency.

PV systems are different and are used for special applications. Equipment is connected to other sources of electricity and electric charges. The network connected system, stand- alone system and integrated solar systems, together with the grid and stand- alone are the three primary classifications [20].

Electricity emerges from sunlight hits in the PV cells, and the photon is dislodged from cell atoms by the absorbed sunlight. The free electrons enter the cell in order to produce electricity [9].

In fact, the most energy entering the cell as the light is lost before it becomes electricity. Remember that the solar cells average electrical output converts at 30% , however the normal efficiency is 10% to 15% . That's why most of the cell research is aimed at increasing efficiency while at the same time reducing costs . The output of certain cells, restricted to physical processes , is inherent and can not be modified , while others can be improved by an acceptable design [10].

Solar Thermal Systems (STS) absorb incoming solar radiation ,transform solar energy into heat, and transfer the heat into a form of water used, including liquid or gases flowing through the collectors. STS system is a technology that converts solar power into hot energy [11].

The collector designed to heat the flow of liquid through the tubes absorb solar energy. The heated fluid transfers thermal energy from solar collector into the fluid supplied in the storage tank that, when necessary , feeds primary water heating system. If a boiler is powered by solar-heated water, it is either not activated or triggered less time by the fossil-fuel water heating system [12]. Solar thermal technologies (STT) are used for main heat- requiring applications such as swimming pools,

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household hot water, space heating, etc. A collector which can be not cantered or concentrated is the part used for converting solar energy to warming. Its working conditions frequently ranges from 60°C to 80°C with a converting -efficiency of approximately 40% to 60 % ,which can be achieved using flat-plate domestic collectors. In countries with a solar radiation of approximately 1.800KWh/(m^2 ,a), and a low- or high – temperature solar energy converted for domestic use, solar system is extremely advantageous [19].

According to [19], a non-concentrating collector makes full use of global radiation , while concentrating collectors only use the radiations direct beam by focusing on the absorbed, thus enhancing the intensity of energy.

The hybrid photovoltaic and thermal systems (PVT) are known as thermal and photovoltaic combination. The two technologies combined because photovoltaic cell efficiency decreases while the unit's temperature increases. The addition of the thermal collector on the back side of panel therefore allows the heat to be extracted from the PV cell by means of a circulating liquid in the pipe for improved cell efficiency. If heating is required for a boiler, it can also help increase efficiency by using the extracted PV power [19].

There are several alternatives to integrated PVT that include; air water or evaporative collectors. Several studies on PV/T technologies have been conducted over the last few years with increased activity rates, and Chow [15], [19] carried out analysis on the efficiency of the PV/T water collector. A PV cells not only produce electricity but also act as a thermal amortizer in a PV/T collector or device. This explains the fact that PV/T systems simultaneously produce heat and power [14]. In addition , the main objective of a hybrid PV/T panel application is to generate electricity. Possibility of increasing the efficiency of electricity is rising if the cell works at a low temperature [16].

The tilt angle encompasses a major impact on the incident of solar radiation on the surface and is defined as the angle in between the solar plane and also the horizontal plane. The utmost power may be obtained if the angle of tilt is equal to the latitude of the position for a set angle. The tilt angle of a PV varies due to the factors like geographical latitude, temperature, time use, etc. The performance of the PV module was full of these factors [17], [18].

4. FUTURE SCOPE

Energy crisis is a problem faced by both developed and developing nations. Solar energy plays a crucial role in this scenario. The use of a PVT collector in residential places has the advantages like reduction in energy consumption and to provide the electrical and thermal energy in household places. These are very useful in the smart city development.

Extracting thermal energy from the PV module not only improves its electrical performance but also increases its overall efficiency and thereby improves its efficacy. This type of system can be installed at remote areas for generating electrical energy, with hot air that can be used for closed door air drying purposes.

The possible areas where the current work can be extended to continue the present research work in the future are listed below.

- The effect of heat pipe based cooling system can be further analysed.
- The influence of nano fluids can also be investigated.
- Cooling the PV panels by using thermoelectric cooling system (TEC) with pettier module can be used to further improve in the performance of the system.
- The utilization of bi-fluids can create the more thermal applications such as hot or cold air or water based applications.
- EGM can be applied in PVT collector by using CFD software.

5. CONCLUSION

ISSN: 2233-7857 IJFGCN

In this study we have briefly explianed the trends design and advancements of Photovoltaic Thermal systems. The various features can be interfaced with the PVT system like cooling mechanism, use of concentrators and heat transfer enhancing materials. As the various components are connected to this system, further investigations are necessary to study the impacts of weather, solar irradiance and temperature. In Photovoltaic Thermal system, the Photovoltaic cells and solar thermal collectors are used in the same space to make the system good for household applications; as area is the limitation in these places. Cooling of Photovoltaic module needs an enhanced heat transfer mechanism that can be done by increasing area of contact between PV and absorber, usage of highly thermal conductive material and optimum mass flow rate.

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