Vandana Publications
IJEMR

Volume-8, Issue-1 February 2018
International Journal of Engineering and Management Research
Page Number: 20-24

# Study of Solar System with Possible Modification to Increase the Efficiency of PV Panel

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**ABSTRACT**

**The present research paper work has been undertaken to study the feasibility, stability and commercial analysis of storing solar energy and using fins for reducing the PV Panel temperature as much as possible to increase the power generation and efficiency. PV cells convert a certain wavelength of the incoming irradiation that contributes to the direct conversion of light into electricity, while the rest is dissipated as heat. Only 15-20% of incident solar energy is converted into electricity. The remaining part of the solar energy is converted into heat, which causes heating of the solar cell in PV panels. The surface of the PV panels can be heated up to 40 °C above ambient temperature. Increasing the temperature of the solar cell causes drop of the electrical efficiency of a photovoltaic panel, Conversation efficiency of PV panel decreased by 0.4% to 0.65% for every increased degree of PV cells temperature.**

***Keywords*—** Solar energy, Heat-transfer, photovoltaic, fins, efficiency

## I. INTRODUCTION

Cooling of photovoltaic cells is one of the main concerns when designing concentrating photovoltaic systems. Cells may experience both short-term (efficiency loss) and long-term (irreversible damage) degradation due to excess temperatures. Design considerations for cooling systems include low and uniform cell temperatures, system reliability, sufficient capacity for dealing with 'worst case scenarios', and minimal power consumption by the system. Solar cell performance decreases with increasing temperature, fundamentally owing to increased internal carrier recombination rates, caused by increased carrier concentrations. The operating temperature plays a key role in the photovoltaic conversion process. Both the electrical efficiency and the power output of a photovoltaic (PV) module depend linearly on the operating temperature. The various correlations proposed in the literature represent simplified working equations which can be apply to PV modules or PV arrays mounted on free-standing frames, PV-Thermal collectors, and building integrated photovoltaic arrays, respectively. The electrical performance is primarily influenced by the material of PV used.

A brief discussion is presented regarding the operating temperature of one-sun commercial grade silicon- based solar cells/modules and its effect upon the electrical performance of photovoltaic installations. Generally, the performance ratio decreases with latitude because of temperature. However, regions with high altitude have higher performance ratios due to low temperature, like, southern Andes, Himalaya region, and Antarctica. PV modules with less sensitivity to temperature are preferable for the high temperature regions and more responsive to temperature will be more effective in the low temperature regions. The geographical distribution of photovoltaic energy potential considering the effect of irradiation and ambient temperature on PV system performance is considered. The response of the photovoltaic (PV) panel temperature is dynamic with respect to the changes in the incoming solar radiation. During periods of rapidly changing conditions, a steady state model of the operating temperature cannot be justified because the response time of the PV panel temperature becomes significant due to its large thermal mass. Therefore, it is of interest to determine the thermal response time of the PV panel. Previous attempts to determine the thermal response time have used indoor measurements, controlling the wind flow over the surface of the panel with fans or conducting the experiments in darkness to avoid radiative heat loss effects. In real operating conditions, the effective PV panel temperature is subjected to randomly varying ambient temperature and fluctuating wind speeds and directions; parameters that are not replicated in controlled, indoor experiments. A new thermal model is proposed that incorporates atmospheric conditions; effects of PV panel material composition and mounting structure, Effect of temperature on the power drop in crystalline silicon solar cells. The influence of temperature and wavelength on electrical parameters of crystalline silicon solar cell and a solar module are presented. At the experimental stand a thick copper plate protected the solar cell from overheating, the plate working as a radiation heat sink, or also as the cell temperature stabilizer during heating it up to 80°C. A decrease of the output power (−0.65%/K), of the fill-factor (−0.2%/K) and of the conversion efficiency (−0.08%/K) of the PV module with the temperature increase has been observe

The electrical efficiency of a photovoltaic system drops as its operating temperature rises and PV cooling is necessary. . In the present work, air cooling of a commercial PV module configured as PV/T air solar collector by natural flow is presented, where two low cost modification techniques to enhance heat transfer to air stream in the air channel are studied. The considered methods consist of thin metal sheet suspended at the middle or fins attached to the back wall of the air-channel to improve heat extraction from the module. Fin's attached to the back wall of the air-channel to improve heat extraction from the module. A numerical model was developed and validated against the experimental data obtained from outdoor test campaigns for both glazed and unglazed PV/T prototype models studied. The validation results show good agreement between predicted values and measured data and thus could be used to study analytically the performance of these PV/T air collectors with respect to several design and operating parameters. The modified systems present better performance than the usual type and will contribute to better performance of integrated PV systems for natural ventilation applications in buildings, both space cooling and heating..

## II. REVIEW OF HYBRID PVT SYSTEM WITH FINS COMPARATIVE STUDY

Heat transfer by convection between a surface and the fluid surrounding can be increased by attaching to the surface thin metallic strips called Fins. The heat conducting through solids, walls or boundaries has to be continuously dissipated to the surrounding or environment to maintain the system in a steady state condition. In many engineering applications large quantities of heat need to be dissipated from small area. The fins increase the effective area of the surface there by increasing the heat transfer by convection. The fin is generally used when the convection heat transfer coefficient is low, especially under free convection. In the field of industry the fin is used widely, for instance, in cooling of electronic accessories, motorcycle engine and in air cooling of molecules with in a material.

***Types of fins***

1) Rectangular fin 2) Triangular fin 3) Cylindrical fin 4) Trapezoidal fin 5) parabolic fin

TABLE I
Properties of Aluminum

| S. No. | Property | Value |
|---|---|---|
| 1 | Atomic Number | 13 |
| 2 | Atomic Weight (g/mol) | 26.98 |
| 3 | Valency | 3 |
| 4 | Crystal Structure | FCC |
| 5 | Melting Point (°C) | 660.2 |
| 6 | Boiling Point (°C) | 2480 |
| 7 | Mean Specific Heat (0-100°C) (cal/g.°C) | 0.219 |
| 8 | Thermal Conductivity (0-100°C) (cal/cms. °C) | 0.57 |
| 9 | Co-Efficient of Linear Expansion (0-100°C) (x10-6/°C) | 23.5 |
| 10 | Electrical Resistivity at 20°C (Ω.cm) | 2.69 |
| 11 | Density (g/cm3) | 2.6898 |
| 12 | Modulus of Elasticity (GPa) | 68.3 |
| 13 | Poisson Ratio | 0.34 |

The performance of an extruded finned plate air heating solar collector is studied theoretically. Outlet air temperature and pressure drop are considered as controlling parameters to find optimum number of fins, fin height and fin thickness. Outlet air temperature increases and then decreases with number of fins whereas pressure drop increases with number of fins. The air heating solar collector with rectangular fins attached is studied theoretically for various controlling parameters such as numbers of fins, H/D ratios and fin thicknesses to use it. Outlet air temperature first increases and then decreases with number of fins. Pressure drop also increases with number of fins and fin height. The thermal performance of a single pass solar air heater with five fins attached was investigated experimentally. Longitudinal fins were used inferior the absorber plate to increase the heat exchange and render the flow fluid in the channel uniform. The effect of mass flow rate of air on the outlet temperature, the heat transfer in the thickness of the solar collector, and the thermal efficiency were studied. Experiments were performed for two air mass flow rates of 0.012 and 0.016 kg s_1. Moreover, the maximum efficiency values obtained for the 0.012 and 0.016 kg s_1 with and without fins were 40.02%, 51.50% and 34.92%, 43.94%, respectively. A comparison of the results of the mass flow rates by solar collector with and without fins shows a substantial enhancement in the thermal efficiency. Longitudinal fins for an absorber plate have to be created to in order to increase; heat exchange surface, outlet temperature, and thermal efficiency. Increases in the mass flow rates affect the temperature of the bottom plate and the temperature of an absorber plate by rates between 4 and 6 0C, for the solar air collector without using fins and with using fins. The efficiency of the type with fins is found to be higher than the type without using fins by rates of 5.1% and 5.83%, respectively; the mass flow rates of 0.012 and 0.016 kg s_1. The maximum thermal efficiency values obtained were 34.4% and 50.33%.

## III. PROBLEM STATEMENT AND GAPS IN RESEARCH

The main problem is overheating of the panel which decreases the performance of system. Our work will continue to make the better idea for integrated technology to build hybrid PVT System which can be easily operate in lower temperature also with good efficiency in both aspects as power output as well as hot water that is thermal energy output. The technical prediction and approach is determined from literature study and research papers, this analysis is mainly proposed for Indian climatic conditions. The main problem is overheating of the panel which decreases the performance of system. Our work will continue to make the better idea for integrated technology to build hybrid PVT System which can be easily operate in lower temperature also with good efficiency in both aspects as power output.

## IV. METHODOLOGY AND PLAN FOR PROPOSED SYSTEM

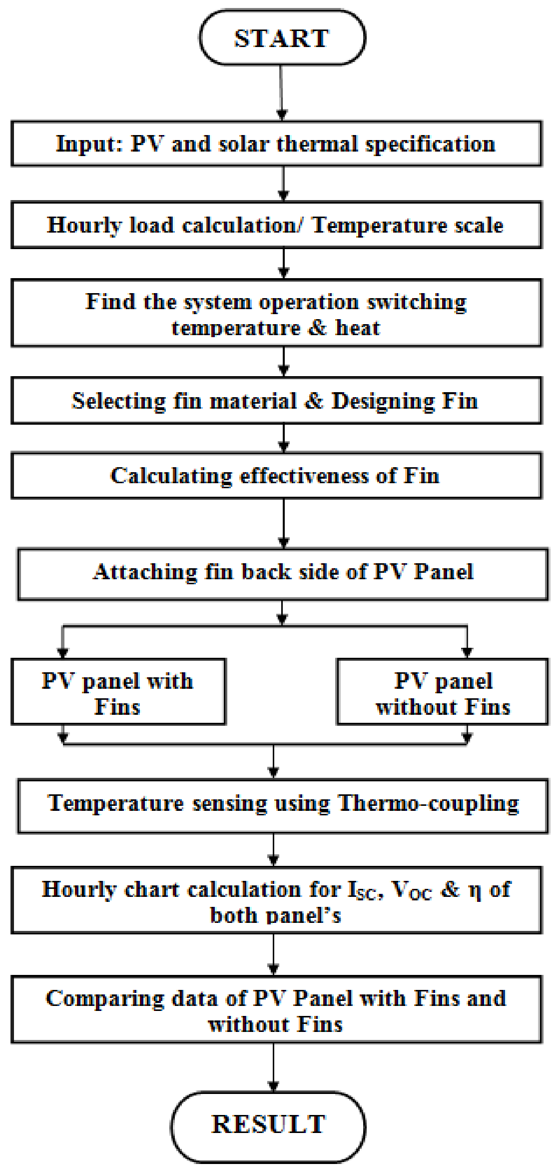


Figure 1: Flow chart for the project operation

In that undertaking research, the majority of the research is through study & literature review, in creating all possibilities and idea to this particular topic. From this, the technology was used to adopt a working design that was investigated to determine if there was merit in the approach or retract to consider different avenues. Once satisfactory information was obtained and a concept established, the next step entailed a hypothetical design that was used to base assumptions and form conclusions. To improve the efficiency of the panel an attempt is made for the improvement of the panel efficiency by reducing the temperature of the panel when the temperature of the panel crosses 60˚C heat transfer is occurred by using fin and the excess amount of heat is exhausted to the ambient through the extended surface from the panel. For making the system efficient fin is cooled through the ambient air, heat gained by the fin from the solar panel is transfer to the ambient

## V. PRIOR APPROACH

The review covers the description of flat plate and concentrating, water and air PV/T collector types, analytical and numerical models, simulation and experimental work and qualitative evaluation of thermal/electrical output. The parameters affecting PV/T performance, such as covered versus uncovered PV/T collectors, optimum mass flow rate, absorber plate parameters (i.e. tube spacing, tube diameter, fin thickness), and absorber to fluid thermal conductance and configuration design types are extensively discussed. Based on an exergy analysis, it was reported that the coverless PV/T collector produces the largest available total (electrical + thermal) exergy. From the literature review, it is clear that PV/T collectors are very promising devices and further work should be carried out aiming at improving their efficiency and reducing their cost, making them more competitive and thus aid towards global expansion and utilization of this environmentally friendly renewable energy device.

## VI. PROPOSED MODEL & APPROACH FOR EFFICIENCY IMPROVEMENT

In present study a model using the solar power cells and panels (poly-crystalline) is proposed. Since solar cells were first developed in 1954, there has been enormous effort put into increasing their efficiency, developing new types of solar cells, and reducing the cost of manufacturing cells. The solar cells start losing their efficiency, when they are subjected to sunlight for long hours, as the temperature of the solar panel increases, there is a reduction in power output. The PV system and solar panels is effective tool for it. We utilize the fins to reduce the excessive heating of solar cells (poly-crystalline) and the analysis is carried out for poly-crystalline panel. This may of optimum utilization of easily available solar energy can bring a revolution in the lives of the people. Polycrystalline silicon, also called poly-silicon, is a material consisting of small silicon crystals. It differs from single-crystal silicon, used for electronics and solar cells, and from amorphous silicon, used for thin film devices and solar cells. Polycrystalline is composed of a smaller crystals or crystallite. Polycrystalline silicon (or semi-crystalline silicon, poly-silicon, Poly-Si, or simply “poly”) is a material consisting of multiple small silicon crystals. Polycrystalline cells can be recognized by a visible grain, a “metal flake effect”. Semiconductor grade (also solar grade) polycrystalline silicon is converted to "single crystal" silicon – meaning that the randomly associated crystallites of silicon in "polycrystalline silicon" are converted to a large "single" crystal. Single crystal silicon is used to manufacture most Si-based microelectronic devices.

***Modification in existing solar panel***

An increase in temperature causes reduction in band gap which in turn, causes some increase in photo-generation rate and thus a marginal increase in current. . Due to this, the cell voltage decreases by approximately 2.2mV per °C rise in operating temperature, depending on the resistivity of the silicon used –higher the silicon resistivity, more marked is the temperature effect. Also, the fill factor decreases slightly with temperature. Hence the efficiency of the solar panel starts decreasing as the temperature increases. There is a need to manufacture solar panel according to the climate condition or certain measures has to be taken for improving the efficiency of the European manufactured solar panels that can also works efficiently in our country.

Measure taken by us is for a 240 watt polycrystalline solar panel. The panel’s back portion is attached with number of extended surface which is also known as fins which takes away the heat generated within the solar panel as the temperature increases which will helps in maintaining the temperature well within the limit. It is not necessary that the temperature of the panel is maintained with this because as the temperature of the ambient atmosphere is about 30oC which is normal temperature for the Indian climate, the solar panel temperature will be about 43-47 °C. The point to be noted is that for summer condition the ambient temperature is about 45-47oC in some parts of our country which is more important issue for which the work is to be carried out. The solar plant working in the summer condition the panel temperature is round about 62-70oC at which the fins are transfer to the excess amount of heat to the ambient. To keep plant working efficiently in this season it is necessary to cool the solar panel by providing some cooling arrangement such as the extended surface from the panel which helps to maintain the temperature of the panel.

## VII. RESULT AND CONCLUSION

A proper characterization of the cell would include open circuit voltage, short circuit current. For the characterization of Solar panel efficiency with temperature variation throughout the day from 11:00am to 04:00pm, Poly-Crystalline panel without fins and Poly-Crystalline with fins Solar Panel and observations were taken for voltage and current. We can test many parameters with this reading such as which is better Poly-Crystalline panel with fins or Poly-Crystalline panel without fins, and the drop of voltage and current with increase in temperature and the change in efficiency with the temperature variation from morning to evening.

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