Experimental Investigation to Enhance the Efficiency of Photovoltaic Cell

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Abstract— Depletion of fossil fuels, increase in energy demand and stringent pollution norms has influenced many researchers to search of alternate energy source. These alternate energy sources must be renewable in nature to sustain for long term applications.

Solar photovoltaic cells produce electricity by receiving solar radiation. The output power of the photovoltaic cells (PV) is mainly influenced by surface temperature during the process of absorption of radiation. To enhance the performance of solar PV cell by decreasing surface temperature is considered in the present work. An active cooling system will be designed that can be tested with different fluids to study the influence of temperature on efficiency.

Keywords: Solar energy, Photo voltaic cell, Energy conversion

1 INTRODUCTION

While the world faces the problem of energy scarcity, global warming and the deterioration of energy. There is a need for the production of energy other than fossil fuel energy, water and wind. The fossil fuel will run out over next few decades, hydroelectric plants depend on annual rainfall and wind energy also depends on climate change.

Solar energy is one of the alternative sources of energy. The solar energy is a very inexhaustible source of energy. The power of sun intercepted by the earth is about $1.8x10^{11}$ MW, which is higher than current consumption rate on earth of all commercial energy sources. Therefore, solar energy could regularly supply the current and future energy needs of world Solar cell are a device that directly converts energy of sunlight into electricity through photovoltaic cells. The scenario method is used to investigate whether or not an energy supply system entirely based upon renewable energy sources (solar radiation, wind, biomass, environmental heat and hydro) can supply the energy globally required by the mid–21st century. A geographical information system (GIS) is employed to assess the spatial match between supply and demand, and the robustness of the scenario against changes in assumptions is discussed.

As many of our primary resources such as coal and oil used for energy are non-sustainable and disappearing fast, renewable energy is an attractive option that will grow as non-renewable energies become more and more scarce and renewable energy technology becomes more and more efficient and cheaper. Only a fraction of money invested in nuclear power is invested in solar panel so with more investment and time, there is definitely a big room for improvement. Considering there is about 6000 more times energy than our current consumption free to harvest, even if we can just get a tiny fraction of that energy, it will reduce our hunger for energy significantly. After recalling shortly the specificities of organic materials, the band structure, the electronic properties and the charge separation process in organic materials are shortly described. Then the new organic solar cell concepts are presented.

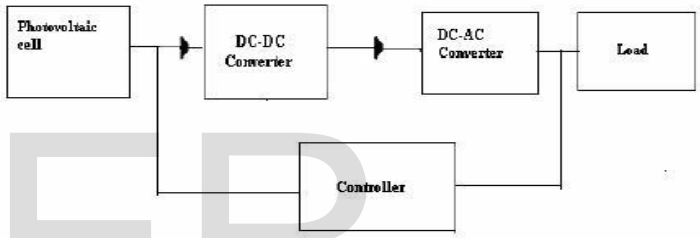

Figure 1 Block Diagram

2. Literature Review

Britt; Jeffery s. (tucswon.AZ) Wiedeman; Scott (Tucson.AZ) [2], They have presented an experimental investigation to study a semiconductor material used in a PV cell and its importance in determining the efficiency of the solar cell at various parameters such as regards to behavior with respect to temperature, weight and as well as other parameters with which it is used and all those contribute to the deciding factor of efficiency of the PV cell

Dubey et.al.[1] , the efficiency of different configurations of PV/Tair collector. It was shown that the case of glass to glass PV with a cooling duct could give the highest efficiency among the four cases considered by the author.In order to enhance the heat transfer from the PV module, thereby effectively reducing the operating temperature and improving the efficiency of the PV module

Prasad and Saini[2] artificially increased the roughness of absorber plate and wall of the channel. However, increased roughness of wall and absorber incurred a pressure drop penalty and, therefore, required a higher pumping power.

Garg and Datta[5] suggested several practical modifications to enhance the heat transfer in the air duct.

Zhao; Xiaofeng (Guangdong, CN) [3], The authors have conducted a study on solar collecting and utilizing device and have concluded that the efficacy of a solar energy conversion system depends on the various parameter such as the quantum of radia-

tion, intensity, direction, the tilt angle of the collector, temperature etc. In case of solar collector and utilizing device, the sun tracking and beam focused radiation are of paramount importance. This device consist of paraboloidal mirror, a sun light collector, a solar storage and conversion device and a solar tracking equipment wherein said sun light collector compresses a light guide which convert factual into substantially parallel light beam and deflect them in a desired direction and a curved surface condenser mirror which receive the substantially parallel light beams reflected from the light guider and converting them into a solar storage and conversion.

Coc Oko and S.N Nanchi [4], they have worked on Optimum Collector Tilt Angle for low latitudes. There are many factors that affect the solar radiations falling on the earth. Some of the factors that affect the intensity of the extra terrestrial solar radiation on the earth's horizontal and tilted surfaces are clouds, dusts and shades. In designing the solar equipment, the designer has to pay more attention towards harnessing the insolation to the optimum level for effective performance of the equipment. Determination of the tilt angle at lower latitudes is one such effort for a country like Nigeria.

2.1 Summary

PV cell is basically used to produce electrical output. It is used to convert DC power to AC through battery bands. It depends on these parameters like quantum of radiation, direction, intensity, temperature, tilt angle. They are collected and utilized in a useful way. The recent research has suggested the factors of which the solar radiation is affected like dust, clouds, etc. The work is based on the semiconducting material of the solar panel on which how it produces the efficiency. It reflects on the temperature, weight etc.

3. Methodology and Fabrication

The literature is reviewed to identify the parameters affecting the performance of photo voltaic cell. Selection of solar panels with designed capacity. Collecting solar radiation data with respect selected location. The active cooling system for photovoltaic cell is designed, based on the collected data.(water and refrigerant cooling system). Performance evaluation is carried out for photovoltaic cells with active cooling system. Effective utilization of high temperature water coming from the cooling system for domestic purpose.

Figure 2 Assembly of solar PV test system

- Cooling system is designed using a polycarbonate sheet of 2mm thickness.
- Dimensions of the solar panel Length-48cm, Breadth-35cm, Thickness-2.5cm
- The solar panel is fixed to the stand with a tilt ange of 34.5°.

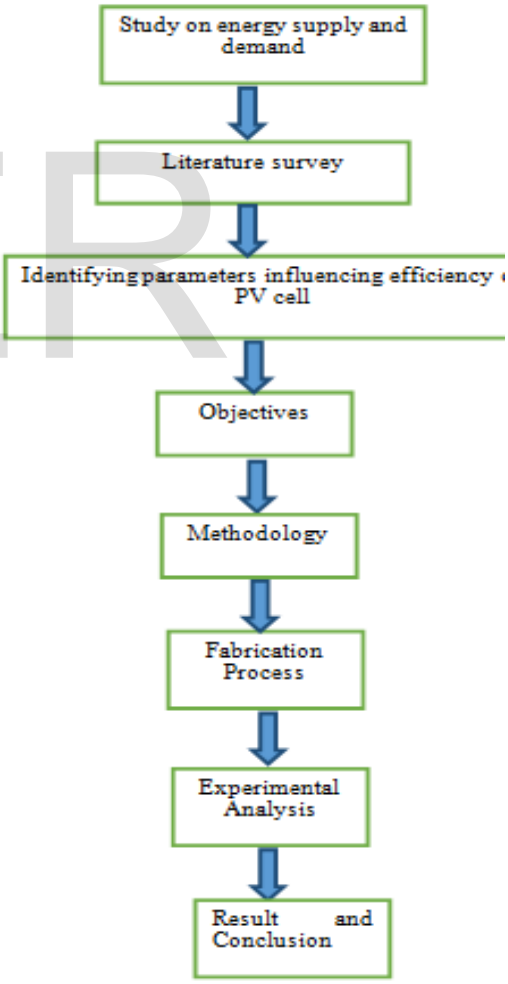

Figure.3. Flow chart of Methodology

4.Result and Discussion

Expeiment is conducted on a sunny day in the selected location and the readings such as, Voltage,current,temperature and solar intensity based on time period are mentioned in the table 1.

The results to the above readings are given below,A graph is plotted to understand the difference between the PV cell with and without cooling.

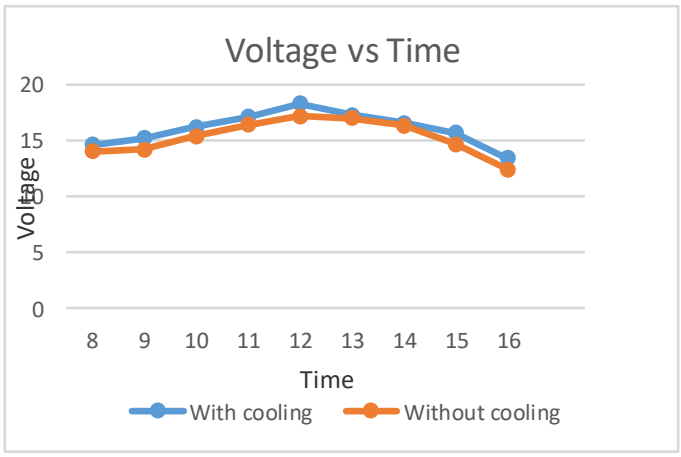

Figure.4. Voltage vs Time

The above graph shows the change in the voltage with respect to time. Here both with cooling system and without cooling system is compared simultaneously with respect to voltage and time. This proves that there is slight increase in the efficiency when the PV cell is cooled.

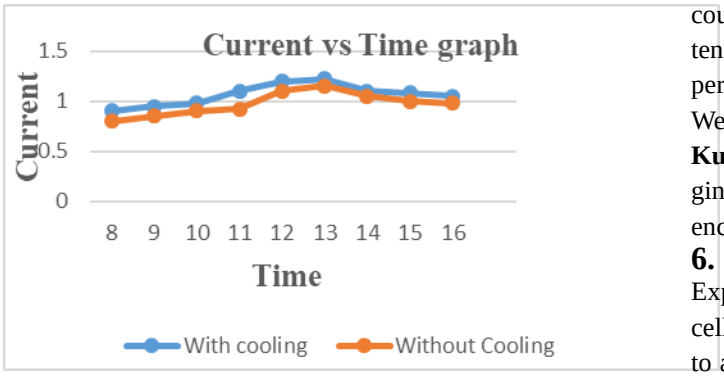

Figure .5. Current vs Time

The above graph shows the change in the current with respect to time. At morning the temperature of panel is quite low, and the solar radiation intensity also minimum so less current output from panel and at afternoon the current output increases with increase in solar radiation intensity and reaches a peak point. This shows that maximum current can be produced by cooling the PV cell.

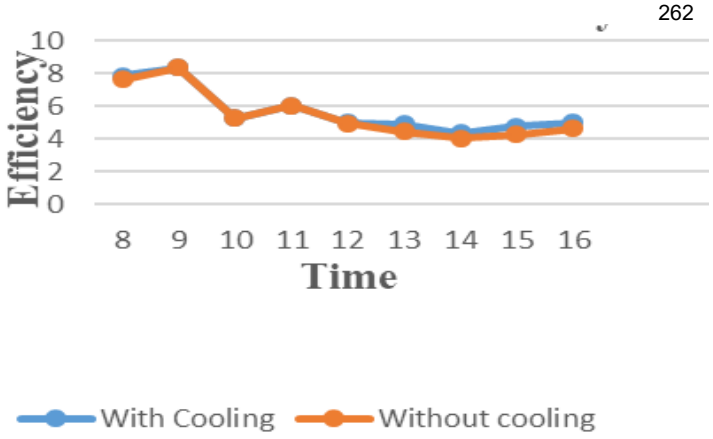

Figure.6. Efficiency vs Time

The above graph shows the improvement in electrical efficiency of photo voltaic module with active cooling system compared to that of photo voltaic module without cooling system.

4.1 FORMULA USED

a) The electrical efficiency of the PV cell is given by,
ɧ=[(V*I)/(A*G)]*100

V- Voltage in volts
I – Current in Amps
A – Surface area in m^2 = 0.375m^2
G – Solar intensity in w/m^2

b) Average power=Average voltage*Average current.

5. Acknowledgement

We are highly indebted to the following people without whom I could not have completed our project work. I would like to extend our gratitude to the following imprinted not just on the papers but also deep in our hearts.

We convey our heartfelt gratitude to our internal guide **Varun Kumar Reddy N** Assistant Professor, School of Mechanical Engineering, REVA University, Bangalore for all his support and encouragement.

6. Conclusion

Experimental results show the increase in efficiency of the PV cell.Water has an ability to cool the PV cell at high temperature to a great extent.The electrical efficiency drawn has high voltage and current which can be used as a secondary source for operating some of the electronic equipments.

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Table 1. Experimental Results

Time (hrs)	Temperature (°C)		Current (A)		Voltage (V)			Efficiency %	
	Without Cooling System	With Active cooling system	Without Cooling System	With Active cooling system	Without Cooling System	With Active cooling system	Solar Intensity (w/m²) -	Without Cooling System	With Active cooling system
08:00	36.1	34.5	0.8	0.9	14.0	14.6	436	7.668	7.87
09:00	44.2	36.2	0.85	0.95	14.2	15.2	458	8.36	8.35
10:00	50.1	39.8	0.9	0.98	15.4	16.2	768	5.27	5.27
11:00	57.7	47.5	0.92	1.1	16.4	17.1	809	6.04	6.05
12:00	61.5	50	1.1	1.2	17.2	18.3	1129	4.95	5.02
13:00	54.3	45.7	1.15	1.22	17.0	17.3	1249	4.47	4.89
14:00	50.3	39.6	1.05	1.1	16.35	16.6	1194	4.05	4.36
15:00	40.7	38.5	1.0	1.08	14.70	15.70	1054	4.26	4.76
16:00	39.9	37.3	0.98	1.05	12.4	13.42	809	4.62	5.02