Enhancement of the Efficiency of Solar Panel Using Concentrator

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Abstract - In the 21st century, there is high demand of energy sources in all over the world. Sun is direct or indirect source of almost every type of renewable energy. Solar Cells or photovoltaic cells are devices which is used to convert solar energy into electrical energy. However, sun is the unlimited source of energy, when exposed to the sun, individual panels cannot generate sufficient amount of energy due to insufficient incident sun rays which demands, number of panels, high installation cost and large land. To solve this problem, we can use Concentrated Photovoltaic Technology, which uses concentrators such as mirrors or lenses to focus sunrays on solar cells for generating electricity with the higher efficiency of individual Solar Panels. But the temperature of the concentrated photovoltaic system will become comparatively very high, therefore in addition to this setup the heat sink and some membrane cooling is used to reduce the temperature of the system. Experimental results have given the significant enhancement in output of the individual solar panel.

***Key Words*:** Concentrated photovoltaics, efficiency improvement, parabolic solar dish, heat sink.

1.INTRODUCTION

Energy is the primary want for mankind today. It guarantees a higher pleasant of life. As blood is to frame, energy is to the financial system of any united states so without it the financial system will quiver and it'll be very difficult to maintain it. All over the arena electricity is one of the main troubles and each united-states is searching out electricity assets as its call for is growing rapidly. Non-renewable electricity assets are both too high-priced or destructive the surroundings also, they're at lengthy remaining going to give up with inside the close to future. That's why the arena is shifting toward renewable electricity assets. Over the centuries, the solar has supplied electricity in each form: mild and heat. Today, solar electricity is used to supply energy via means of the use of photovoltaic cells. Due to energy transmission constraints, solar energy is a form of renewable energy resource that has been extensively explored and has a wide range of applications. Solar energy typically outperforms coal and oil in terms of lowering carbon emissions, being cleaner, and providing an endless supply of energy. In light of the foregoing, researchers must introduce and build up innovation in the solar energy area to overcome its shortcomings and obstacles in order to meet the world's expanding energy demand. By achieving high efficiency, researchers are contributing to remarkable innovation in the solar energy area.

YEAR	SOLAR POWER GENERATION (TWh)
2016-17	12.09
2017-18	25.87
2018-19	39.27
2019-20	50.13
2020-21	60.40

Table 1.1 Annual solar power generations in India

A) PRINCIPAL OF SOLAR CELL:

Solar cells are made of semiconducting substances, including silicon, that are doped with special impurities. This produces unequal distribution of loose electrons (n-type) on one facet of junction and extra of holes (p-type) on different facet of junction. Solar mild has photons which hit the sun panel and excite the loosely certain electrons that are designed to transport best in a single course in sun cells and consequently electron-hollow

pairs are created in respective junctions and power is acquired in outside circuit. Whatever the scale is, an ordinary solar cell produces 0.5 - 0.6 Volt DC below no load and open circuit condition.

The cutting-edge and voltage (power) score of a PV cell particularly relies upon on its performance, size (floor area) and is proportional to the depth of mild placing the floor of cell. Under top daylight situations, an ordinary business PV panel will produce 2 Watts top power. If the depth is 60% of top it's going to produce approximately 1.2 Watts. Substantial studies indicate that output of a PV cell may be multiplied with the aid of using methods, fabrications and passive gadgets. Passive gadgets are used broadly to beautify the performance and fabrication is high-priced one.

B) EFFECT OF IRRADIANCE:

Efficiency of solar panel is substantially suffering from the quantity of sun irradiance. It is one of the maximum crucial elements on which overall performance of solar panel will depend. It is the degree of quantity of sun radiation from the solar placing at the floor. It is generally expressed in Watts/ rectangular meter (W/m^2). In perfect situations a solar panel ought to acquire an irradiance of one thousand W/m^2 however deplorably this isn't true. Irradiance relies upon on geographical position, altitude of solar to sun panel and quantity of electricity wasted with the aid of using mirrored image from fog or clouds or from dirt particles. Therefore, change of irradiance approach change of output overall performance of solar panel.

C) EFFECT OF TEMPERATURE:

Conducting substances include loose electrons. When irradiance increases, extra photons strike the panel and this electricity is absorbed with the aid of using the atoms and electrons and that they collide with every different begin emitting extra loose electrons and consequently growing the temperature. Temperature is immediately proportional to the resistance to the glide of cutting-edge. Temperature additionally impacts performance. At better temperature, output of solar panel reduces in comparison to a low temperature. According to estimation for each diploma upward thrust in temperature, performance of PV module decreases 0.5%. PV modules are generally synthetic at 250^0 C (770 F) and may be operated above 200^0 C. To reduce the effect of temperature we need the cooling system with the setup

D) COOLING:

In cold temperature solar cell work better. When we employ concentrators, our major goal is to lower the temperature of the PV panels in order to increase their productivity. By using cooling methods on the PV cell, the heat inside the cell can be condensed. Over its normal test 17 conditions, the performance of a PV module is lowered by 4/10-5/10 percent for every 1°C increase. When the panel achieves a temperature of 25^0 Celsius. The solar panel's efficiency is also improving. Solar panel cooling comes in a variety of forms:

- Thermo-Electric Cooling
- Active type cooling
- Passive type cooling
- Nano Fluids Cooling etc.

METHODOLOGY

A) Material:

1. Parabolic Dish Concentrator: This concentrator has a parabolic shape and is made up of a parabolic solar reflector dish, a solar receiver, and a mounting structure. A parabolic dish resembles a satellite antenna in that it focuses solar rays to a focal point due to reflection from the parabolic dish's surface. The main benefit of the parabolic concentrator's shape is that it focuses more wavelengths of solar radiation on the surface and can always be directed at the sun, which a flat panel cannot. Aluminium paint is employed as a reflector surface in this parabolic dish concentrator because it is a good heat reflector. In this experiment, aluminium foil is used only to serve the experiment purpose. The mirror obviously reflected the most of the light but in all days of the year there is not same amount of sunlight which is also a major drawback of the mirrors as well as solar panels, hence the aluminium foil or aluminium paint reflected the most sunlight on cloudy days when there was no light, the experimental setup includes a structure of plastic material on which a solar panel is placed at the focus point of the dish, solar panel is also connected to the multimeter.

2. Solar Panel: A monocrystalline solar panel is used in this experimental setup which has the highest efficiency in comparison to any other type of solar panels. The peak power of Solar panel is 5W whose length, width and height are 170, 250, 4.5mm respectively. The cell temperature, storage temperature and working temperature are 25^0C, 65^0C and 85^0C respectively.

3. Heat Sink: An aluminum heat sink is used on the backside of the solar panel as a passive heat exchanger, which absorbs the unwanted and excessive heat of the panel. In this, an aluminum plate fin heat sink is used, which maximizes the surface area of the heat sink and extracts heat by convection. Aluminum is the material of choice for heat sinks because it is light in weight, easy to manufacture, has good conductivity, and is cost-effective, whereas a copper heat sink must be machined and skived, which increases the cost.

B) Experimental Setup and Procedure:

This experimental setup consists of all the materials that were already mentioned above. A Parabolic dish concentrator is placed on the earth or roof where the experiment will be carried out. The reflector of the dish is made up of aluminum foil or aluminum paint, which concentrates (not absorbs) a wide range of solar wavelengths and reflects them on the focal point of the dish. After determining the focal point, the solar panel is set on the focal point with the help of a mounting stand, which is made up of plastic material. Due to this reflection, a large number of sun rays will strike the solar cells, resulting in the temperature of the solar panel crossing its normal temperature range. If this temperature does not decrease, then the semi-conductor material of the solar cell will be affected. Therefore, for cooling purposes, heat sinks or aluminum plate fins are used. Membrane cooling (Water-soaked cotton) is also used in the aluminum fins to decrease the temperature.

2. OUTCOMES

A) Without dish and without cooling: When Solar panels are used without any other equipment installation or without any concentric dish and any cooling method, the temperature is about 22^0 C which is commonly used around the world for a long time but in current scenario this method cannot give sufficient results hence it is losing its value. The value of the table 1.2 shows that output power by using a solar panel without dish concentrator and without cooling is less than other readings.

B) With dish and without cooling: When Solar panel is set on the focus point of the parabolic dish concentrator then temperature of the solar panel is abruptly increase. Due to this high temperature solar panel doesn't give any voltage which is totally undesirable.

C) With dish and with cooling: When the cooling method is applied in addition to the experimental setup (with parabolic dish concentrator) the results obtained from those readings are appreciable as it gives comparatively higher values at different hours of the day. Data of this method has shown in the table 1.3

Time	Current Rating (mA)	Voltage Rating (Volts)	Power Rating (Watt)
2:00 pm	147.60	10.65	1.571
2:15 pm	142.50	9.84	1.402
2:30 pm	137.30	9.65	1.322
2:45 pm	132.20	9.79	1.294
3:00 pm	119.10	9.72	1.157
3:15 pm	103.78	9.75	1.011
3:30 pm	92.50	9.65	0.892
3:45 pm	79.80	9.69	0.765
4:00 pm	64.90	9.63	0.624

Table 1.2 Current, Voltage and Power, without dish and cooling.

Time	Current Rating (mA)	Voltage Rating (Volts)	Power Rating (Watts)
2:00 pm	187.87	10.72	2.014
2:15 pm	189.27	10.73	2.030
2:30 pm	195.74	10.74	2.102
2:45 pm	191.29	10.75	2.056
3:00 pm	185.11	10.70	1.980
3:15 pm	178.79	10.65	1.904
3:30 pm	176.09	10.61	1.868
3:45 pm	183.24	10.71	1.962
4:00 pm	170.81	10.59	1.808

Table 1.3 Change in Current, Voltage and Power, with dish and cooling.

3. CONCLUSION

The results of this experiment had been incredibly motivating. Using a parabolic solar concentrating dish plus heat sink cooling with having membrane cooling is better than using an increasing number of solar panels in terms of cost and man power. The output power from a simple solar panel without using a parabolic dish was **1.115 Watts** and from a solar panel with dish and cooling was **1.969 Watts**, which means one can obtain **76%** more power from the same solar panel using this technique. This will fulfill the basic requirement of using renewable energy sources because it takes small land area and it is cost effective with having greater efficiency.

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