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IMPROVE THE EFFICIENCY OF SOLAR PANEL BY USING WATER COOLING METHOD

Phatangare P.A.*[1] And Galhe D. S*[2]
*[1]. PG Student Dept. Of Mech. Engg. JCOE, Kuran
[2].Asst. Prof. Dept. Of Mech. Engg. JCOE, Kuran
Pune,India

ABSTRACT
The experimental rig is produced to investigate and evaluate PV module performance with the proposed cooling technique. Due to the heat loss by convection between water and the PV panel's upper surface, an increase in system output is achieved at peak radiation conditions. Long-term performance of the system is estimated by integrating test results in a c transient simulation package using radiation site and ambient temperature data. A simulation results of the system's annual performance indicated that an increase of 5% in delivered energy from the PV module can be achieved during dry and warm seasons. Solar energy is becoming another for the limited conventional fuel resources. One of the simplest and most direct applications of this energy is the conversion of solar radiation into heat ,that used for in water heating systems. A commonly used solar collector is the flat-plate. A lot of research has been conducted in order to analyze the flat-plate operation and improve its efficiency. There is an increasing demand for the solar collectors, especially the flat-plate liquid solar collector. Therefore, an extensive research has been done to model the flat-plate solar collectors operation and to predict the performance of different types solar collector.

KEYWORDS: Flat Plate Solar, Photovoltaic (PV) Module, Water pump.

INTRODUCTION
In all over the world, energy is an essential for human. Energy is classified into two different categories, which are non-renewable energy and renewable energy. As development outcomes of world economy the world can't continue to depend on fossil fuels (natural gas, oil and coal). Most of the world's energy is generated from fossil fuels. The reserves of fossil fuels are limited lead to the cost of fossil fuels is day by day increasing. Renewable energy sources are becoming important as significantly benefits. Among all the renewable energy sources, A PV energy is a very efficient solution for renewable energy because of no pollution, abundance and completely free of cost. PV energy is energy that comes from the sun converts into electricity. Now a day the PV system is likely recognized and widely using in electric power applications. This is because it can be produced direct current electrical energy without any environmental harm when is exposed to solar radiation. Very low PV cell conversion electrical efficiency is one of the main obstacles that face the operation of the PV panel is. This is also a key obstacle of scientists and researchers to improve the electrical efficiency of PV cells. The power output yield by the PV system depends on several climatic factors such as the solar radiation, the operating temperature of the state of the PV panels (ageing, cell material, cleanliness, etc.) . The efficiency of PV plant is not only strongly depended on solar radiation, but also depends on the operating temperature of PV panels. The cause of low PV cell conversion electrical efficiency is overheating due to excessive solar radiation and high operating temperatures. This is because the PV panel only 15 % of sunlight energy converts into electricity to the rest converted into heat. To obtain increased electrical efficiency, the PV panel needs to be cooled by removing the excess heat from the cell assembly in some. Different research and studies have been present to increase the electrical efficiency of PV panel. The common PV panel cooling methods are water cooling, air cooling, and heat pipe cooling.As panel temperature increases output voltage of solar panel decreases so cooling of panel is necessary for improvement of efficiency. Hybrid Photovoltaic/Thermal (PV/T) solar system is one of the most popular methods for cooling thephotovoltaic panels now adays . The hybrid system consists of a solar photovoltaic panels combined with a cooling system. Water is transfer around the PV panels for cooling the solar cells, and the warm water leaving the panels pump back to water tank. Warm water mixed with cool water

of tank. It is concluded that the cooling system could solve the problem of overheating the PV panels due to excessive solar radiation and maintain the efficiency of the panels at an acceptable level by the least possible amount of water.DC motor water pump and small diameter nozzles are used to perform water layer along PV module upper surface. There are three main advantages of applying this technique is a drop in cell temperature, an increase in incident radiation due to radiation refraction by water, and continued surface cleaning by water flow. However, the drawback of the system is the power required by the pump to circulate cooling water.

Structure of the solar cell

In conventional solar cells, the electrical field is created at the junction between two regions of crystalline semiconductor having contrasting types of conductivity (Figure 3). If the semiconductor is silicon, one of these regions (n-type) is doped with phosphorus which has five valence electrons (one more than silicon). This region (the p-type) is doped with boron, having three valence electrons (one less than silicon). The concentration of holes is greater. The large difference in concentrations from one region to the other causes a permanent electric field directed from the n-type region towards the p-type region. This is the field responsible for separating the additional electrons and holes produced when light shines on the cell.

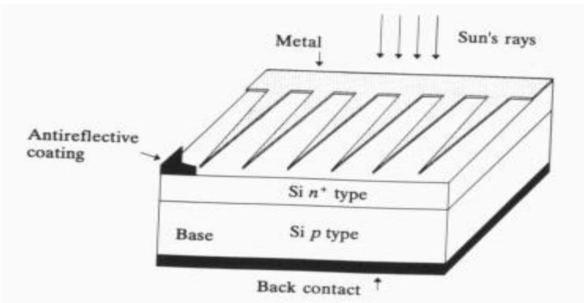

Figure 1 : The p-n junction

Problem Statement

Conducting materials consist of free electrons and some electrons are held tightly by the nucleus of atoms. When irradiance increases, more packets of photons strike the pane land this energy is absorbed by the atoms and electrons and they collide with each other emitting more electrons from the atoms and thus raising the temperature. Increase in temperature leads to increase in resistance to the flow of current. Efficiency is also dependent on temperature. At high temperature output performance of solar panel reduces as compared to a lower temperature. .

Objective

Solar panels can diminish and produce less power when exposed to high temperatures. The objective of this experiment was to develop an efficient method of cooling down solar panels to increase their lifetime, as well as power production/efficiency.

Scope

The solar industry's structure will rapidly evolve as solar reaches grid parity with conventional power between 2016 and 2018. Solar will be seen as a viable energy source, not just as an alternative to other renewable sources but also to a significant proportion of conventional grid power. The testing and refinement of off grid and rooftop solar models in the seed phase will help lead to the explosive growth of this segment in the growth phase.

MATERIALS AND METHODS

General theory of PV cells

The conversion of the energy carried by electromagnetic radiation into electrical energy is a physical phenomenon known as the photovoltaic effect. Solar cells are without doubt the most important type of device for carrying out such conversion. When sunlight falls on semiconductor materials (e.g. silicon), the photons

making up the sunlight can transmit their energy to the valence electrons. Silicon is representative of the diamond crystal structure. Each atom is covalently bonded to each of its four nearest neighbors. That each silicon atom shares its four valences electronic with the four neighboring atoms forming four covalent bonds. Silicon has atomic number 14, and the configuration of its 14 electrons. The core electrons, 1s2, 2s2 and 2p6, are very tightly bound to the nucleus and, at real-world temperatures, do not contribute to the electrical conductivity. At absolute zero atoms are formed-the lower valence band and the upper, "conduction" band. The valence band has 4N availability energy states and valence electrons and therefore filled. Conversely, the conduction band is completely empty at absolute zero. Thus the semiconductor is a perfect insulator. The temperature of the solid is raised above absolute zero energy is transferred to the valence electrons making it statistically probable that a certain number of the electrons will be improved in energy are free to conduct electrical charge in the conduction band. The amount of heat necessary to bridge the valence and conduction bands is referred to as the forbidden gap E.g., which is 1.12 ev. At room temperature for silicon. Each time a photon breaks a bond and electron becomes free to roam through the lattice. The absent electron leaves behind a vacancy that can also move through the lattice as electrons shuffle around it. The movement of the electron and holes in opposite directions electric current in the semiconductor. The current carry through an external circuit allowing the energy absorbed from the light to be dissipated in some useful work. To separate the electrons from the holes and prevent the bonds from reforming an electrical field is used. That provides a force propelling the electrons and holes in opposite directions. The result is a current in the direction of this field.
The main characteristics that distinguish photovoltaics from other renewable are:

- Direct production of electrical energy, even in very small scale of few Watt or mWatt
- They are easy to use. In certain small applications they can be installed directly from the user
- They can be installed in city centers without offending aesthetically the environment
- They can be combined with other sources of energy (hybrid systems)
- They can be expanded in order to meet higher demands
- Their operation has minimum noise production as well as no emissions
- Their operation life can be large with minimum maintenance
- They require high investment cost

The four main types of silicon photovoltaic cells

- Single-crystal silicon.
- Polycrystalline silicon.
- Ribbon silicon.
- Amorphous silicon

Single-crystal silicon
Most photovoltaic cells are single-crystal types. That make them silicon is purified melted and crystallized into ingots. The ingots are sliced into thin wafers to make individual cells. The cells have a uniform color usually blue

Polycrystalline silicon
Polycrystalline cells are manufactured and operate in a similar manner. The difference is that a lower cost silicon is used. These results in slightly less efficiency but polycrystalline cell produced assert that the cost benefits outweigh the efficiency losses. The surface of polycrystalline random pattern of crystal borders instead of the solid color of single crystal cells.

Ribbon silicon Ribbon-type photovoltaic cells are made by growing a ribbon from the molten silicon instead of an ingot. The anti-reflective coating used on most ribbon silicon cells gives them a prismatic rainbow appearance.

Amorphous or thin film silicon
The previous three types of silicon used photovoltaic cells have a distinct crystal. Amorphous silicon has no such structure. Amorphous silicon is sometimes abbreviated and is also called thin film silicon. Amorphous silicon units are made by depositing very thin layers of vaporized silicon in a vacuum onto a support of glass,

metal. Since they can be made in sizes up to several square yards they are made up in long rectangular strip cells. These are connected in series to make up modules.

CALCULATION AND DISCUSSION

PV panel
The voltage of PV cells is very small in order to supply a device. This reason many cells are combined together in a PV panel with common electrical output. The main advantages of the panel are the peak power. The peak power is the power from the photovoltaic when the solar irradiance is 1000 W in every square meter, when the temperature is 25 ƒ C. obvious that the power from the panel depends on the area of the panel the type and its operation temperature. The maximum power is given from the manufacturer. The operating voltage is another important characteristic of the panel. Most photovoltaic's today are constructed in a way that they produce power higher than 12 V in order to charge the 12 Batteries. from the voltage the operating current is another parameter. It is the current which is determined from the maximum power from the panel and the voltage created, when the irradiance is equal to $1000W/m^2$For a panel with peak power equal to 40 W and operating voltage 17 V, the operating current would be equal to: 40 W/ 17 V=2,3A For bigger PV systems, panels with operating voltages equal to 24 V or even 48 V are used. The short circuits current (Isc) as well as the open circuit voltage (Voc) are other important parameters. The short circuit current is the current from the PV when it is connected with a cable of minimum resistance. The open circuit voltage is the voltage of the PV when it is measured by a cable with infinite resistance. Both of the above are two of the main parameters of the PV cell. In every curve, represented in the diagram, there is a point where the voltage and the current have such values that the electrical power (P=VxI) has the maximum value.. That point is called point of maximum power and the following formula can be written:

Pmax=Imax xVmax ……………………………….(i)

where: Pmax -is the maximum power
Imax - is the maximum current
Vmax- is the maximum voltage

When R (resistance) is equal to zero or infinity, the electrical power is zero, since in the first case the voltage is zero, and in the second the current reaches zero. In intermediate cases, the electrical power is gaining values which are represented in figure below:

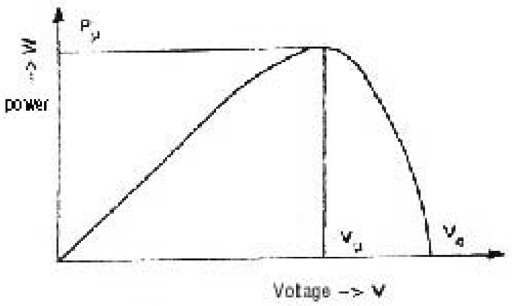

Figure 2: Power as a function of voltage

Therefore for given solar irradiances, the biggest power the PV can provide depends on the appropriate choice of the system's resistance. For different irradiances, a group of transposed curves is created. This represented n the figure

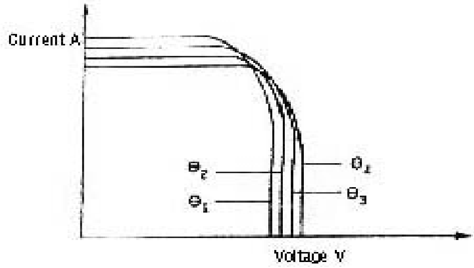

Figure 3: Current vs. voltage

Voltage regulator or controller

This device controls the current flux from the PV to the batteries. When the battery is fully charged, the voltage regulator decreases the current not to overcharge the battery. When the battery is overcharged, the operational life is decreased.

Battery

The electrical energy is stored to the batteries in order to be provided in intervals with minimum solar irradiance (during nights, cloudy days). Generally the batteries used for PV systems are the same as the ones used in cars. The most common type is the battery with lead electrodes (poles) in a sulphuric acid solution. This type is the most economic viable for PV systems. In cases were there is large temperature variations, alkaline Ni-Cd (nickel-cadmium) batteries are used.

$$E_{tot}= CxVxN............(ii)$$

When the cost of the battery is divided with Etot, the cost for every KWh is found. It is obvioust hat this cost should be kept low.

- Operating temperature: the capacity of the battery is decreasing with decreasing temperatures. Many manufactures provide, among other specifications, the correction curve of the battery. An example is given below:

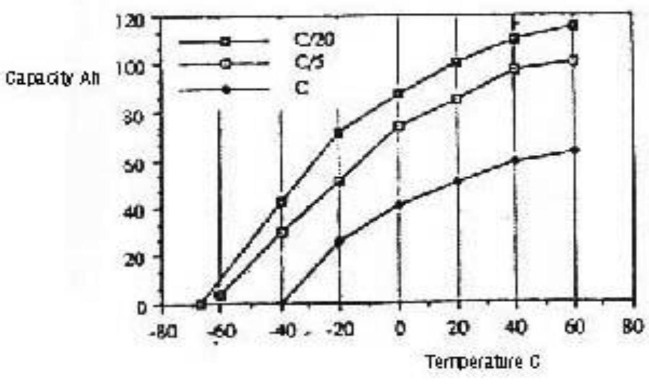

Figure 4 : Capacity vs. temperature

From the figure above,it can be seen that for discharge rate of C/5, and minimum temperature 0°C, the corrected capacity is 73 Ah. Rate of discharge of C/5 means that the battery can provide20 A and has capacity of 100 Ah.

- Operational life of the battery: the operational life of the battery depends on many factors such as the rate of charging and discharging, the number of charges, and the extreme operating temperatures. In a PV system, a common lead battery has an operational life no more than 5-6 years. On the other hand, nickel-cadmium batteries last longer when they are operating in similar conditions.

Load

The term load indicates the total number of electrical appliances that they will be operated withthe electrical energy provided by the PV. For a PV system to be well designed, the electrical energy that these appliances consume in a time interval of one month, should be equal or less to the energy produced by the system in the same time interval. For every electrical appliance,

Inverter

This device converts D.C to A.C. in order for many devices to operate. One type of an inverter is the centrifigular one. At this type, the D.C. current rotates a motor which provide power to a A.C. generator. This type of inverter is rare today, since there are types with no moving parts. The efficiency of the later is higher and their maintenance small. Depending on the type of the photovoltaic, there is the appropriate inverter. A stand-alone PV is connected to a converter which operates with the electrical energy from the PV and convertsD.C. to A. The table below represents the various costs associated to a complete PV system.

Table 1 Example of various costs of a stand-alone PV system

COST FACTOR	CONTRIBUTION TO THE TOTAL COST
PV panels	65%
PV panel support and cabling of the PV elements	5%
Batteries	15%
Voltage, power controllers arrangement andprotection control	12%
Auxiliary generator	3%

As said before, the main parameters which characterize the photovoltaic cell are: the open circuit voltage (Voc), the short circuit current (Isc), the voltage at maximum power point (Vmax) and the current at maximum power point (Imax). Furthermore, another important parameter is the Fill Factor (FF) which is also a measure of the quality of the silicon cells conversion ability. All the above are described below:
The Fill Factor is an important parameter and can be described as follows:

$$FF = \frac{V_{max} \times I_{max}}{V_{oc} \times I_{sc}} \quad \text{.........................(iii)}$$

The Fill Factor varies little among devices and takes values in the range of 0,7 to 0,8 for many crystalline semiconductor cells (Si, Gas, InP).The energy-conversion efficiency of a solar cell is defined as the ratio between the maximum electrical power that can be delivered to the load and the power input. Therefore:

η==…………..(iv)

This efficiency and the maximum power output are obtained only if the resistance of the load has the right value of VM/IMThe power absorbed by the collector is given by:

$$Qp = GA\tau_c\alpha_p \text{....................................(v)}$$

where:Qp= absorbed power (W)
G= total irradiance (W/
A= area of solar collector (m^2)
τ_c= transmission factor of cover
α_p= absorptance factor of collector plate

The power loss from the collector is given by:

$$Q_L = uA(T_c - T_a)\text{……………………. (vi)}$$

where:
Q = power loss from the collector (W)
U = collector U value (W/m
T_c = temperature of collector plate (K)
T_a = ambient air temperature (K)

The useful power supplied by a solar collector (Qs) can be derived from the above equations which forms the basis of the ***Hotter-Whiller*** equation:

$$Q_s = Q_p - Q_L \quad \text{(vii)}$$

$$Q_s = GA\tau_c\alpha_p - [uA(T_c - T_a)] \quad \text{(viii)}$$

In the case of the PV module the above equation becomes:

$$Q_s = GA\tau_c\alpha_p - [uA(T_c - T_a)] - GA\varepsilon_E \quad \text{(ix)}$$

where:
ε_E: efficiency of electrical conversion

CONCLUSION
Increasing cooling efficiency due to the direct contact between water and PV module surface. Increasing incident solar radiation on PV module due to solar beam refraction in water layer. Maintaining the PV module upper surface free of dust due to continuous water flow. Elimination of the circulating pump required for the cooling process due flow under gravity. A cooling technique that is simple and can be added to any standard module without a significant increase in cost

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REFERENCES
[1] Y.M.Irwan, W.Z.Leow, M.Irwanto, Fareq.M, A.R.Amelia, N.Gomesh,I.Safwati, Indoor Test Performance of PV Panel through Water Cooling, Method, 2015 International Conference, Energy Procedia 79(2015)604 – 611.
[2] Rizwan Arshad, Salman Tariq, Muhammad Umair Niaz, 2014 International Conference on Robotics and Emerging Allied Technologies in Engineering (iCREATE) Islamabad, Pakistan, April 22-24, 2014.
[3] K.A. Moharram, M.S. Abd-Elhady, H.A. Kandil, H. El-Sherif, Enhancing the performance of photovoltaic panels by water cooling, Received 29 September 2012; revised 8 February 2013; accepted 24 March 2013.
[4] Chen Hongbing, Chen Xilin, Li Sizhuo, Chu Sai, Experimental Study on the Energy Performance of PV-HP Water Heating System, International Conference on Applied Energy – ICAE2015 The 7thScience DirectEnergy Procedia 75 (2012) 294 – 300 .
[5] Swapnil Dubey, Jatin Narotam Sarvaiya, Bharath Seshadri,(2012)"Temperature Dependent Photovoltaic (PV) Efficiency and Its Effect on PV Production in the World A Review"