EXPERIMENTAL ANALYSIS OF WATER COOLED PHOTOVOLTAIC/THERMAL HYBRID SYSTEM

R.Venkateswar[1], M.Venkatesh[2], K.Venkatesan[3]
[1,3]M.E., AP/MECH, [2]M.E., AP/EEE
ACT College of Engineering and Technology, Kancheepuram

Abstract
The absorbed solar radiation which is not converted in to electricity increases temperature of PV module results in decrease in efficiency. In order to improve the efficiency of the panel the temperature of cells should be maintained optimized level. This can be achieved by passing water through a duct using hybrid PV/T collector.

Extracting heat from the PV panel by using water as a cooling medium. The objective of the project is to improve the efficiency and power output in the hybrid PV/T collector and to optimize the power output from the PV panel. The analysis is carried out in a 50W PV panel with cooling and without cooling. The cooling of the PV panel is done through the forced convection of water in duct. The objective of the project is to compare the efficiencies and power output of the panels with cooling and without cooling.
Keywords: PV cell, solar thermal energy, hybrid technology , heating and cooling

I. INTRODUCTION

Photovoltaic (PV) materials and devices convert sunlight into electrical energy, and PV cells are commonly known as solar cells. Photovoltaic's can literally be translated as light-electricity. Solar Energy is the energy received from the sun that sustains life on earth.Solar energy is abundant quantity and it is also free source of energy.

SOLAR ENERGY IN INDIA

The utilization of solar energy is of great importance in India since it lies in a temperature climate region of the world where sun light exposure is maximum throughout the year. The following things about solar power make it the most feasible renewable source of energy in our country:

- Solar energy is available in huge amount.
- Available throughout the country – it doesn't have geographical limitations like other source of energy.
- Available most duration of the year.
- It is non polluting form of energy, there is emission or disposal of solid/liquid wastes.
- Modularity and scalability. The solar energy conversion into electricity is two types
- Solar thermal energy conversion
- Solar photovoltaic energy conversion

Solar thermal energy conversion:

Concentrating solar power plants produce electric power by converting the sun's energy into high-temperature heat with the help of mirror arrangements. The heat is made to flow into conventional generator. The plants have two parts: one will absorb solar energy and stored in it, and another part that convert stored energy into electrical energy. This stored electrical energy can be distributed for any electrical purpose. The mirror arrangement is used to heat the working fluid. Finally, the hot working fluid is used to rotate the turbine. Then mechanical energy produced from the turbine is converted into electricity.

There are three categories in thermal energy conversion system,

- Parabolic trough system
- Solar power tower system
- Parabolic dish system

Solar photovoltaic energy conversion:
Photovoltaic (PV) materials and devices convert

sunlight into electrical energy, and Photovoltaic cells are also called solar cells. Photovoltaic's' can literally be translated as light-electricity. There are two types of technologies in photovoltaic energy conversion are crystalline silicon and thinfilm technology.

II. HYBRID TECHNOLOGY

PV-T stands for **Photovoltaic-Thermal. It** Generates both the electricity and usable thermal heat simultaneously from each panel. The photovoltaic cell convert solar radiation into electricity and thermal system converts excess solar energy from the PV module into useful thermal heat energy. The efficiency of the PV cells is increased because of hybrid system.

WATER TYPE PV/T COLLECTORS

A water-based PV/T module has a similar structure as the conventional flat-plate solar collectors. Underneath PV cell plenty of heat absorbing tube is placed to collect the excess heat from the PV cell.

Working fluid is made to flow across the tube with the help of pump, and then it carries excess heat energy from PV panel and keeps it in lower temperature, that makes the panel more efficient. The heat collected by the fluid is stored in a separate storage medium; the stored heat energy may be used for special purpose. The special purpose of pv maybe heating, cooling and electricity generation.

III. EXPERIMENTAL SETUP

The experimental setup is fabricated to carry out the experiments as shown in Fig 1.The panel with the cooling arrangement to extract heat from the panel is mounted on the support structure. The panel is mounted in such a way that there is 180° rotation of panel in both ways.

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Fig 1 Photographic View of the PV Panel With cooling Arrangement

There are four ducts behind the panel in order to carry the cooling fluid to extract heat from the panel. The experiment is carried out using water as the cooling medium. Water is pump by a solar DC water pump from the water tank and evenly distributed through the four ducts behind the panel. The water is getting heated by extracting heat from the panel and the hot water is collected in the other end of the panel through the outlet pipe. The radiation is measured using the weather station in Institute for energy studies, Anna University

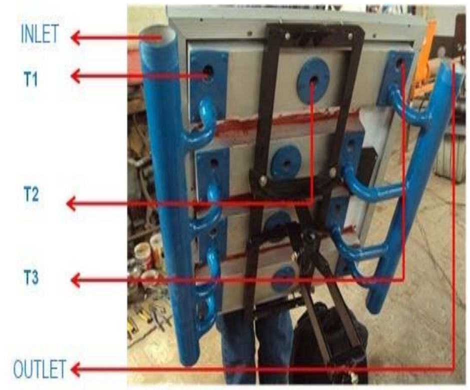


Fig 2 Position of thermocouples

Thermocouples have been attached in the inlet, middle and outlet sections of each of the four ducts to measure the temperature of water.

The panel surface temperature is measured using an infrared thermometer. Fig 2 shows the position of thermocouples in the ducts behind the panel.

The thermocouples are all J type (IronConstantan) thermocouples which can measure the temperatures in the range of 40°C to 750°C and the sensitivity of the thermocouple is about 55μV/°C.The temperature has been measured using the microprocessor based control panel shown in Fig 3

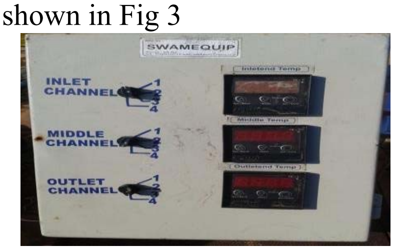


Fig 3 Control panel

IV. EXPERIMENTAL OBSERVATIONS

The experimental observations for the panel with cooling arrangement and the panel without cooling arrangement under higher and smaller radiations are tabulated in the tables 1.1 and 1.2 the power output of the panels with and without cooling

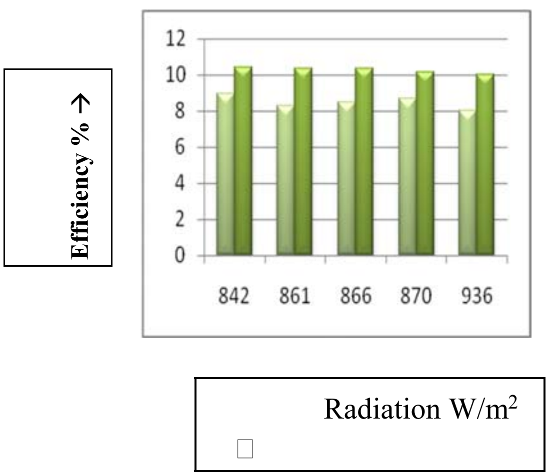
TABLE 1.1 EXPERIMENTAL OBSERVATIONS WITHOUT COOLING

Radiation (W/m^2)	V (V)	I (A)	P (W)	Efficiency (%)
842	17.1	1.72	29.41	8.95
861	16.5	1.68	27.72	8.25
866	16.5	1.73	28.54	8.45
870	16.8	1.76	29.56	8.71
936	16.7	1.75	29.22	8

TABLE 1.2 EXPERIMENTAL OBSERVATIONS WITH COOLING

Radiation (W/m^2)	V (V)	I (A)	P (W)	Efficiency (%)
842	19.5	1.75	34.12	10.39
861	19.4	1.81	35.11	10.34
866	19.6	1.78	34.88	10.36
870	19.3	1.78	34.35	10.17
936	19.8	1.85	36.67	10.03

Fig 4 Efficiency comparison of solar panel without and with cooling



V- CONCLUSION

The PV cell temperature is increased when the panels are continuously in operation. The increasing of PV cell temperature is affecting the performance and significantly reduces power output. The experimental observation shows that the power output and the efficiency of the PV panel with cooling are high when compared to the PV panel without cooling. The power output of the panel is increased when the panel is cooled. The increase in power output is significant only up to 41° C of the panel surface temperature. When the panel is cooled below 41° C there is no significant power improvement in the panel. So the cooling is not beneficial below 41° C and the panel is giving maximum power output between 41-43°C of operating temperatures. The circulation of water to extract the heat from the panel will be an effective method to increase the efficiency of the panel. The future scope of my work is to improve the efficiency and heat extraction from the PV/T by increasing the cooling area. The extracted heat can be used to various applications of the buildings.

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