WATER HEATING SYSTEM INTEGRATED WITH SOLAR PV PANEL

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Abstract - *One of the challenges facing the world currently is how to minimize energy consumption using fossil fuel. One of few approaches is to increase renewable energy sources such as solar as an alternative clean source. Solar energy can be converted to electricity or heat using two different conversion technologies photovoltaic system and solar collector. Solar energy is mostly used in the form of electricity or heat for commercial or residential application. Therefore, heat extraction from solar PV panel result in the electrical efficiency Improvement. Here we present a review of conventional flat plate PV/T and concentrating PV/T system using liquid. The output defined the common problem with the heat increasing in the solar cell which caused the low efficiency .this idea supported the new innovation solution to extract heat and utilize it for other purpose. This work here primarily concentrates to obtain hot water for domestic use as well as produce electricity by cooling the PV panel and is done by using working fluid as water because it has extremely low environmental health, fire and corrosion risk and one of good heat absorber. The proposed study is appropriate for the verification pf overall efficiency of the system and also show the comparison between existing one.*

Key Words*: *Domestic water heater, PV panels ,cooling with water for domestic use.

1.INTRODUCTION

In order to improve the energy performance of the photovoltaic system, much effort has been spent on the research and development of hybrid PVT (photovoltaic-thermal) technology using water as the coolant. The fin performance of the thermal absorber is known to be one crucial factor in achieving a high overall energy yield of the collector. Accordingly, an aluminum-alloy flat-box type PVT collector was constructed, with its fin efficiency approaching unity. Its design is primarily for natural circulation and for domestic water heating purpose. Our test results showed that a high final hot water temperature in the collector system can be achieved after a one-day exposure. A numerical model of this photovoltaic-thermo syphon collector system was also developed and the model accuracy was verified by comparison with measured data. The energy performance of the collector system was then examined first, through reduced-temperature analysis, and second, as applying in the ‘‘hot summer and cold winter’’ climate zone of China. The numerical results are found very encouraging, and the equipment is capable of extending the PV application potential in the domestic sector. Hybrid photovoltaic/thermal (PV/T) solar systems can simultaneously provide electricity and heat, achieving a higher conversion rate of the absorbed solar radiation than standard PV modules. When properly designed, PV/T systems can extract heat from PV modules, heating water or air to reduce the operating temperature of the PV modules and keep the electrical efficiency at a sufficient level. In this paper, we present system for domestic hot water application with passive (thermosyphonic) water circulation. hence we can conclude that PVs have better chances of success especially when both electricity and hot water is required as in domestic applications.

1.1 The effect of temperature on PV-cells:

One of the key factors impacting the amount of electricity your solar panels produce is the temperature at which they operate. It is easy to presume that more sun and therefore more heat result in more electricity but this is wrong. Different solar panels react differently to the operating ambient temperature, but in all cases the efficiency of a solar panel decreases as it increases in temperature.

If you look at the data sheet provided by your solar panel manufacturer they will refer to a term normally described as the temperature coefficient PMAX This value, which is normally given in the form of negative percentage, reveals the impact of temperature on the panel. Solar panels are power tested at 25^0C, so the temperature coefficient percentage illustrates the change in efficiency as it goes up or down by a degree. For example if the temperature coefficient of a particular type of panel is -0.5%, then for every 1^0C rise, the panels maximum power will reduce by 0.5%.So on a hot day, when panel temperatures may reach 45^0C, a panel with a temperature coefficient of -0.5% would result in a maximum power output reduction of 10%. Conversely, if it was a sunny winter’s morning, the panels will actually be more efficient.The effect of Temperature and output power of the PV-Cell can be better understood by the following graph as shown below. From the graph it is clear that the electrical efficiency i.e the output of the pv module decreases with the increase in temperature of the module

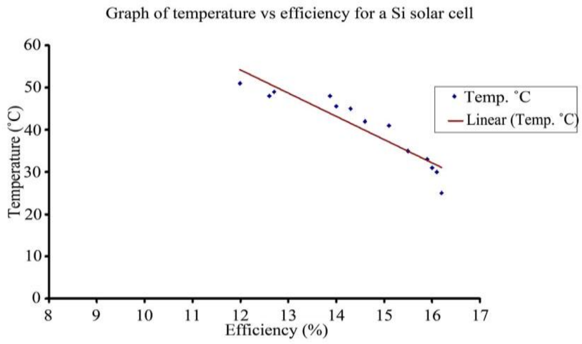

Fig:2.2- Graph of temperature vs efficiency of a Si solar cell

1.2 PV/T SYSTEM: The water pump sucks the water from the middle of the water tank via a suction pipe to avoid sucking any dust. The suction pipe consists of a non-return valve and a strainer to avoid sucking of large particles that could damage the water pump. The sucked water passes through the water filter, and then, it is sprayed over the PV modules for cooling. Water is sprayed using water nozzles, which are installed at the upper side of the modules, as shown in Fig. Afterward, the water used.The PV/T system was constructed for their performance determination. PV panel absorb up to 80% of the solar radiation. However, only 5-20% of the incident energy is converted into electricity, depending on the PV cell technology used. The remaining energy is converted into heat. Owing to this effect, on sunny days PV laminates can reach temperatures as high as 350C above ambient temperature. In PV thermal panel (PV/T) panels this heat is extracted from the PV panel and made available for use. PV/T systems are the system that converts solar radiation into thermal and electrical energy. It is obvious that both electricity and heat are fundamental needs for all consumers. PVT technology can be good choice to use solar energy on efficient way and, therefore, it is expected to be a promising technology in the future.

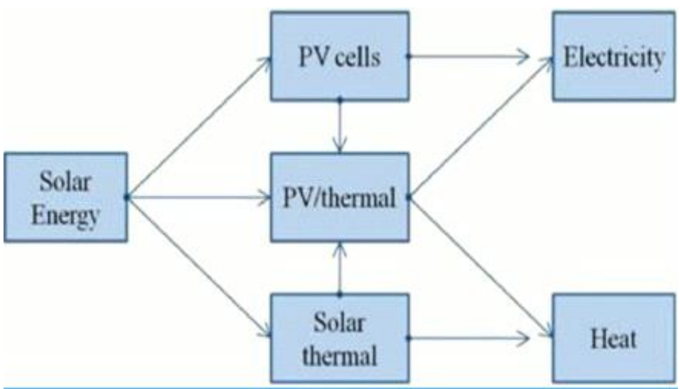

Fig: PV/T System

2. PV/T collector designs: PV/T collectors being considered in this report are collectors, which can provide both electrical and thermal energy. The following diagram given below shows the experimental setup and configuration of the PV/T integrated with hot water system.The integrated system of photovoltaic module and water heating system consists of a rotameter to measure flow rate, a set of thermocouples to measure the temperature at the inlet and outlet of the system, a hot water collecting tank. The water enters from the bottom of the PV panel. It absorbs the sensible heat from the panel lowering its temperature, hence increasing the efficiency of the PV module. The heated water comes out from the top of the panel and is passed into an insulated hotwater.

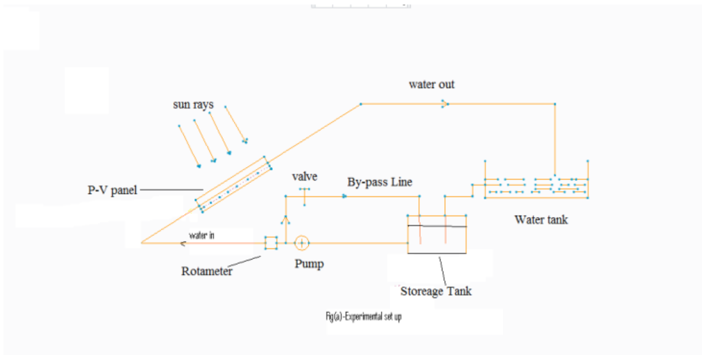

Fig . Experimental setup

3. In a PV-T collector, a thermal absorber and the PV cells are integrated into a single module. The sunlight that is not converted to electricity, and not lost to the surroundings, is transferred to the rear thermal absorber and to the fluid. As a result, both heat and electricity are generated from the same panel. The same considerations apply to PV-T regarding the variety of module designs as for thermal collectors. In a conventional PV module, 90% of the sunlight is absorbed, but only ~15% of this is converted to useful electricity. The rest is partially stored as thermal energy (which is why PV modules can reach temperatures up to ~80 °C during operation on hot days) and ultimately lost to the environment. In a PV-T module, a useful fraction of the heat loss is instead transferred to a fluid stream at the back of the solar cell resulting in a thermal output that can be used in various applications. The efficiency of silicon solar cells drops by 0.4% per °C temperature rise from 25 °C. If heat is required at low temperature (e.g., for heat pumps or pool heating at ~40 °C) the PV module is cooled down by the fluid so that the module itself operates at a higher efficiency, making the electrical output of the PV-T system higher than that of an equivalent conventional PV system. This means that on a sunny day, when the module temperature reaches 80 °C, a PV module with an 18% peak efficiency at the standard temperature of 25 °C will operate with an efficiency of about 14% if no cooling takes place.

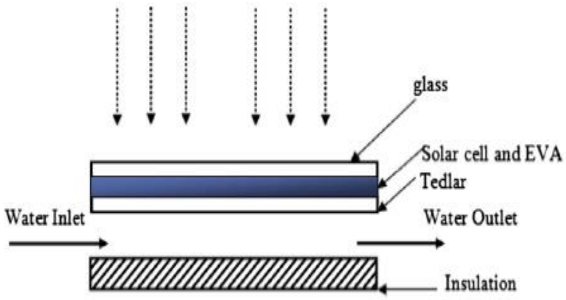

Fig. Cross sectional view of water cooled PV/T system.

A PV-T module increases the longevity of the PV cells as these are operated at lower temperatures, especially in applications such as swimming pools, hotels, heat pumps and underfloor heating, which require a large amount of low-temperature heat. This benefit arises from the fact the solar cells in PV-T collectors suffer lower temperature stresses, which are known to give rise to major causes for PV system failures due to cell breakage, encapsulation dis-coloration and delamination. Moreover, PV-T systems enable 'self-consumption' – the generation and use of electricity on site. Self-consumption is the cheapest way to generate energy with renewables and reduce the stress on the local grid at the same time. PV-T systems can be integrated with heat pumps or cooling systems and the electricity generated in excess could be stored in the integrated thermal store, or in the ground to be reutilized by ground-source heat pumps. Careful planning of the energy use (demand-side management) may also be important in the effective operation of the system. Even though PV-T systems combine the benefits of solar thermal and PV technologies, only a small number of manufacturers are producing. PV-T systems and the market remains small. In the UK, there are only a few hundred such installations. The capital cost of a PV-T system in the UK is up to $750 per m2 , of installed area, twice the cost of an equivalent PV system. The main system-cost component is attributed to the collector and there is a large potential for designing and manufacturing cost-competitive modules.

4. Conclusion:

The objective of this research is to cool the PV panels using the least amount of water and energy. A non-pressurized cooling system has been developed based on spraying the PV panels by water once in a while. A cooling rate model has been developed to determine how long it will take to cool the PV panels by water spraying to its operating temperature. A mathematical model has been used to determine the heating rate of the PV panels, in order to determine when to start cooling. An experimental setup has been developed to validate both models, i.e., the heating and the cooling rate models, experimentally, and to study the influence of cooling on the performance of PV panels. It can be concluded from the results of this study that;

- It is possible to cool and clean the PV panels using the proposed cooling system in hot and dusty regions.
- The cooling rate for the solar cells is 2 _C/min based on the concerned operating conditions, which means that the cooling system will be operated each time for 5 min, in order to decrease the module temperature by 10 _C. The result of the cooling rate model has shown good agreement with the experimental measurements.
- Both the heating rate and the cooling rate models have been validated experimentally.

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