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PERFORMANCE ENHANCEMENT OF PHOTO-VOLTAIC PANEL

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ABSTRACT: A photo-voltaic cell is a device used for the generation of electricity from sun light. The sunlight comprising of both photon energy and thermal energy. The PV cell utilizes only the photon energy to generate electricity. The radiation energy has other effects. It is absorbed by cell. Due to this absorbed radiation the temperature of the cell rises. This elevated temperature affects the conversion efficiency of cell and thus power output is reduced. Though there are other factors like dust, shadow effect, the elevated temperature is of most important factor. High solar cell temperature has always been a major concern as the exceeding operational cell temperature will result in shorter cell life and can also cause permanent cell damage. For this matter both active and passive cooling methods are being used to limit the temperature rise. Passive cooling methods though being less effective are simpler and reliable than active cooling methods. In this study a passive heat sink has been designed using a phase change material (PCM) to improve upon the efficiency of a solar panel. The ability of PCMs to store and release large amounts of heat energy in response to a small temperature change has attracted a great deal of attention in recent years. The phase change material used in this research is Paraffin Wax, which is an organic based PCM.

Key words: Photo-voltaic panel, thermal energy storage, phase change material, passive cooling methods

1. INTRODUCTION

The photo voltaic cell is made of semiconductor materials and used to convert sunlight (photon energy) into direct current electricity through photovoltaic effect.

Photovoltaic Effect

When sunlight strikes a PV cell, the photons of the absorbed sunlight dislodge the electrons from the atoms of the cell. The free electrons then move through the cell, creating and filling in holes in the cell. It is this movement of electrons and holes that generates electricity. The physical process in which a PV cell converts sunlight into electricity is known as the photovoltaic effect.

The overall efficiency of PV cells ranges from about 5 % - 20 % and the conversion efficiency is decreased by 0.25% to 0.5% per ^{o}C rise in temperature.

Thermal energy storage

Thermal energy can be stored in two different forms as, Sensible heat and Latent heat.
Sensible heat storage utilizes the sensible heat capacity and temperature change during heat storing and releasing process. The heat absorbing material can be in solid or liquid state without any change of phase.
Latent heat storage is the combination of both sensible heat capacity and latent heat capacity. An isothermal phase transition occurs in latent heat storage. The PCM is the best example of latent heat storage materials.

Phase change material:

Phase Change Materials (PCMs) are "latent" thermal storage materials. They use chemical bonds to store and release heat. The thermal energy transfer occurs when a material changes from a solid to a liquid or from a liquid to a solid form. This is called a change in state or "phase."
The phase change occurs at the transition temperature, the phase change is also termed as charging and discharging which occurs when it gains and loses heat

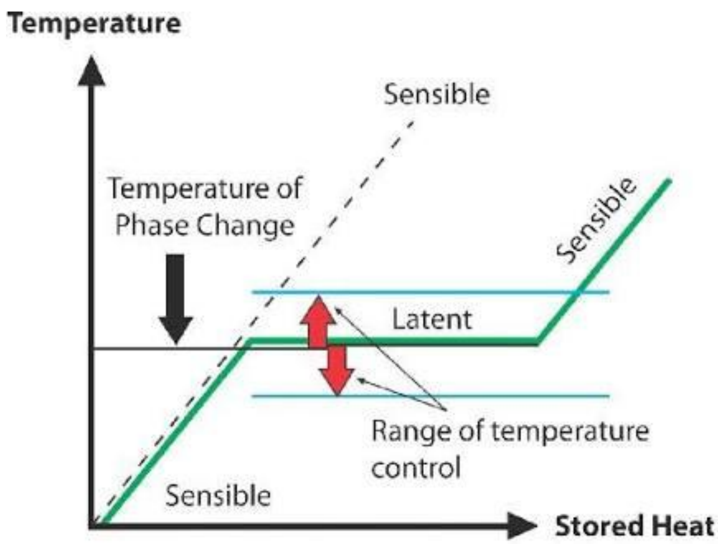

Fig. Phenomenon of phase change

2. EXPERIMENTAL SETUP AND WORKING

Experimental setup consists of a 75 w PV panel, Paraffin Wax as PCM, digital thermometer,a multimeter.

Paraffin wax properties

Melting point	40^0C
Latent heat(L)	190kJ/kg
Specific heat(c_p)	2.15kJ/kgK
Density(ρ)	900kg/m^3
Thermal conductivity(k)	0.25w/mK

PV panel specifications

Maximum Power ,P_{max}	75 ±3%
Type	Polycrystalline
Open circuit voltage	21.6
Maximum power current	4.20
Maximum power voltage	17.82
Temperature coefficient	-0.43% /K
Number of cells	36
Dimensions	94×67 cm

Fig. 75w PV panel and aluminum tray with PCM

When the temperature of the pv panel rises when placed under working, the paraffin wax absorbs all the heat and it stores the thermal energy. When the temperature reaches beyond the melting point of the Paraffin wax it changes its phase to liquid and when the temperature reduces Paraffin wax releases its thermal energy and solidifies. Thus it maintains the lower temperatures during the day and improves the conversion efficiency.

3. RESULTS

In the experimental results it is observed that as the temperature of the PV panel is increased the power output is decreased accordingly. It is also evident that the rise in ambient temperature and the continuous radiation causes the overheating of the panel placed at the 15^0 elevation facing south direction. The variation is observed in fig .

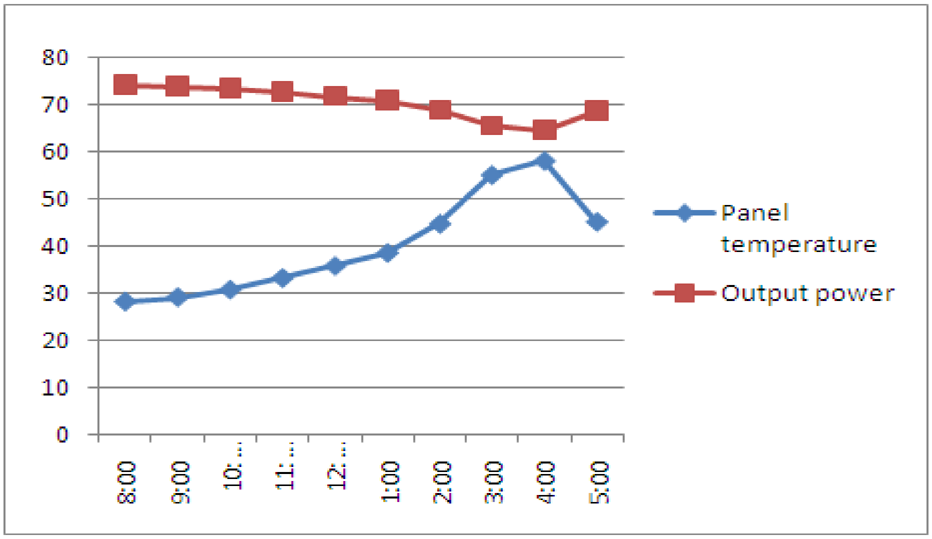

Fig. Variation of output power of PV panel without PCM

It can be understood that as the PCM is the latent heat storage material, the panel temperatures greater than 40^0 C are maintained constant almost as the PCM melting point is 40-42^0C it started melting at these temperatures. The variation of the output power is depicted in following fig

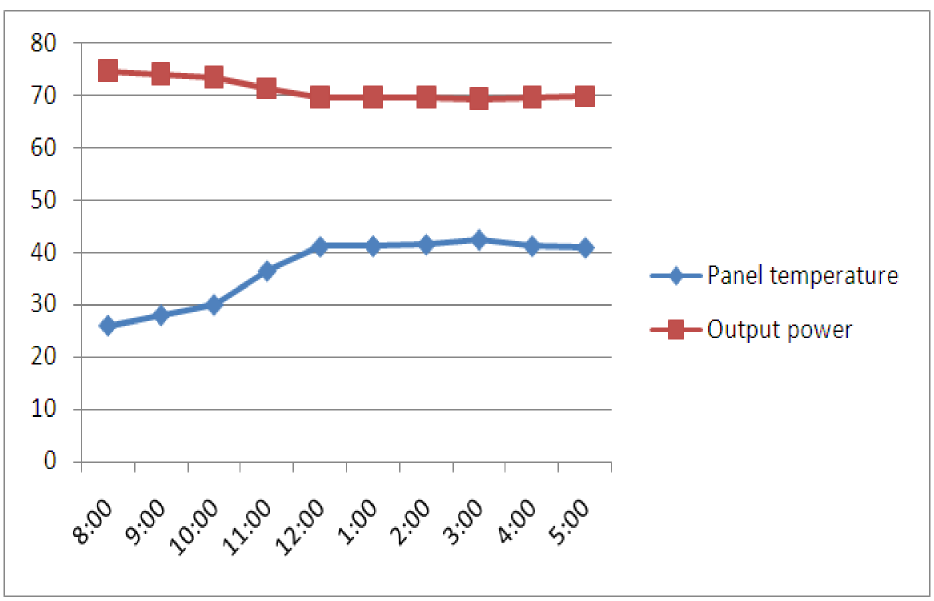

Fig. Variation of output power with panel temperature with PCM

4. CONCLUSION

Energy conservation is has got the meaning of saving energy and extracting maximum energy with the available resources. This can be achieved by reducing the wastage and improving the conversion efficiency of the energy delivering system. The solar energy conversion system of Photo-Voltaic panel has got the problem of achieving its maximum conversion efficiency. The main reason for this problem is rise in temperature of the PV panel. I got the improvement of 0.256 % in the conversion efficiency of the panel. The passive cooling system is the combination of Aluminum tray with Paraffin wax.

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