



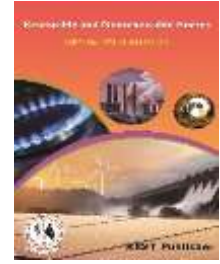
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Performance Analysis of 1mw Solar Power plant by Using Anti-Reflection Mirror Over absorber Plate

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Abstract: The present commercial PV cells convert solar energy into electricity with a relatively low efficiency i.e. less than 20%. More than 80% of the absorbed energy is dumped to the PV cell as waste heat. The purpose of this project is to investigate how to improve the efficiency of solar PV panels so that they could become a more reliable source of energy. As a first step, an anti-reflective coating glass over absorber plate of solar PV panel is considered. Radiation loss from absorber plate can be reduced with anti-reflective coating glass because of its high solar absorptivity and low long wave emissivity, whereas normal glass over solar PV panel absorbs only visible light and 33% transmitted energy to the absorber plate is reflected back to the environment. The second idea explored is, to use a cooling system in order to reduce the temperature within the solar panel, thus boosting the efficiency. One of the main difficulty that is faced in the operation of photovoltaic panels (PV) is overheating due to excessive solar radiation and high ambient temperatures. The efficiency of photovoltaic panels decreases as the panels temperature increases, which results in the reduction of electricity generation. In order to reduce this effect, cooling system has been used with different cooling media like air, tap water and distilled water. The investigations are carried out at sun shine electric LLP at Hyderabad, under simulated sun light as well as real time day light.

Keywords: antireflective coatings (ARC), solar cells, I-V characteristics, PV cooling; active cooling.

1. INTRODUCTION

The present commercial PV cells convert solar energy into electricity with a relatively low efficiency is less than 20%. More than 80% of the absorbed energy is dumped to the PV cell as waste heat. This heat is generated in two ways i.e., First, there are I²R_s as a result of the current flowing through the resistance, R_s, of the solar cell. Second, there is the thermal energy which represents the difference between the absorbed solar photons and the realized electrical energy of the generated electron-hole pairs. Cell temperature is of vital importance for performance of PV cells. Temperature dependence on performance parameters and energy conversion in PV cells has been investigated by many authors. It is well known fact that the efficiency of PV cells decreases with increasing cell temperature. Anti-reflection (AR) coating for glass surfaces, which reduces the sun's reflection from photovoltaic panels while at the same time improving their efficiency. Anti-Reflective (AR) coatings have been in commercial use for many years in a variety of applications including vision lenses, display cases, flat panel display cover glasses, plastic lenses, and commercial cover-ups to reduce the reflection interferences that block vision clarity and, in many cases, to improve overall aesthetics. mRecently, though, AR coatings have been used more extensively as a functional tool towards improving energy efficiency in various applications. Anti-reflection coating glass contains gallium indium phosphide and gallium arsenide which absorbs visible light, infrared light respectively where as normal glass over solar panel absorbs only visible light. Present this type of glass are using as eye lens which avoids the reflection effect with different wavelengths of light.

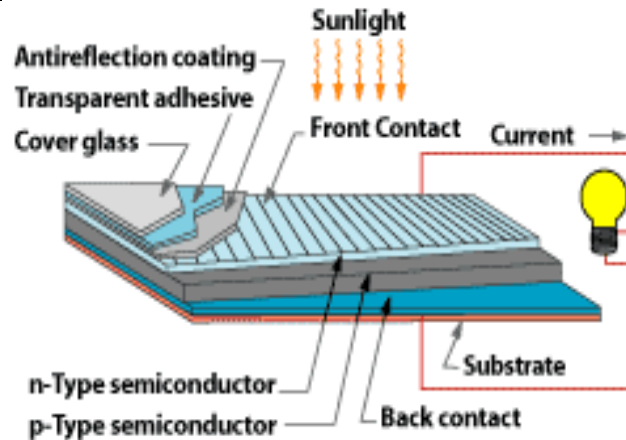


FIGURE 1. Schematic View of a Typical Anti-Reflection Solar Cell

In solar applications, AR coating are now being used in a many Photovoltaic (PV) module technologies (crystalline silicon, thin film, etc.) on its cover glass in order to reduce reflection losses from the sun and, in return, allow more sunlight (broadband range of 0-1,400 nm) to reach the semiconductor material and translate it more efficiently into electrical energy.

2. LITERATU REREVIEW

High Performance and Durable Antireflective (AR) Coatings. Proceedings from Glass Performance Days. 11-12 June 2009, [1, 4, 8] the basic factor that affects the efficiency of a solar cell is the reflection of light from its front surface. The reflection coefficient can be reduced by covering the top of the solar cell surface by antireflective coatings (ARC) – Various techniques can be used to deposit antireflective coatings: the chemical vapour deposition (CVD), spray, spin-on or screen printing. The spin-on is the simplest technique which is very efficient and does not need expensive equipment; however, this method can be used only on smooth, polished surfaces. Another method – plasma enhanced chemical vapour deposition (PECVD) is more expensive, but it enables the deposition of layers with very good parameters (reflection coefficient, chemical contents) – very uniform and of controlled thickness.



FIGURE 2. Photograph of Non-AR coated and AR Coated Silicon wafer

Standard glass consist of single absorber layer gallium indium phosphide absorbs only visible light. Refractive indices (r) is about 1.5

Cover plate properties:

- To transmit maximum solar energy to the absorber plate.
- To minimize upward heat loss from the absorber plate.
- Protecting the absorber plate from direct exposure to weathering. 33 % transmitted energy to the absorber plate reflecting back to the environment.

3. EXPERIMENTALWORK

The standard glass over absorber plate replaced with the anti-reflection glass is useful in collecting the more sun light and focusing it onto the receiver, which is the solar cell. A typical concentrator system is achieved with the help of glass acting as the collector. The term concentration ratio is defined as the amount of solar energy concentrated on the solar PV panel.

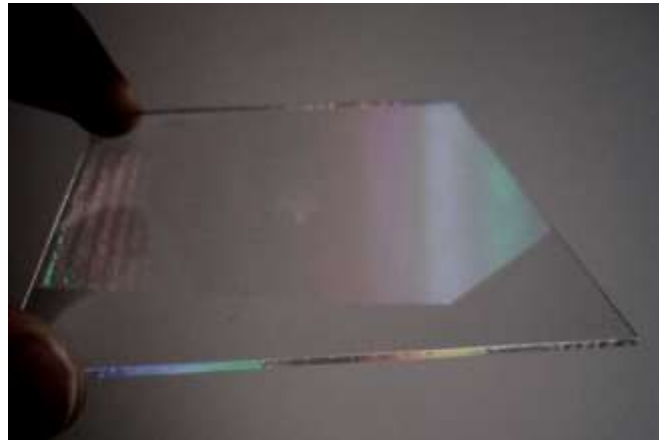


FIGURE 3. Anti-Reflection Coating Glass

Owing to the sun-earth geometry and the location of HYDERABAD, India, the 130W solar panel was kept surface of the roof top. The length of the panels both standard glass and anti-reflection glass was aligned along the north-south direction, so that the maximum possible amount of light was reflected on to the panel. The overall experimental setup is illustrated in Fig 3.2 the pieces of plane and anti-reflection coating is used to reflect sun-light effectively at any time of the day.



FIGURE 4. PV system using anti-reflection coating

Pyranometer: A pyranometer is a type of actinometer used to measure broadband solar irradiance on a planar surface and is a sensor that is designed to measure the solar radiation flux density (W/m^2) from a field of view of 180 degrees. The name Pyranometer stems from Greek, "pyr" meaning "fire" and "ano" meaning "above, sky".



FIGURE 5. Eppley - Precision Spectral Pyranometer

Here the global solar radiation incident on a horizontal surface was measured using an Eppley - Precision Spectral Pyranometer with sensitivity, $1\text{mv} = 195.3126 \text{ W/m}^2$. The voltage and current was measured by multimeter of $\pm 0.001\%$ accuracy. It can be easily inferred from the curves in Fig.4.2 that for any given time of the day, the value of efficiency with the anti- Reflection glass PV panel is greater than that standard mirrors. The improvement while using anti-reflection glass PV panel was observed highest at the mid-day, when the I_{sc} with the mirrors exceeds the I_{sc} standard mirror over a wide margin. Fig.3.11 shows the concentrated PV system using anti-reflection. Fig. 4.1 show the performance of the PV panel efficiency with time for anti-reflection studies

4. RESULTS AND DISCUSSIONS

Sample calculation for finding the PV panel efficiency with mirror concentration method: From the Table 4.9 at the time of 13hr the below parameters are calculated

Here

Pyranometer voltage, $V_{py} = 3.91\text{mV}$

Panel O/P voltage, $V = 98.89\text{V}$

Current, $I = 3.19\text{A}$

Area of panel, $A_c = 1.2 \text{ m} \times 0.5 \text{ m}$

(From 130W Panel name plate details)

$A_c = 0.60 \text{ m}^2$

Radiation, $E = V_{py} \div (5.12 \times 10^{-6} \text{ V/W-m}^2)$

$= 3.91\text{mV} \div (5.12 \times 10^{-6} \text{ V/W-m}^2)$

$E = 763.671 \text{ W/m}^2$

Panel I/P power, $P_{in} = E \times \text{Area of panel}$

$= 763.671 \text{ W/m}^2 \times 0.60 \text{ m}^2$

$P_{in} = 458.2026 \text{ W}$

Panel O/P power, $P_{out} = V \times I$

$= 98.89 \times 3.19 \text{ A}$

$P_{out} = 314.839 \text{ W}$

Panel efficiency, $\eta = (P_{out} / P_{in}) \times 100 \%$

$= (314.839 / 458.20) \times 100 \%$

$\eta = 68.71\%$

Therefore, the efficiency of PV panel at 13hr is,

$\eta = 68.71\%$.

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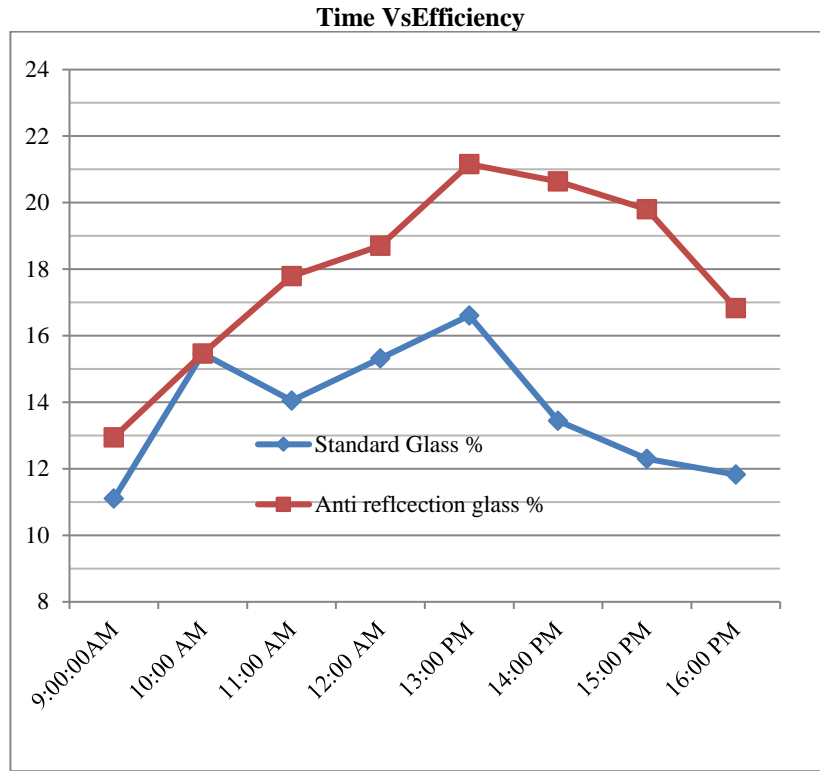


FIGURE 6.

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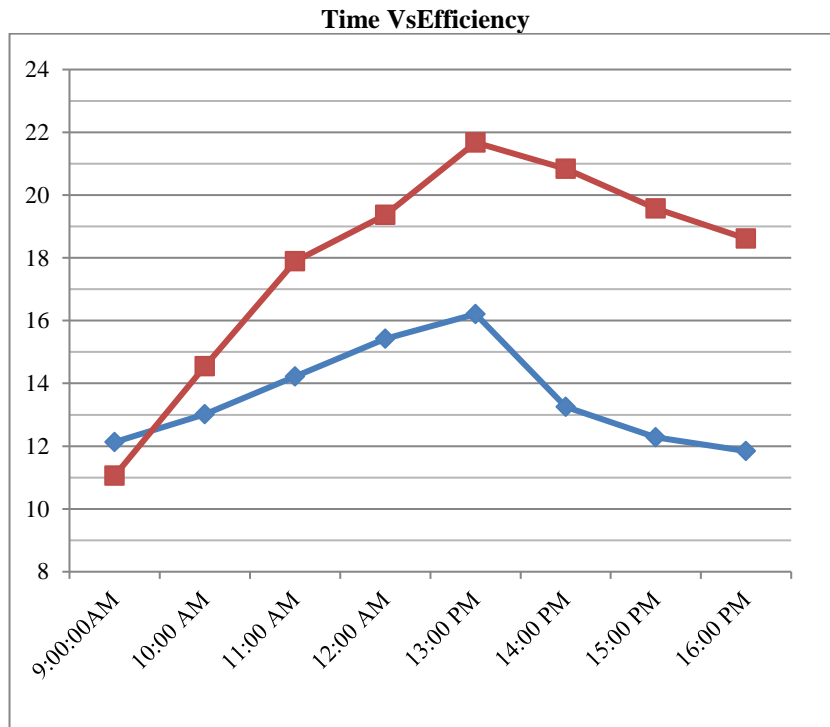


FIGURE 7.

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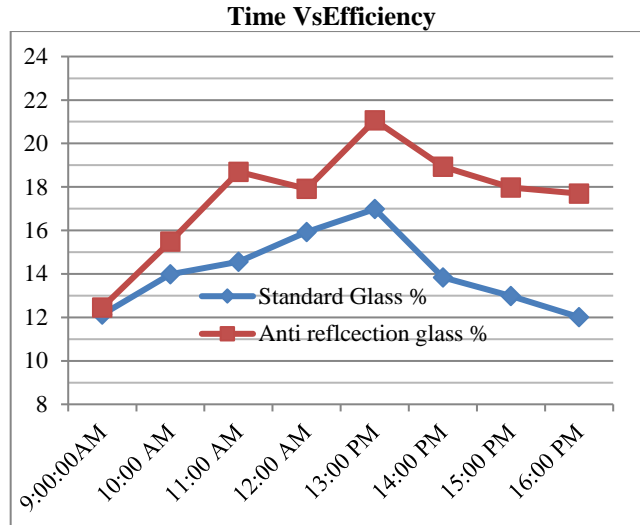


FIGURE 8.

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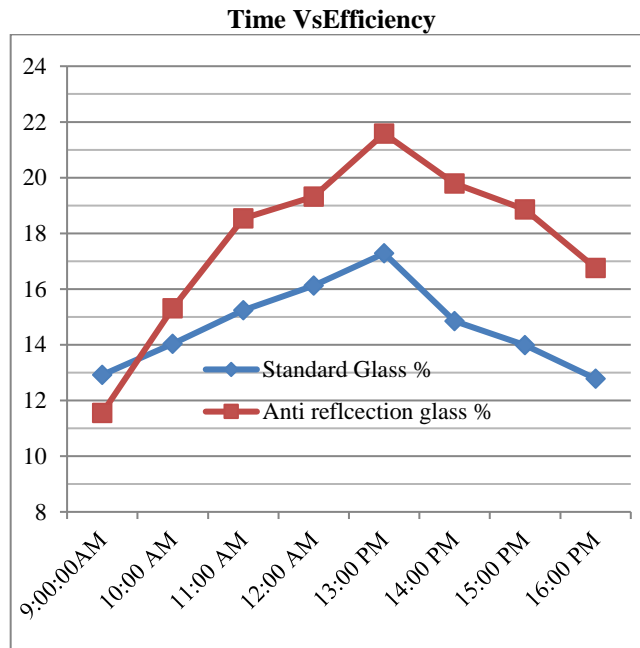


FIGURE 9. Graphs of Efficiency Variation for Pv Panel in Sun Light with Standard Glass and Anti-Reflection Glass Mirror Pv Panels

5. COOLING SETUP

It is well known fact that the efficiency of PV cells decreases with increasing cell temperature. This decrease arises from the drop in voltage parameters of PV cells. Therefore, it is necessary to keep the PV cell temperature and cell reflection as low as possible in order to enhance the efficiency of PV cells. Air-cooled or water-cooled technology for PV cells has been studied for many years. Active cooling may be considered one of the most effective methods to provide an acceptable level of cooling for PV cells. This technique enables to cool a PV cell by using low-cost extended surfaces via natural convection and requires no additional device such as fan, pump, etc. for heat extraction. Therefore, active cooling method is quite cheap and practical. Herewater is used as a cooling media the setup is quite simple. Some standard garden sprays located at the top of PV panels. These sprays are fed by a small 18-watt pump. PV panels are setup in two rows, with 5 on top and 4 below, with a small gap between the rows (say 5mm). Fig.4.1 shows the schematic diagram of experimental setup using simulated sunlight.



FIGURE 10. Solar Setup Including Water Cooling

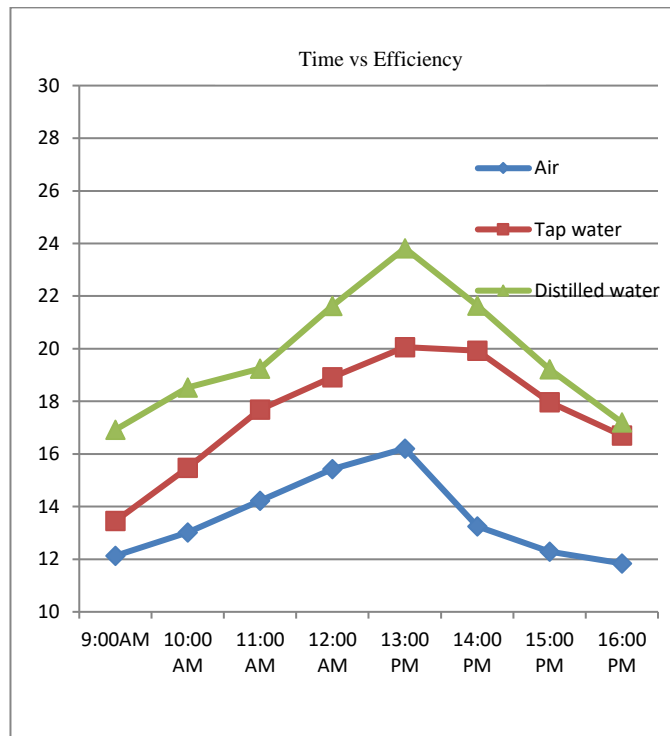


FIGURE 11. Graph of Efficiency Variation for PV Panel with Different Cooling Media

TABLE 1. The Maximum Values in the Cooling System of PV Panels with Cooling Media

Liquid media	T (°C)	P _{max} (W)	η _i (%)
Air	49.6	60.84	16.20
Tap water	37.4	98.75	20.06
Distilled water	36.9	132.8	23.82

6. CONCLUSIONS

In common opinion it is not possible to produce efficient solar cells without any Antireflective coatings. In this work, the efficiency of the normal PV panel was compared with the efficiency of Anti-reflection concentrated PV panel. It is observed that the Anti-reflection CPV panel provides maximum efficiency of 16.28CUF while normal PV panel maximum efficiency is 11.52 CUF. Further, active cooling experiments were conducted by using active cooling method with different liquid media such as tap water,

distilled water. It was found that the maximum efficiency was obtained for distilled water, 23.82%. It was found that, maximum efficiency was obtained by using Tap water was 20.06%. The results show that on a design day, the active cooling system reduces the temperature of the cells and increases electrical efficiency of the PV panel by 5.24%.

REFERENCES

- [1]. Thomsen, Scott V.; Sharma, Pramod; and Lewis, Mark. High Performance and Durable Antireflective (AR) Coatings. *Proceedings from Glass Performance Days. 11-12 June 2009, Tampere, Finland*
- [2]. PotugantiPrudhvi, PonnappalliChaitanyaSai "Efficiency Improvement of Solar PV Panels Using Active Cooling"-2012 IEEE
- [3]. P G Nikhil, M. Premalatha "Performance enhancement of solar module by cooling: An experimental investigation"-2010 from *international journal of energy and environment*
- [4]. J. T. Cox and G. Hass, Antireflection coatings for optical and infrared materials" in *Physics of Thin Films, eds. G. Hass and R. E. Thun, vol. 2 (Academic Press, New York, 2010) p.239*
- [5]. P G Nikhil, M. Premalatha "Performance enhancement of solar module by cooling: An experimental investigation"-2010 from *international journal of energy and environment*
- [6]. Yiping Wang, Zhenlei Fang, Li Zhu, Qunwu Huang, Yan Zhang, Zhiying Zhang "The performance of silicon solar cells operated in liquids"-2009
- [7]. A.Virtuani, D. Pavanello, and G. Friesen: Overview of Temperature Coefficients of Different Thin Film Photovoltaic Technologies. *5th World Conference on Photovoltaic Energy Conversion, 6-10 September 2010, Valencia, Spain.*
- [8]. Chakravarty B.C., Vinod P.N., Singh S.N., Chakraborty B.R., Design and simulation of antireflection coating for application to silicon solar cells, *Solar Energy Materials and Solar Cells* 73(1), 2002, pp. 59–66.
- [9]. SEI, (2004). *Photovoltaics Design and Installation Manual*.New Society Publishers.
- [10]. M.Rosa-Clot, P.Rosa-Clot, G.M.Tina, P.F.Scandura
- [11]. : Submerged Photovoltaic solar panel: SP2, *Renewable Energy* 35 (2010) 1862-1865.