

Comparative analysis of Various PV modules for Energy Generation

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ABSTRACT

Solar cells are known for the conversion of solar light to electric current. A PV module is one that has solar panels interconnected to each other. The efficiency of the module is defined as the ratio of output power of a solar panel to the unit area of the panel in whole. It is noted that the generation of electricity is found to increase when these panels are cleaned. The cleaning methods using dry cloth and water have been analyzed. A comparative study of increase in generation for HIT (Heterojunction with Intrinsic Thin-layer), Polycrystal, Monocrystal and Cd-Tel (Cadmium Telluride) and the advantages and disadvantages of these types are shown.

Keywords: Pv module, HIT (Heterojunction with Intrinsic Thin-layer), Monocrystal, Polycrystal, Cd-Tel (Cadmium telluride)

INTRODUCTION

Solar energy has taken a prominent place in the world of renewable energy due to its major advantages. But it still lags behind in the sense of Generation with respect to the area of installation. PV module consists of solar cells packed and arranged close together and when these modules are cleaned periodically with water or dry cloth there is found to be a productive increase in terms of generation. This aspect cannot be neglected as the though the investment for cleaning is small and the generated output increase is of great capacity in comparison. The c-SI (crystalline Silicon) such as monocrystal and polycrystal types consist of the worlds 90% Photovoltaics today. HIT's and Cd-Tel's are thin film technology which are new and have found great importance due to its advantages. These four types of Solar panels have been analyzed and the results have been studied.

METHODS AND MATERIALS

The various materials and method types that are to be reviewed here are,

1) **Monocrystal-** It is one of the types of C-Si (crystalline silicon) type PV modules. This type of PV module gets its name from the fact that it uses single crystal – Si. It is hence also called as single crystalline silicon type. Silicon ingots are used to make the solar cells. These are found to be cylindrical in shape. (Marion.B, 2002) But in-order to cut the costs, the edges is cut off to make it a four sided silicon wafer corresponding to the characteristic look of the monocrystal solar PV panels.

Advantages- They are made out of the highest grades of silicon and hence provide with the highest efficiency. These panels take lesser space comparatively. The monocrystalline solar panel is also found to have the longest life.

Disadvantages- Since they utilize pure silicon, they are the most expensive. Breakdown of entire circuit is possible when the panel is covered by dirt or shade. Since the cylindrical shape is cut, there is wastage of silicon. (K. Machida, et. al. 1997)

2) **Polycrystal-** The major disadvantage of the monocrystalline silicon cell is that they have silicon wastage. This is avoided by pouring raw molten silicon into a square mould and the square wafers are made. So hence the Czochralski process used in monocrystal module is not required for the production of polycrystal module.

Advantages- The production cost of Polycrystalline module is cheaper and simple. Wastage of silicon is reduced by a good margin by the use of melting and square moulds. They are less heat tolerant and hence more suitable for small applications.

Disadvantages- Since the purity of the silicon is compromised, the efficiency is lower. Due to reduction in efficiency, the Space-efficiency is also reduced as it requires larger area to produce the same output as that of monocrystalline solar panel.

3) **HIT-** Heterojunction with Intrinsic Thin-layer has a thin solar film which is amorphous in nature and this thin layer is present / placed behind monocrystalline cells. The presence of this layer extracts more energy from the sunlight present. These hence do not need a lot of space to produce the same output compared to the other panels.

Advantages- Takes least installation space and hence can be used in areas where space is an issue. They can extract the most energy from the sunlight at any particular time.

Disadvantages- Due to the extra amorphous layer, the cost is increased. These panels are not usually recommended if there is lot of space available as the expenditure is high.

4) **Cadmium Telluride (Cd Tel)-** It is of the thin film solar panel technology and is only solar panel of this type that has a greater cost-efficiency than that of crystalline silicon solar panels. Cadmium telluride panels have an efficiency of 9 to 11 percent. Due to the usage of thin film technology, the Panel is flexible and hence makes it more convenient for usage in terms of large scale.

Advantages- Production in Large scale is cheaper as well as simple compared to solar cells which are crystalline based. Dust, shades and snow have little effect on solar panel performance. Tolerant to high temperatures and can be preferably used only in areas where space is an issue. (Nakajima, et. al. 2004)

Disadvantages- It has lesser space-efficiency compared to that of monocrystalline PV panel. The latter is found to produce four times the amount of electricity for the same space. The major disadvantage of this type is that they have a lesser life as they deteriorate faster.

The PV module current voltage and Power-voltage characteristics are

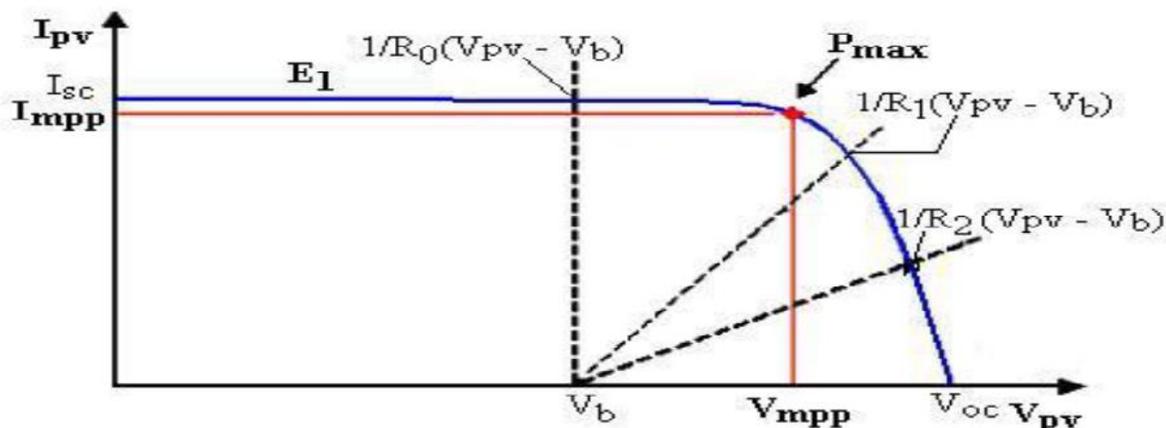


Figure.1. voltage current characteristics

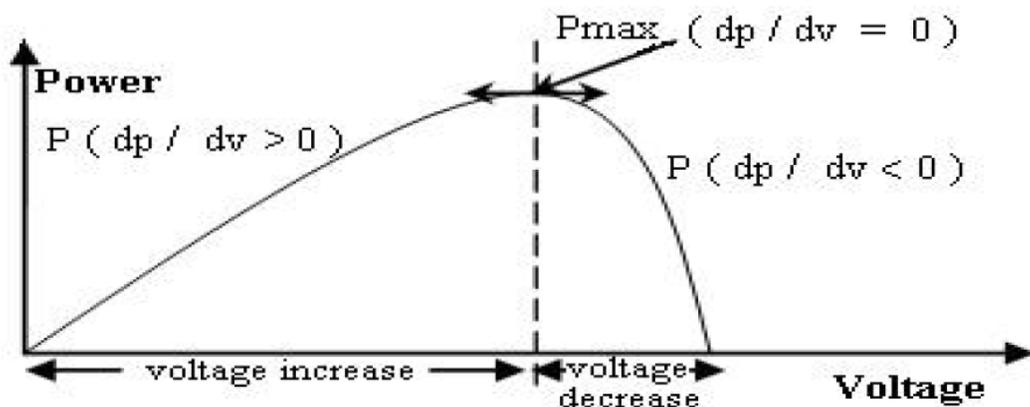


Figure.2. Power-voltage characteristics

CLEANING METHODS

Solar panel maintenance not only is found to improve the Generation but also improve the lifetime of the Panel installed. Rain is considered as a natural cleaning agent. But the problem is that it will invite pollution through oxidation, dust settlement and hence may harm the solar panel (K. Machida, et. al. 1997). It is favorable to use Ultra pure water or dry cloth as these cleaning components do not utilize chemicals in them. Usage of chemicals will cause grievances and disposal of the same becomes an issue. When these chemicals are dispersed into the environment they exceed the environmental regulations. Non usage of chemicals will prevent the adverse effects which the chemicals can cause to the panels. (King, D.L., et. al., 2002)

Care should also be taken that the transparency of the panels is not affected during the cleaning process. Manual cleaning also comes with the risk of working in heights.

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Research shows that scheduled cleaning will improve efficiency and increase the solar output. Here the results of cleaning with pure water and dry cloth are discussed.

RESULTS OF CLEANING

The Results of cleaning are tabulated below and the Kwh generation values for uncleaned PV module, cleaned with water and cleaned with dry cloth details of PV modules are portrayed.

A graph on the percent increase in generation is also shown as a comparison between the Cleaned with water and dry cloth. These results have been analyzed for a period of three days.

Table.1. Analysis of HIT (Kwh)

Day	Generation when panel is uncleaned (Kwh)	Generation when Cleaned with water (Kwh)	Generation when Cleaned with dry cloth (Kwh)
1	1.265	1.45	1.45
2	1.39	1.6	1.595
3	1.335	1.54	1.535

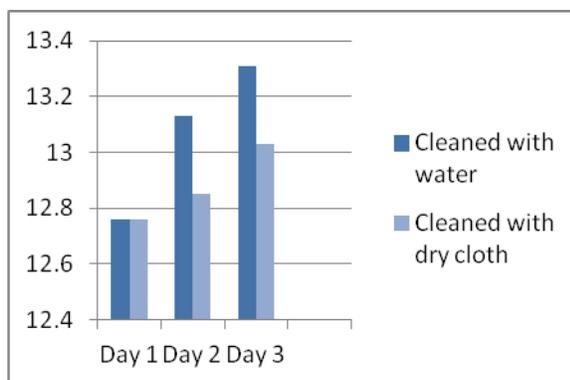


Table.2. Analysis of Polycrystalline (Kwh)

Day	Generation when panel is uncleaned (Kwh)	Generation when Cleaned with water (Kwh)	Generation when Cleaned with dry cloth (Kwh)
1	1.315	1.445	1.435
2	1.45	1.585	1.56
3	1.39	1.525	1.525

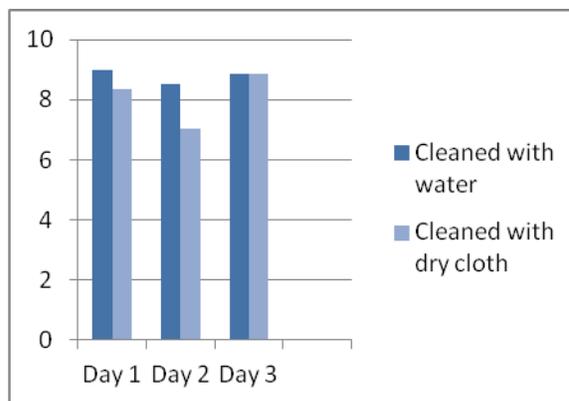


Table.3. Analysis of Monocrystalline (Kwh)

Day	Generation when panel is uncleaned (Kwh)	Generation when Cleaned with water (Kwh)	Generation when Cleaned with dry cloth (Kwh)
1	1.165	1.38	1.39
2	1.27	1.495	1.51
3	1.22	1.425	1.47

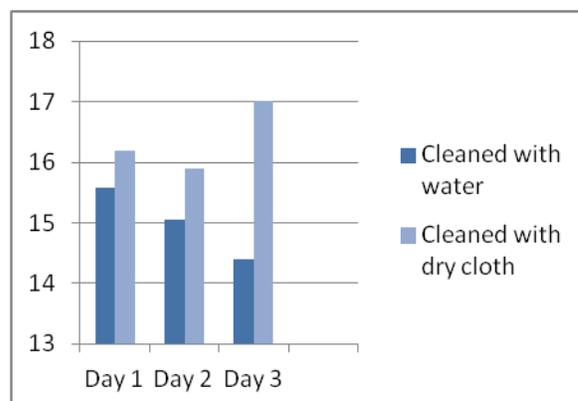
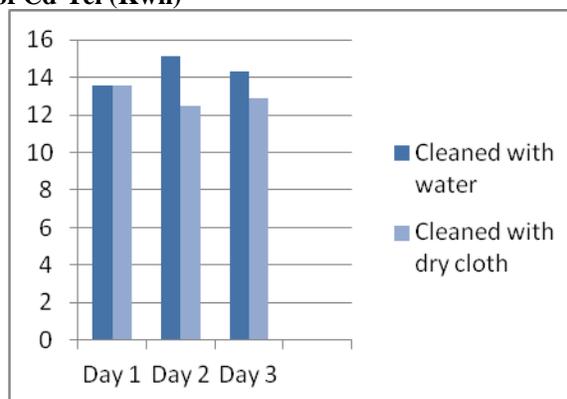


Table.4. Analysis of Cd-Tel (Kwh)

Day	Generation when panel is uncleaned (Kwh)	Generation when Cleaned with water (Kwh)	Generation when Cleaned with dry cloth (Kwh)
1	0.51	0.59	0.59
2	0.56	0.66	0.64
3	0.54	0.63	0.62



CONCLUSION

There is presently an environmental need for solar energy with economy as a major issue in the field of renewable energy. Clean, replenishable and safe form of energy is provided by the sun. Harvesting this energy through the use of solar PV modules has been found to be uneconomical for a large section of society in terms of cost to generation ratio. But with the rise of new technologies such as thin film, the generation aspect of the system has been taken care of. Unnecessary wastage of energy is prevented by the usage of cleaning systems. Water and dry cloth methods do not come with harm to the panels as well as the environment as they do not use chemicals. Thus efficiency improvement through cleaning of solar panels have been achieved through water and dry cloth cleaning procedures and the results and advantages of the HIT, Monocrystal, Polycrystal and Cd-Tel have been portrayed in this paper.

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