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International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-4, February 2020

Design and Fabrication of Experimental Setup for Detecting and Analyzing the Defect in Solar Panel

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Abstract*: *The energy consumed by the people around the world for one year is equal to the emission of power by the sun in one minute. Hence inventors have invented photovoltaic solar panels absorb sunlight as a source of energy to generate electricity. The solar panel efficiency depends on many factors, in which one of the factor in its defects. This project deals with design and fabrication of the defect detecting setup that helps to detect the intensity of the solar panel. The major concern of our project is to detect the percentage of the defect more precisely. Keeping the above mention criteria in mind all calculations was performed. The model was designed using AUTOCAD for 2D modeling and CATIA for 3D modeling. The overall cost of the project is certainly low as compared to the commercially available solar panel defect detector.

Keywords: Defects in solar panel, photovoltaic technology, PV cells, solar panel, solar power, renewable energy, thermocouple, tri-axial accelerometer.

I. INTRODUCTION

Photovoltaic technology operates by catching the photons of light and manipulating them to produce free electron. These electrons generate electric current. The main way to develop this technology is through solar power panel or PV cells. A PV cell is a semiconductor cell which is able to convert solar rays into electrical power. In these solar cells there are many types of defects. Some are hot spots, micro cracks, snail trails contamination, PID effect, Internal corrosion. Thus it is essential to have a defect finding and analyzing machine to help us. Unfortunately these machines are quite costly, hence we have developed a setup that is cost efficient and can detect the defects of the solar panel.Sufficient research has been done related to available Photovoltaic technology and defects analyzer.

Revised Manuscript Received on February 28, 2020.
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MostefaGhassoul [1] constructed an experimental setup that has a tracking system that is based on PILOT scheme.

This setup thus helps in controlling the solar panel that optimizes the extraction of the solar energy by the solar panel. By having this setup the efficiency of the solar panel can also be increased.

Dayal Singh Rajput et al., [2] performed a work that deals with the effect of dust and dirt deposition on the solar panel, and relating it with the efficiency of the solar panel. Hence he concluded that the dust deposition is inversely proportional to the efficiency of the solar panel.

Saad odeh et al., [3] constructed an experimental setup that helps in improving the efficiency of the solar panel by introducing a water cooling system. By this system the efficiency is well improved.

Moshe Sela et al., [4] discussed the various methods by which the effeciency of the solar panel are estimated. by this methods it has been easy to find the rise or fall of the effeciency is there is any changes done to the system.

Askari Mohammad Bagher et al., [5] did a detail analysis on the different type of solar panel, and listed them with their characteristic and specification in detail.

Liga Rozentale et al., [6] conducted an experiment in Latvia that compares the electricity consumption without solar panel system with the electricity consumption with solar panel system. By this he concludes the importance of the renewable system i.e., solar energy.

K. Vaisakh et al., [7] did a detailed discussion on the types of renewable energy present till date, and also mentioned the methods by which all types of renewable energy is being converted into useable electricity.

Farhan Ali Khan et al., [8] performed an analyzing work that deals in detecting the presence of defects that is present in the considered solar panel by using the thermal imaging system that uses the PCA and ICA method.

E. Azadi et al., [9] did a detail study on the smart solar panel present in the satellites, which are used for production of electric power experience direct solar flares from the sun. To avoid the defects caused by the sun smart solar panel are used.Karan Kapoor et al., [10] discussed the evolution, development and advancement of the solar panel in India. Also discussed the terms, policy and condition of solar panel in India. Feng –Ming Li et al., [11] did a detailed analysis on lattice vibration, molecular structure, lattice arrangement,

arrangement of molecules etc in a material. Seth B. Dworkin et al., [12] found a method for predicting and analysis of the hybrid solar panel performance in various operating modes and condition.

By this method of prediction one can easily find the efficiency of the hybrid solar panel.

II. PROBLEM DEFINITION

Many types of solar panel are invented till date, but these solar panels have different types of defects. Some of the defects are:

- Hot spots
- Micro cracks
- Snail trail contamination
- PID effect
- Internal corrosion

With the presence of these defects, it is essential to have a defect finding and analyzing machine to help us. Unfortunately the machines which are used to estimate the defects are quite costly.

III. OBJECTIVES

The defects mentioned above are some of the cause for the depletion in the efficiency of the solar panel. Hence to rectify them, these defects must be identified and analyzed first, and then only proper steps can be identified.

So we have developed a setup that can detect the crack defects and its intensity in the solar panels using different sensors like thermocouple (temperature sensor), tri-axial accelerometers (vibration sensors).

By using our setup one can easily know the percentage of defect and can easily analyse the results with obtained with the good no defect solar panel.

IV. METHODOLOGY

Firstly a solar panel with no defect is considered, it converts the solar energy into electric energy that is used to heat the water. Now the time required to heat the water to 100^0c is noted. At the time of boiling the system temperature and vibration are measured and noted using sensors like thermocouple and tri-axial accelerometer.

Secondly the same experiment in conducted with defective solar panel where numbers of cracks are considered. And the output readings are noted.

Thirdly the same experiment in conducted with defective solar panel considering the depth of crack. Now outputs reading are noted. Then the resulted are tabulated and analyzed to get the percentage of defects in the solar panel.

LITERATURE REVIEW

PROBLEM DEFINITION

COMPONENTS SELECTION

DESIGNING THE SETUP

FABRICATION OF SETUP

TRI-AXIAL ACCELEROMETER READING

THERMOCOUPLE READING

RESULT AND ANALYSIS

CONCLUSION

V. EXPERIEMENTAL SETUP

The below fig.1 displays the entire experimental setup, and the specification of the setup is mentioned below.

Fig.1 Experimental setup

The component's uses and specifications of our setup are listed below.

A. Solar panel:

The solar panel is one which converts solar energy into electric power. Their specifications are - Polycrystalline type of solar panel with 150 watt and 12V.

B. Inverter:

The inverter is used to convert DC current which comes as an output from the solar panel into AC current. Their specifications are – 12 V, 100 Watt and 32 bit DSP processor.

C. Water container:

Water container is used to store water and is heated using heating or induction coil which is supplied with the output from the inverter. Their specifications are - tank dimension is 30*30*15 cm and its capacity is 13.5 liters.

D. Tri-axial accelerometer:

The tri-axial accelerometer is used to sense the vibration occurring in the system. Its specifications are – its sensitivity is 100mV/g, measurement range is 50 g pk, frequency range is 1 to 4 kHz and weight is 5.4 gram.

E. Thermocouple:

The thermocouple is used to sense the heat or the temperature of the system. Their specification is 32 deg F to 900 deg F.

F. DAQ:

The DAQ are used to acquire the signals from the solar panel using the sensors.

Its specifications are 8 channel, 51.2 kS/s per channel and 5V analog input.

MODEL DESIGNING

A.2D DESIGN

The below fig.2 displays the 2D design of our entire experimental setup, and the explaination of the design is mentioned below.

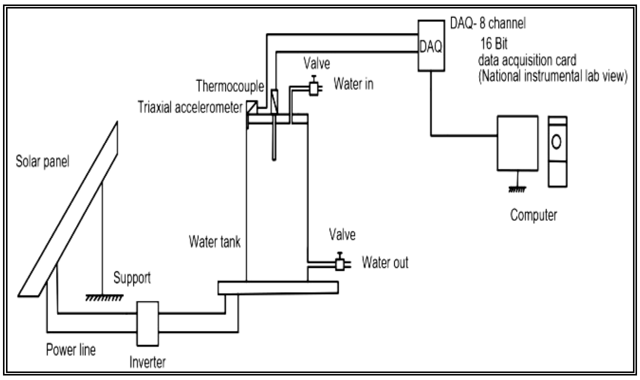

Fig2. 2D Design

The 2D model of our project is mentioned above. This model is created using the AUTO CAD software. This model clearly explains the components of our project.

B. 3D Design

The below fig.3 displays the 3D design of our entire experiemental setup, and the explaination of the design is mensioned below.

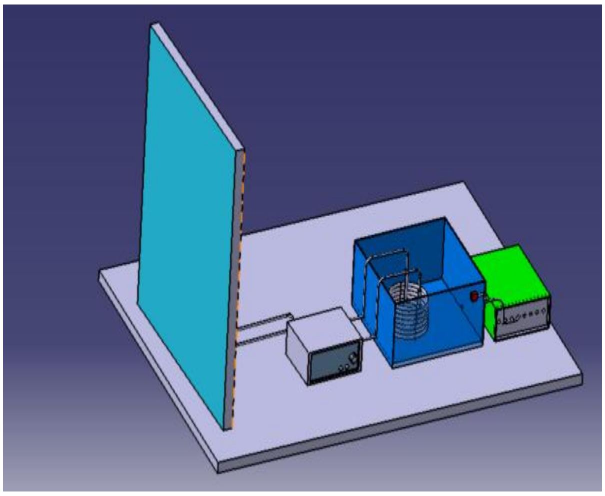

Fig.3 3D Design

The above mentioned is the 3D model of our project which was modeled using the CATIA software. This model provides the clear 3D view of our experimental setup.

VI. DESIGN CALCULATION

Nomenclature

- ✓ C_P=Heat capacity of water (kJ/kg.K)
- ✓ m=Mass of water (kg)
- ✓ T_2-T_1=Temperature difference (K)
- ✓ C_{Vap}=Heat of vaporization ofwater (kJ/kg)

A. Watt calculation of the solar panel

Step 1: Energy required for raising the water from 30^0c to 100^0c

E1= m* C_P*(T2-T1)

=2*4.186*(100-30) (1 liters = 1Kg)

=586.04 KJ

Step 2: Energy required for vaporizing the water to produce steam

E2=m*C_{vap}

=2*2257

=4514KJ

Step 3: Total energy of the system

E=E1+E2

=586.04+4514

=5100.04 KJ

Step 4: Total power of the system

Power = [Total energy /Time]

=5100.04/3600

=1.416 KJ/sec (or) 1416 J/sec (or) 1416 Watt

Cost of 1500 Watt solar panel in market is Rs. 50000. As the cost is too high we increase the time of the heating process, which results as follows:

Step 5: Recalculating the power

Power =5100.04/34000

=0.1500 KJ/sec (or) 150 J/sec (or) 150 Watt

Hence 150 Watt solar panel is considered for our setup. Then other components like DC convertor, heating coil etc are considered based on the solar panel specification i.e., 150 Watts.

B. Calculating of the size of frame

The best angle for the solar panel depends on the latitude and longitude of the location. As we are present near the equator the favorable angle in 30^0. Hence the frame is manufactured to keep the solar panel in 30^0.Now to find the base length and height of the frame, following calculation are made. They are Known data: length of the solar panel is 149 cm.

Step 1: find the base length of the solar panel

Now applying PYTHAGORAS THEOREM

Cos (30) =Base/149

So,

Base =Cos (30)*149

=130 cm

Step 2: find the base height of the solar panel

Now applying PYTHAGORAS THEOREM,

Sin (30) =Height/149

So,

Height =Sin (30)*149

=75 cm

Hence the dimension of the frame used is 130cm base and 75cm height.

VII. CONCLUSION

The above setup is fabricated and assembled in such a way to have the ability to provide results related to solar panel defects. These results are then analyzed by generating graphs using ORIGIN software. From the generated graphs, the defects and also the efficiency of the solar panel can be estimated.

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