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DESIGN AND IMPLEMENTATION OF SOLAR TRACKER WITH REFLECTED MIRRORS

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ABSTRACT

Solar energy is the best renewable energy source when compared to all other renewable energy sources to develop electric power. The generation of electric power is completely depends upon photovoltaic effect. Generally photovoltaic panel is always fixed in the direction. The present study includes the design and implementation of a solar panel tracking system with linear actuator. In addition to the solar tracking system, it consists of reflecting mirrors. Solar tracking system with reflecting mirrors allow more energy to be produced because of the movement of solar panel along with the movement of the sun as it aligned to the sun. The solar tracking system with linear actuator will be designed and the performance of the system will be evaluated. Ultimately a working system will be demonstrated to validate the design.

KEYWORDS: Linear Actuator, Solar Energy, Reflected Mirrors

INTRODUCTION

Now a day's Electric power is one of the major needs for the world. The production of electric power is completely based on non renewable energy sources. The overall power generation from fossil fuel is around 65%. The environmental pollution is increasing due to the production of electricity using fossil fuels (i.e., the percentage of green house gas in the atmosphere is increasing). Now the world is facing a problem called green house effect. This effect increases the atmospheric temperature which further leads to severe effects to living organisms. So we need to reduce the emission of green house gases by introducing solar based electric power generation, which is a renewable energy source. In this system the power generation from the solar energy can be done by photovoltaic effect. The availability of the photovoltaic panels is plenty in the market, but the power generation by photovoltaic panel is very less due to their excess cost and due lack of knowledge to produce electricity using these panels. In the paper, Asmarashid Ponniran [1] proved experimentally that the single axis tracking system was very efficient when compared to fixed photo voltaic panel. A lot of work has done on single axis and dual axis tracking system and proved that dual axis tracking system is more efficient than single axis system. Reflected mirrors will be introduced in the single axis tracking system.

DESIGN OF SOLAR TRACKER

Charge Controller

Charge controller is a major component in this system. It is connected in between solar plates and battery. It controls the overheating of battery and protects against overvoltage. The basic function of charge control is to allow the energy into battery and to control the overcharging of battery. The working principle of charge controller is simple i.e., Charge controller blocks the reverse current and protects the battery from overcharging.

Linear Actuator

The photovoltaic panel is fixed in flat position or with an inclination then the amount of power produced by photovoltaic panel is less when compared to a photovoltaic panel with the solar tracking system. Now the solar tracker system requires actuators to rotate about an axis. These actuators are either single axis or dual axis. In this work a linear actuator is used. In this linear actuator rotary motion of motor is converted into linear movement. Linear actuator consists of an electric motor which is connected to a lead screw by using a helical thread throughout its circumference. This arrangement will be connected by a nut. When the motor is rotating then lead screw will starts rotation. The movement of nut will depends upon the rotation of the lead screw. The direction of movement of nut is completely based upon direction of rotation of lead screw. The arrangement of linear actuator is as shown in figure 1.

Figure 1: Linear Actuator

LED Sensors

Sensor is a transducer. The function of sensor is to sense the signal and transform this information in the form of electrical signal or optical signal. In this system the sensors used are LED sensors. These sensors consist of lenses which are provided at a distance of 5 mm from the light emitting diodes as shown in figure 1. LED sensor is a semi conductor device just like photo voltaic cell. LED sensors are mounted on a solar panel. When it is exposed to sun light it will develop a voltage of 1.7 volts approximately. This voltage will further be utilized as input to turn the LED sensor to solar sensor. This system consists of two rows of LEDS. One row of LED drives the motor in the west direction and other row of LED in east direction. Each row consists of four LED's which are connected in parallel. The sun creeps across the sky then LED will expose to sun light and the tracker will updates rotating solar sensor. All the sensors are used to update the tracking position either in the morning or after a cloudy period.

Batteries and Inverters

Photo voltaic panel batteries are deep cycle batteries. These batteries can be charged and discharged for a longer period of time. These are not similar to transportation vehicle batteries, which provide a large amount of current within a short period of time. To get longer life of these batteries they should be maintained with a minimum of 50% of their capacity. If the discharge is beyond this limit then battery life will be reduced. Generally batteries store direct current with a voltage range of around 12 volts to 24 volts. But now a day's all modern devices are operated on alternating current with a voltage range of around 220 volts to 240 volts. An inverter is an electrical device that will converts direct current from batteries to alternating current.

Overload Protection

A circuit is said to be overloaded if the current flowing through the system exceeds the rating of protective device. If the circuit is overloaded the components will get over heated, leads to their damage. This overload may cause a fire. This overload can also be caused due to a short circuit in wiring or a fault in devices. So charge controls should have overload protection. But most of the systems require additional protection in the form of fuses or circuit breakers. If a circuit with a wire size for which the safe carrying capacity is less than the overload limit of the controller, then it must protect that circuit with a fuse or breaker of a suitably lower amp rating.

Reflected mirrors

Reflected mirrors are used in this project to increase the incident solar radiation on photovoltaic panels. In early hours and in the evening the intensity of sun radiation is very low when compared to afternoon. The intensity of sun radiation will be increased by reflecting sun radiation on to solar panel by reflected mirrors. The arrangement of reflected mirror is as shown in figure.

Figure 2: Arrangement of Reflected Mirrors

EXPERMENTAL SETUP

Solar panels and reflected mirrors are placed in the L angular bracket with dimensions of 2x1.5x3.5 inches. The solar panels and reflected mirrors are arrested by using rivets. This will help to restrict the movement of plates and mirrors. Two rectangular cross section bars will be used to support the solar panel frame. The solar frame is attached to rectangular cross section bars by using bolted joint. A couple is attached to rectangular cross section bars by using welding joint. On the other side of couple a post is attached by threading. A sleeve is threaded to the bottom of the post in order to give the post a strong support against wind. This sleeve will be attached to a base plate; base plate further is bolted to a concrete block for a strong foundation.

Figure 3: Solar Tracking System.

RESULTS AND DISCUSSIONS

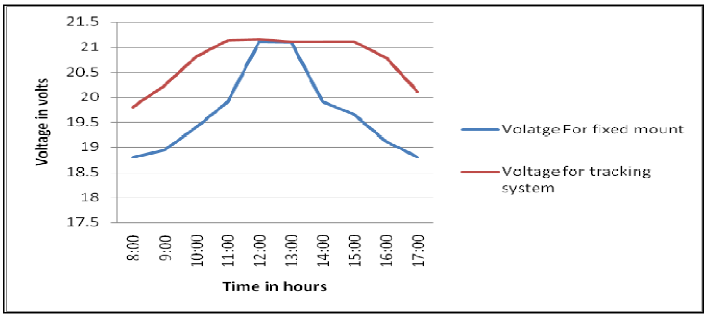
The following tables and graphs show the variation of current, voltage and power for static photovoltaic panel and power for single axis tracking system. In fixed mount system the power generated is less as compared to power generated with single axis tracking system as shown in the table. The incident radiation on photovoltaic panel was increased by single axis tracking system. In addition to this, the reflected mirrors will increase the incident radiation on photovoltaic panel. LED sensors are used to sense the solar radiation. Based upon sensors information linear actuator will move from east to west. In paper [6], the efficiency of single axis tracking system is 32.17% more than that of static panel. To that single axis tracking system reflected mirror will be attached such that this system improves the efficiency up to 58.18%.

Table 1: Fixed Mounts with Reflected Mirrors

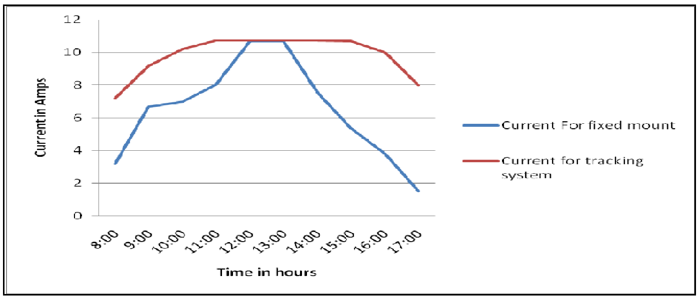
S.NO	Time	Voltage(volts)	Current(Amps)	Power(Watts)
1	08:00	18.8	3.18	59.78
2	09:00	18.93	6.68	126.45
3	10:00	19.4	7.01	135.99
4	11:00	19.9	8.02	159.60
5	12:00	21.1	10.69	225.56
6	01:00	21.09	10.7	225.66
7	02:00	19.9	7.54	150.05
8	03:00	19.65	5.36	105.32
9	04:00	19.1	3.8	72.58
10	05:00	18.8	1.52	28.58
	Average power			**128.96**

Table 2: Tracking System with Reflected Mirrors

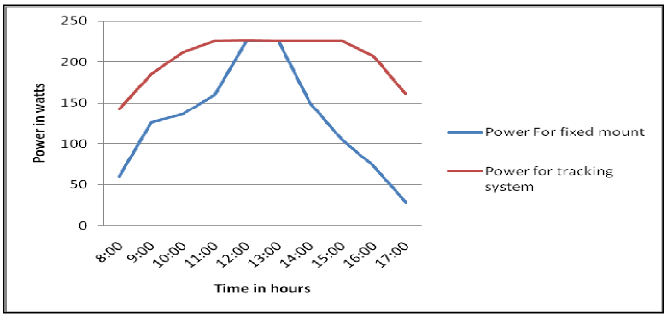
S.NO	Time	Voltage(Volts)	Current(Amps)	Power(Watts)
1	08:00	19.8	7.2	142.56
2	09:00	20.23	9.18	185.71
3	10:00	20.8	10.21	212.37
4	11:00	21.12	10.71	226.19
5	12:00	21.15	10.72	226.73
6	01:00	21.1	10.71	225.98
7	02:00	21.1	10.71	225.98
8	03:00	21.1	10.7	225.77
9	04:00	20.78	9.99	207.59
10	05:00	20.1	8.01	161.00
	Average power			**203.99**



Graph 1: Voltage Comparison for Fixed Mount and Tracking System



Graph 2: Current Comparison for Fixed Mount and Tracking System



Graph 3: Comparison of Power With and Without Tracking System

CONCLUSIONS

This paper includes a single axis tracking system with reflected mirrors. This tracking system has designed by linear actuator. Paper [1] describes that single axis tracking system is efficient in terms of power generation from the photovoltaic panels when compared to static solar panel system. The efficiency of single axis tracking system without a reflected mirror is around 32% when compared to static panels. The efficiency of single axis tracking system with reflected mirrors is 58.18% when compared to static panel from our readings. The tracking system with reflected mirror is more efficient when compare to tracking system without a reflected mirror and static panel.

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