Performance of Solar Photovoltaic Tracking System by using Stepper Motor

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***Abstract- The* Solar photovoltaic (PV) tracking system control by electronic and electrical unit was designed and fabricated. Experimental setup was installed in the CAET, Dr PDKV Akola of latitude 20.42^0 N and longitude 70.02^0E. Performance of PV System was tested using load and it was found that the voltage-current (VI) characteristics was better as compare to the untracked system. The systems consume a very low power of about 6 W only and it was observed that the panel tilted through an angle of 15^0 for every hour.**

Key words- Solar Photovoltaic System, Stepper motor, Battery Charging Arrangement, Spraying

I. INTRODUCTION

Solar energy is a renewable resource that is clean, economical and less polluting. It is rapidly gaining importance among various renewable energy resources. The most useful way of harnessing solar energy is by directly converting it into electricity by means of solar photovoltaic (PV) cells. Photovoltaic (PV) power generation has been receiving considerable attention as one of the more promising energy alternative. The most useful way of harnessing solar energy is by directly converting it into electricity by means of solar Photovoltaic (PV) cells. Photovoltaic (PV) power generation has been receiving considerable attention as one of the more promising energy alternatives. A photovoltaic system involves the solar cells energy storage component, power conditioning unit and control equipment.

Tracking the sun harnesses optimum solar energy by the solar cells. It has been found that after comparing the experiment results of power output of a sun tracking solar cell with that of a stationery solar cell, the tracking was found to produce 30 percent more electrical energy in the course of a relatively clear day (Mosher et at, 1977). A Photovoltaic tracking system using operational amplifier, comparator and d c motor components, which consumed a power 12 W (Kharche, 1997). Stepper motor is more proper for discrete rotations so a study was undertaken for performance of solder photovoltaic tracking system with load as battery and sprayer (Tayade and Kuttappan, 1999)

II. MATERIALS AND METHODS

Solar photovoltaic (PV) module used for study consisting of 36 solar cells, Max power 35 W, Open circuit voltage (Voc) = 21 V and Short circuit current (Isc) = 2. 4 A respectively. Module was made by BHEL Bangalore with 5 kg weight and cross section has 1015 mm X408 mm X 40 mm. The mechanical power transforming unit consists of a gear train (worm and worm wheel and full and half circular gears) having a reduction ratio of 1:150. The motor used in the tracking system was a 4 pole stepper motor. The stepper motor is a form of synchronous motor which is designed to rotate a specific number of degree for each electrical pulse received by its contraol unit (Fitzgerald et al.,1971). The shaft of the motor used in the present study moved in step of 2^0.

The electrical unit consisted of power supply regulator, stepper motor, comparator and driving unit etc. the function of the power supply regulator was to bring down the voltage of 21 V, which was generated by the PV module, to 12 V and 5 V.Two window compactors, consisting of light dependent resistor (LDR)place at the lower closed of two PVC pipes, were placed apart to the ends of the panel.

The following instruments aided in the noting down of the various readings the testing of the tracking system. 1. Digital photo type tachometer 2.Digital multimeter and 3.Stop watch. Testing of the tracking system was done and it was found that a specific of the window comparator kept on panel for locating the sun's position was necessary. Using the digital photo type tachometer the rotational speed of the shaft was found to be 95 rpm. The photovoltaic system with tracking arrangement was tested for load battery charging (Lead acid rechargeable battery Size:10 cm X 7.0 cm, 6 Volts, 4.5 Ah, 2Nos) and sprayer (motor pump, which is used for cleaning the windscreen of the car or vehicle as wiper pump was used.

III. RESULTS AND DISCUSSION

The performance of photovoltaic tracking system with load as battery and sprayer was found out. The readings of voltage current and solar lux were noted 9.00 AM to 4.00 PM at one hour intervals. The angle through which the module travelled per hour was also noted down. The angle was read from a graduated scale fixed on the half circular gear and a stationary pointer on the rod that supported the motor and gear assembly. The observations are given in Table-1 and Table-2

TABLE I. OBSERVATION TAKEN FOR PV MODULE DURING TRACKING WHEN LOAD USED WAS BATTERY (12V)

Sr No	Time	Open circuit voltage Voc (Volts)	Short circuit current Isc (Amps)	Solar Intensity (lux)	Angle (^{0})	Charging Voltage (V)
1	09.00 am	14.2	1.3	24400	43	12
2	10.00 am	14.2	1.2	50500	60	12
3	11.00 am	15.0	1.0	56900	75	12
4	12.00 am	17.8	1.1	60100	90	12
5	13.00 pm	17.7	1.0	55000	105	12
6	14.00 pm	15.2	0.9	50200	116	12
7	15.00 pm	14.1	0.5	32600	130	12
8*	16.00 pm	12.3	0.6	32300	145	12

*Note: When the reading were taken at this instant, there were thick dark clouds in the sky

A. *Load used as a Battery:*

The open circuit voltage (Voc), varied from 14.1 V to 17.8 V with a maximum of 17.8 V at 12.00 AM and short circuit current (Isc) varied from 09 to 1.3A (Table-1). The tracking system for itself consumed nearly 6 W (for stepper motor).

B. *Load used as Sprayer along with Battery charging:*

The open circuit voltage varied from 13.5 V to 18.8 V, with a maximum of 18.8 V at 12.00 AM (at 61500 lux) and short circuit current varied from 1.2 A to 1.9 A with a maximum of 1.9 A at 12.00 AM (Table-2). The voltage 12 V and current 2.8 A to the motor of the sprayer is a constant once as it was generated by the batteries, which were also included in the test. The spraying done on small experimental plots of 10 m x10 m size. It was observed that the panel tilted by an angle 15 for every hour. Also the system consumed a very low power of about 6 W only for stepper motor.

TABLE II. OBSERVATION TAKEN FOR PV MODULE DURING TRACKING WHEN LOAD USED WAS SPRAYER ALONG WITH BATTERY CHARGING

Sr No	Time	Open circuit voltage Voc (Volts)	Short circuit current Isc (Amp)	Solar Intensity (lux)	Angle (^{0})	Charging Voltage (V)	Current supplied to motor (I)
1	09.00 am	13.5	1.3	24300	43	12	2.8
2	10.00 am	14.3	1.5	51600	60	12	2.8
3	11.00 am	15.4	1.6	56600	75	12	2.8
4	12.00 am	18.8	1.9	61400	90	12	2.8
5	13.00 pm	17.7	1.7	53600	105	12	2.8
6	14.00 pm	16.6	1.5	50200	116	12	2.8
7	15.00 pm	15.3	1.3	33100	130	12	2.8
8	16.00 pm	14.7	1.2	32600	145	12	2.8

The tracking system ensured a constant supply of voltage (12V) as battery was used in the system. The sprayer gave the maximum discharge during noon and few hours after noon period.

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