International Journal of Advance Research in Science and Engineering
Vol. No.4, Issue 11, November 2015
www.ijarse.com
IJARSE
ISSN 2319 - 8354

SOLAR WATER HEATER WITH TRACKING SYSTEM

Jyoti Verma[1], Shweta Tyagi[2], R. B. Dubey[3]

[1,2,3]Department of Electronics and Communication Engineering

Hindu College of Engineering, Sonepat, Haryana, (India)

ABSTRACT

A solar tracker is a device for orienting a day lighting reflector, solar photovoltaic panel or concentrating solar reflector or lens towards the sun. The sun's position in the sky varies both with the seasons and time of day as the sun moves across the sky. Solar powered equipment works best when pointed at or near the sun, so a solar tracker can increase the effectiveness of such equipment over any fixed position, at the cost of additional system complexity. An experimental study was conducted to investigate the performance of the solar heating coil with tracking and without tracking. The results of experiment indicate that in the case of exposing the solar heating coil to the sun for 20 minutes, the heating coil with two axes tracking can increase water temperature.

Index Terms: Solar Tracker, Day Lighting Reflector, Solar Photovoltaic Panel, and Solar Heating Coil.

I. INTRODUCTION

Solar trackers may be active or passive and may be single axis or dual axis. Single axis trackers usually use a polar mount for maximum solar efficiency. Single axis trackers will usually have a manual elevation adjustment on a second axis which is adjusted on regular intervals throughout the year. Compared to a fixed amount, a single axis tracker increases annual output by approximately 30% and a dual axis tracker an additional 6%. There are two types of dual axis trackers, polar and altitude-azimuth.

Polar trackers have one axis aligned to be roughly parallel to the axis of rotation of the earth around the north and south poles. Single axis tracking is often used when combined with time-of-use metering, since strong afternoon performance is particularly desirable for grid-tied photovoltaic systems, as production at this time will match the peak demand time for summer season air-conditioning. A fixed system oriented to optimize this limited time performance will have a relatively low annual production. The polar axis should be angled towards the north and the angle between this axis and the vertical should be equal to latitude. Simple polar trackers with single axis tracking may also have an adjustment along a second axis: the angle of declination. This allows angling the panel to face the sun when it is higher in the sky in the summer and to face it lower in the sky in the winter. It might be set with manual or automated adjustments, depending on polar-tracking device. If one is not planning on adjusting this angle of declination at all during the year, it is normally set to zero degrees, facing panel straight out perpendicular to the polar axis, where the mean path of the sun is found. Occasional or continuous adjustments to the declination compensate for the northward and southward shift in the sun's path through the sky as it moves through the seasons over the course of the year. When the manual method is used for adjustment of the declination, it should be done at least twice a year: Once at the autumnal equinox to establish the best position for the winter, and a second adjustment on the vernal equinox, to optimize it for the summer. The sun's declination at the spring equinox is 0'. It moves up to 22.5' in the summer, and then drifts back down through 0' at fall equinox and down to -22.5' in the winter.

Several manufacturers can deliver single axis horizontal trackers which may be oriented by either passive or active mechanisms. In these, a long horizontal tube is supported on bearings mounted upon frames. The axis of the tube is on a north-south line. Panels are mounted upon the tube, and the tube will rotate on its axis to track the apparent motion of the sun through the day. Since these do not tilt toward the equator they are not especially effective during winter mid day, but add a substantial amount of productivity during the spring and summer seasons, when the solar path is high in the sky. These devices are less effective at higher latitudes. The principal advantage is the inherent robustness of the supporting structure and the simplicity of the mechanism. Since the panels are horizontal, they can be compactly placed on the axle tube without danger of self-shading and are also readily accessible for cleaning. For active mechanisms, a single control and motor may be used to actuate multiple rows of panels. A single axis tracker may be constructed that pivots only about a vertical axle, with the panels either vertical, at a fixed, adjustable, or tracked elevation angle. Such trackers with fixed or seasonably adjustable angles are suitable for high latitudes, where the apparent solar path is not especially high, but which leads to long days in summer, with the sun traveling through a long arc. This method has been used in the construction of a cylindrical house that rotates in its entirety to track the sun with vertical panels mounted on one side of the building.

A type of mounting that supports the weight of the solar tracker and allows it to move in two directions to locate a specific target. One axis of support is horizontal and allows the panel to move up and down. The other axis is vertical and allows the panel to swing in a circle parallel to the ground. This makes it easy to position the panel: swing it around in a circle and then lift it to the target. However, tracking an object as the earth turns is more complicated. The panel needs to be adjusted in both directions while tracking, which requires a computer to control the panel. Active trackers use motors and gear trains to direct the tracker as commanded by a controller responding to the solar direction. Active two-axis trackers are also used to orient heliostats - movable mirrors that reflect sunlight toward the absorber of a central power station. As each mirror in a large field will have an individual orientation these are controlled programmatically through a central computer system, which also allows the system to be shut down when necessary. Light-sensing trackers typically have two photo sensors, such as photodiodes, configured differentially so that they output a null when receiving the same light flux. Mechanically, they should be Omni directional and are aimed 90 degrees apart. This will cause the steepest part of their cosine transfer functions to balance at the steepest part, which translates into maximum sensitivity. Since the motors consume energy, one wants to use them only as necessary. So instead of a continuous motion, the heliostat is moved in discrete steps. Also, if the light is below some threshold there would not be enough power generated to warrant reorientation. This is also true when there is not enough difference in light level from one direction to another, such as when clouds are passing overhead. Consideration must be made to keep the tracker from wasting energy during cloudy periods.

Passive trackers use a low boiling point compressed gas fluid that is driven to one side or the other to cause the tracker to move in response to an imbalance. As this is a non-precision orientation it is unsuitable for certain types of concentrating photovoltaic collectors but works fine for common PV panel types. These will have viscous dampers to prevent excessive motion in response to wind gusts. Shader/reflectors are used to reflect early morning sunlight to wake up the panel and tilt it toward the sun, which can take nearly an hour. The time to do this can be greatly reduced by adding a self-releasing tie down that positions the panel slightly past the zenith and using the tie down in the evening. The term passive tracker is also used for photovoltaic modules that include a hologram behind stripes of photovoltaic cells. That way, sunlight passes through the transparent part of the module and reflects on the hologram. This allows sunlight to hit the cell from behind thereby increasing the module's efficiency. Also, the module does not have to move since the hologram always reflects sunlight from the correct angle towards the cells.

A chronological tracker counteracts the earth's rotation by turning at an equal rate as the earth, but in the opposite direction. Actually the rates aren't quite equal, because as the earth goes around the sun, the position of the sun changes with respect to the earth by 360° every year. A chronological tracker is a very simple yet potentially a very accurate solar tracker specifically for use with a polar mount. The drive method may be as simple as a gear motor that rotates at a very slow average rate of one revolution per day. In theory the tracker may rotate completely, assuming there is enough clearance for a complete rotation, and assuming that twisting wires are not an issue, such as with a solar concentrator or the tracker may be reset each day to avoid these issues. Nowadays, an electronic controller may be used with a real time clock to infer the solar time [1-7].

II. CIRCUIT DIAGRAM

Solar tracker is a device that moves so as to aim a collector of solar energy at the sun as it crosses the sky. It is the one which follows the sun’s movement throughout the day and provides uninterrupted reflection to the solar panel. The sun rays will fall on the solar panel in two ways, which is, they will fall directly on the solar panel and also the reflector will reflect the incident rays on the solar panel.

We have designed a simple electronic circuit for solar tracking. This circuit consists of a transistor, an LDR, a resistance, a 6V relay, a 9V battery and a dc motor. It is a single axis solar tracker. It supports only vertical axis and allows the panel to swing in a circle parallel to the ground. LDR (light-dependant resistor) is a light sensor and it has a low resistance in bright light and a high resistance in dim light. When sunlight falls on LDR, its resistance becomes low. Due to decrease in resistance the voltage drop across LDR decreases and the forward bias of emitter-base junction of transistor will not be possible that is transistor is off in this case. So there is no current in collector and the relay will switch off the motor. Thus as a result the solar panel remains stable in the direction of sunlight. Now when the earth rotates and the sun gets shifted from its earlier position the reflection of the incident rays will also change. Now LDR resistance becomes high. Due to increase in resistance, the voltage drop across LDR increases and the forward bias across emitter-base junction also increase. So the current starts flowing in collector circuit and the relay will switch on the motor. As the motor is attached to the panel, so panel moves and align itself in the direction of sunlight. Thus the solar tracker circuit is so designed that whenever sun changes its position the panel align itself in the direction of sunlight.

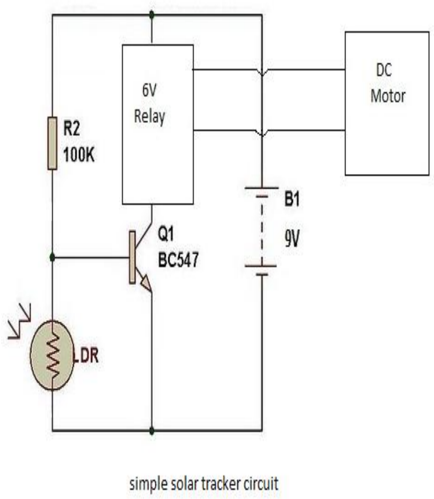

Fig. 1: A Simple Electronic Circuit for Solar Tracking

III. ADVANCEMENT IN SOLAR TRACKER CIRCUIT

An improve circuit is proposed by making a two axis solar tracker. One axis of support is horizontal and allows the panel to move up and down. The other axis is vertical and allows the panel to swing in a circle parallel to the ground. This makes it easy to position the panel: swing it around in a circle and then lift it to the target. It can be designed by using four LDRs, two LDRs for horizontal axis support and two for vertical axis support. The circuit for two axis solar tracker is shown in Fig. 2.

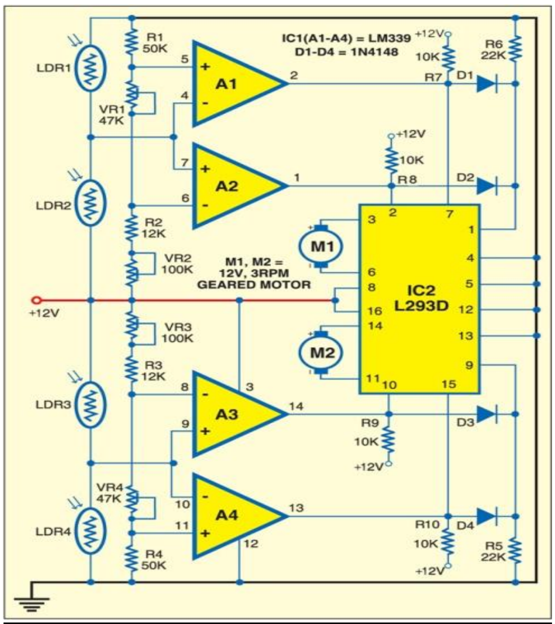

Fig. 2: The circuit for two axis solar tracker

This solar tracker comprises comparator IC LM339, H-bridge motor driver IC L293D (IC2) and a few discrete components. Light-dependent resistors LDR1 through LDR4 are used as sensors to detect the panel's position relative to the sun. These provide the signal to motor driver IC2 to move the solar panel in the sun's direction. LDR1 and LDR2 are fixed at the edges of the solar panel along the X axis, and connected to comparators A1 and A2, respectively. Presets VR1 and VR2 are set to get low comparator output at pins 2 and 1 of comparators A1 and A2, respectively, so as to stop motor M1 when the sun's rays are perpendicular to the solar panel. When LDR2 receives more light than LDR1, it offers lower resistance than LDR1, providing a high input to comparators A1 and A2 at pins 4 and 7, respectively. As a result, output pin 1 of comparator A2 goes high to rotate motor M1 in one direction and turn the solar panel.

When LDR1 receives more light than LDR2, it offers lower resistance than LDR2, giving a low input to comparators A1 and A2 at pins 4 and 7, respectively. As the voltage at pin 5 of comparator A1 is now higher than the voltage at its pin 4, its output pin 2 goes high. As a result, motor M1 rotates in the opposite direction and the solar panel turns. Similarly, LDR3 and LDR4 track the sun along Y axis. Fig.3 shows the proposed assembly for the solar tracking system.

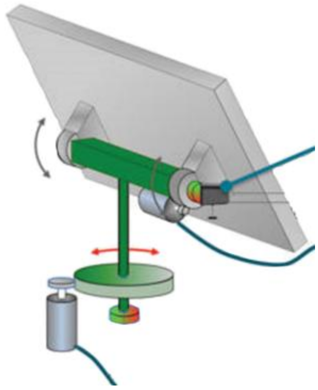

Fig. 3: The proposed assembly for the solar tracking system.

IV. CONCLUSIONS

A solar heating coil with two axes sun tracking system was designed and constructed. An experimental study was conducted to investigate the performance of the solar heating coil with tracking and without tracking. The results of experimentation indicate that in the case of exposing the solar heating coil to the sun for 20 minutes, the heating coil with two axes tracking can increase water temperature from 20^{o}C to 80^{o}C, while the heating system without tracking can increase water temperature from 20^{o}C to 50^{o}C.

REFERENCES

[1] B. Barakat, H. Rahab, B. Mohmedi and N. Naiit. Design of a tracking system with photovoltaic panels. Proceedings of the Fourth Jordanian International Mechanical Engineering Conference, JIMEC pp. 471-488, 2001.

[2] S. Abdallah, S. Nejmeh. Two axes sun tracking system with PLC control. Energy Conversion and Management, vol. 45, pp. 1931-1939, 2004.

[3] M. Al-Saood, E. Abdallah, A. Akayle, S. Abdallah and E.Hrayshat. A parabolic solar cooker with automatic two axes suntracking system, Applied Energy, vol. 87, pp. 463-470, 2010.

[4] http://en.wikipedia.org

[5] http://www.electronicsforu.com

[6] http://www.allaboutcircuits.com

[7] http://www.alldatasheet.com