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DESIGN AND FABRICATION OF A SELF-POWERED SOLAR TRACKER

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Abstract*- To get the maximum energy from sunlight, we need to track down the sunlight. This paper represents detail information and design about a sunlight tracker. This system is fully mechanical and adapts a self-powered mechanism. Due to the immobile nature of solar panels the amount of energy produced by most photovoltaic (solar) panels is low. However, when photovoltaic panels track the movement of the sun their efficiency increases significantly. The aim of this research is to design and build a device that adapts a mechanism to continually turn its face toward the Sun. The total system works with fluid pressure. Fluid such as methyl spirit which has low boiling temperature is used to create the fluid pressure. This pressure works as a lifting force for pistons that helps to rotate the whole arrangement towards the sun. Since the fluid pressure is created by the sun light itself, we say it a self-powered mechanism. The experimental result shows that the physical setup can move from East to West following the Sun as the day progresses, which suggest the usefulness of the methos proposed in this paper.*

Keywords: Solar Tracker, Parabolic Reflector, Fluid Pressure, Piston.

1. INTRODUCTION

Sunlight is one of the biggest sources of renewable energy. For the developing country like Bangladesh solar energy is very important and cost effective due to lack of natural gas and other conventional sources of energy. In recent years, with the continuous demand of energy consumption, energy structure based on conventional energy source is becoming more and more unsuitable to meet the requirement of social development. It is of vital strategic significance to accelerate the development of solar energy for the sustainable development of the world. The sunlight tracker is an opportunity to use the sunlight properly in the field of photovoltaic energy. It is essential to put forward higher demand for the collection and utilization of solar energy due to its weakness such as: it is low- density, intermittent and changing continuously on the space distribution. How to improve the collection and utilization of the solar energy has become a vital field of research for the domestic and overseas scholars.

Many aspects of solar energy tracking have been investigated. Saenz Roberto Yecora [1] invented a mechanical solar tracker consisting a system for tracking the position of the sun in relation to the earth, with the aim of orienting thermal and photovoltaic solar energy capture and conversion systems based on electromagnetic radiation dispersed or concentrated in any of the varieties thereof, in order to produce good perpendicularity in dispersed capture systems and perfect focusing in concentration systems, in relation to the sun. Nevzat Onat [2] is working on maximum power point (MPP). In photovoltaic (PV) system applications, it is very important to design a system for operating of the solar cells (SCs) under best conditions and highest efficiency. Maximum power point (MPP) varies depending on the angle of sunlight on the surface of the panel and cell temperature. Hence, the operating point of the load is not always MPP of PV system. Therefore, in order to supply reliable energy to the load, PV systems are designed to include more than the required number of modules. The solution to this problem is that switching power converters are used, that is called maximum power point tracker (MPPT) [2]**.** Peng Zhang [3] designed a new active sun tracker for solar streetlight combined with photoelectric tracking mode mainly and time-based tracking mode auxiliary was proposed. The sun tracker was designed through three aspects: mechanical structure, electrical system and control procedure. Tiberiu Tudorache [4] works on single axis solar tracker device. Jonathan T. Ota [5] designed a solar tracker which is self powered and works as mechanically. The design contains a device that can track the movement of the sun without consuming electricity by mimicking the phototropic qualities of the sunflower. But the result of his experiment was not very much successful. The elongation of the pistons did not translate into the movement of the head of the device [5].

Inspiring from the concept of helio tracker as in [5], we intend to design and build a device that adapts a mechanism to continually turn its face toward the Sun. Here, the emphasis will be placed on the successfulness of the mechanically solar tracking system. The paper is organized as follows. Section II concisely describes the proposed solar tracking system. Section III shows the experimental setup and how the system works. Section IV is devoted to experimental results and discussion. And finally the closing remarks are presented in Section V.

2. PROPOSED SELF-POWERED SOLAR TRACKER

A solar tracking device is sometimes referred to as a slowly rotating mechanism in which a specific surface or axis of the apparatus is maintained to always point toward the sun.

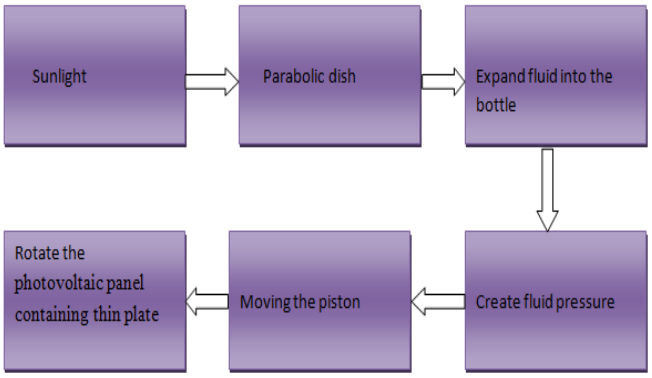

Fig. 1. Principle of proposed solar tracker

Here fluid pressure is used for tracking mechanism. The flow diagram of the proposed solar tracker is shown in Figure 1. Four glass bottles contain methylated spirit, which are connected with four syringes containing a piston each. A long bar is utilized for holding the syringes and total system which is placed in the middle of the arrangement.

The glass bottle is used for absorbing the solar energy which is placed in a parabolic sun reflector. Parabolic sun reflector reflects the sunlight and make the rays of sunlight unified into the bottle. Methylated spirit absorbs the solar energy and it becomes vaporized. This vaporized methylated spirit creates pressure to the liquid methylated spirit which works as a trigger to pull the piston and helps to rotate the whole arrangement toward the sun.

The parabolic reflector containing bottle is attached to a rectangular thin plate. This plate mainly rotates because of the piston pressure. Four pistons help to rotate the plate about three axes. The type of joint between the bar and plate is cylindrical slide way. The rectangular thin plate can carry the photovoltaic panel or other devices. In this project, the special thing is that the sunlight tracker tracks the sun light by using the solar energy. The sunlight help the system to rotate toward the sun and thus the photovoltaic panel gets direct and full sunlight intensity.

3. EXPERIMENTAL SETUP AND PROCEDURE

The total experimental setup is shown in Figure 2. The experimental setup consists of the following main components as indicated in Figure2: 1. Base, 2. Supporting bar, 3. Piston, 4. Parabolic reflector, 5. Tube, 6. Thin plate containing photovoltaic panel, 7. Fluid contain glass bottle, and 8. Methylated spirit (fluid in the bottle and piston).

A. Base

Base can be made by any solid material like wood, metal or concrete. Wood is preferred most than other and is use in this setup.

B. Supporting Bar

It is an iron rod. Because the total weight of the arrangement goes to the base through the supporting bar.

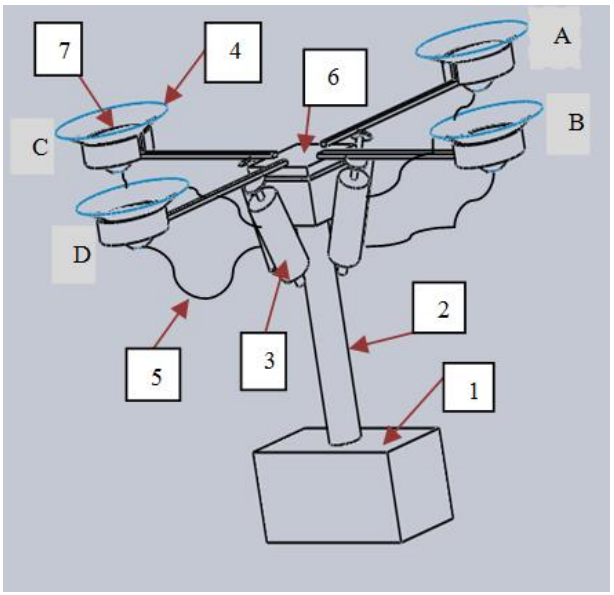

Fig. 2. Experimental setup of the solar tracker

Fig. 3.

C. Piston

In an engine, its purpose is to transfer force from expanding gas in the cylinder to the crankshaft via a piston rod and or connecting rod. But we use 20 ml syringe as a piston in this arrangement. A syringe is a simple pump consisting of a plunger that fits tightly in a tube. The plunger can be pulled and pushed along inside a cylindrical tube (called a barrel), allowing the syringe to take in and expel a liquid or gas through an orifice at the open end of the tube. Here its purpose is to transfer force from expanding liquid in the bottle and tube to the thin plate.

D. Parabolic Reflector

A parabolic reflector is a reflective surface used to collect or project sunlight. Its shape is part of a circular paraboloid which can correct spherical aberration found in simpler spherical reflectors.

E. Glass Bottles

Glass bottles can vary in size considerably, but are most commonly found in sizes ranging between about 10 ml and 5 liters and in this arrangement 25 ml bottles are used.

F. Methylated Spirit

Methylated spirits used in this study have physical and chemical properties of: boiling point is 78.5°C; melting point is−130°C; specific gravity is 0.79; and vapor pressure is 40. mm at 19°C.

G. Working Procedure

From the Figure 2., when the parabolic reflector (A) has its position toward the sun, it gets maximum intensity of sunlight. The parabolic reflector centralizes the maximum sunlight into the methylated spirit containing bottle. Methylated spirit which has low boiling temperature gets

Fig 3. Demonstration of experiment

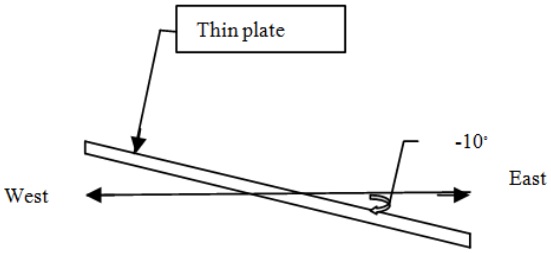

Fig. 4. Typical rotation of thin plate containing photovoltaic panel

vaporized and creates maximum fluid pressure. This maximum fluid pressure creates maximum force into the parabolic reflector (D) through the piston. By getting maximum force on the side of the reflector (D), thin plate containing the photovoltaic panel gets upward and the side of the reflector (A) gets downward. By this movement the total setup rotates toward the sun. All the four pistons contribute to the total rotation of the system about three axes. The real view of the setup is shown in Figure3.

4. EXPERIMENTAL RESULTS

In the morning when the sun is in the East horizon, the total setup rotates toward the East direction due to the variation of fluid pressure. After that when the sun changes its position toward the west according to time, the total setup also rotates with the sun. Fig.4 shows the typical rotation of thin plate. The Table I shows the result of the experiment i.e. the rotation of photovoltaic panel with respect to time.

The total arrangement works successfully and gives us some actual data. The data shown in the Table I shows that the system always faces toward the sun. In the morning the sun is in the East sky and the total system also faces to the East. At noon when the sun is in the mid sky, the system faces straight up (0 degree at 12.00 PM). In the afternoon as the sun moves toward the Western sky the system also leans to the West. Therefore, Table I confirms the success of the solar tracker.

Table 1: The results of the experiment on May 30th, 2014

Time	Angle (Degree)	Direction of angle
9.38 AM	-12°	East
9.46 AM	-10°	East
9.49 AM	-9.9°	East
9.51 AM	-9.8°	East
9.58 AM	-9.5°	East
12.00 PM	0°	-
4.28 PM	-10°	West
4.32 PM	-15°	West
4.36 PM	-17°	West

5. CONCLUSION

Self-powered sunlight tracking system is an useful strategy that facilitates effective utilization of solar energy. Here piston works based on fluid pressure. Methylated spirit is expanded by solar energy and creates fluid pressure. This pressure works as a lifting force for pistons that helps to rotate the whole arrangement towards the sun. The movement of the pistons depends on the concentration of solar energy. Since the fluid pressure is created by the sunlight itself, we say it a self-powered mechanism. The experimental results confirms the validity of the solar tracking system. This study shows the way of utilizing the maximum solar energy in our life.

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