

Concept of Mechanical Solar Tracking System

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ABSTRACT: *Emphasizing the importance of non renewable energy sources, solar energy will be the major primary source of energy which will satisfy our needs for the coming years ahead. So, there needs the requirement of enhancing the utilization of solar energy with maximum possible efficiency. “Mechanical Solar Tracking System” is developed to fulfill the purpose. Gear train operating system with the help of potential load is employed to rotate the solar concentrator with the movement of the sun. The comparison between the “Mechanical Solar Tracking System” and “Electro-Mechanical Solar Tracking System” shows that it consumes zero energy from the produced energy and thereby, increasing the overall efficiency by 5 to 8%. It can be concluded that “Mechanical Solar Tracking System” is more efficient than “Electro-Mechanical Solar Tracking System”. “Mechanical Solar Tracking System” can be cheaper, require unskilled worker, easy to maintain and can be placed at hilly areas, remote or dusty or rainy place to develop electrical energy or to produce heat energy for different applications.*

Keywords: *Concentrator, Gear Train, Potential Load, Solar Tracking, Utilization of Solar Energy.*

I. INTRODUCTION

Energy has become an important and one of the basic infrastructures required for the economic development of a country. Any physical activity in this world, whether by human beings or by nature is caused due to the flow of energy in one form or other? Energy is required to do any kind of work. The word energy itself is derived from the Greek word ‘en-ergon’, which means ‘in-work’ or ‘work-content’. The work output depends on the energy input. The capability to do work depends on the amount of energy one can control and utilize. Even though renewable options are not likely to supply a substantial amount of energy to developing countries over a short term, they do have these advantages:

Renewable energy is an indigenous resource available in considerable quantities to all developing nations and capable in principle, of having a significant local, regional or national economic impact. The use of renewable energy could help to conserve foreign exchange and generate local employment if conservation technologies are designed, manufactures, assembled and installed locally.

Several renewable options are financially and economically competitive for certain applications, such as in remote locations, where the cost of transmitting electric power or transporting conventional fuels are high, or in those well-endowed with biomass, hydro or geothermal resources. Because conversion technology tends to be flexible and modular, it can rapidly be deployed. Other advantages of modular over very large individual units include easy in adding new capacity, less risk in comparison with ‘lumpy’ investments, lower interests in borrowed capitals because of shorter lead times and reduced transmission and distribution costs for dispersed rural locations.

The sun radiates energy uniformly in all directions in the form of electromagnetic waves. When absorbed by a body, it increases its temperature. It provides the energy needed to sustain life in our solar system. It is clean, inexhaustible, abundantly and universally available renewable energy. Solar energy is also used by various well known natural effects and appears in nature in some other forms of energy. Solar energy has the greatest potential of all the sources of renewable energy and if only a small amount of this form of energy could be used, it will be one of the most important supplies of energy, especially when other sources in the country have depleted.

Thus, solar energy is a mother of all forms of energy: conventional or non-conventional, renewable or non-renewable, the only exception being nuclear energy. 3.8×10^{24} joule of solar radiation is absorbed by earth and atmosphere per year. Solar power where sun hits atmosphere is 1017 watts and the total demand is 1013 watts. Therefore the sun gives us thousand times more power than we need. If we can use 5% of this energy, it will be 50 times what the world will require. The energy radiated by the sun on a bright sunny day is 4 to 7 kWh/m².

Solar technologies are broadly characterized depending on the way they capture, convert and distribute sunlight.

Active Solar Techniques include the use of photovoltaic panels, solar thermal collectors, with electrical or mechanical equipment, to convert sunlight into useful outputs.

Passive Solar Techniques include orienting a building to the sun, selecting materials with favorable thermal mass or light dispersing properties, and designing spaces that naturally circulate air.

As the sunlight passes through the atmosphere, some of it is absorbed, scattered and reflected by air molecules, water vapors, clouds, dust and pollutants. This is called diffuse solar radiation.

The solar radiation that reaches the surface of the earth without being diffused is called direct beam solar radiation. The sum of diffuse & direct solar radiation is called total radiation or global solar radiation.

Energy is an important input to all sectors of any country. The energy requirement increases rapidly with the increase in population and increase of standard of living. Presently conventional energy sources such as fossil fuels and coal are being used extensively for power generation. But these sources of energy are depleting and may be exhausted by the end of the century or beginning of the next century. As a result most countries have started to explore and experiment the possibility of using non-conventional energy sources such as solar energy, wind energy, water energy and nuclear energy etc in large scale.

The basic problem associated with the conversion of the solar energy into useful form is that the solar modules used are stationary, so during the morning and evening hours the sun rays fall at an angle upon the module. This decreases the efficiency of the system as the duration of light falling perpendicular to the module is very less. Thus the conversion efficiency of the solar energy into useful form is not up to the mark.

This project work is done in order to absorb as much energy as possible using a solar panel and utilize that energy when A.C supply is not available.

Objectives

To increase the efficiency of the system by using solar tracking mechanism. This mechanism will ensure that the light with maximum intensity will be falling on the solar panel throughout the day.

By means of our system we can gather maximum solar energy and that energy is used to get the electricity. Since it is mechanical system the people from rural area can use with ease.

Description of Mechanical Solar Tracking System

A solar tracking mechanism is an effort to increase the efficiency of power generation through the solar module. The conventional solar module are stationary hence the sun rays falling on them are at different angles at different points of time and the duration of the sun rays falling perpendicular to the surface of the solar module is very small. Please refer to "Fig"-1. Thus large part of energy from sun is wasted. This decrease the efficiency of the system as the maximum efficiency is obtain only during the time when sun is exactly perpendicular to the surface of solar module. During the morning and evening hours the efficiency of the solar module is as low as negligible. Those factors lead to problem of very low output by system.

The output of the system can be efficiently increase by the solar tracking mechanism. By the use of this mechanism we can rotate the module according to the movement of the sun is that the sun rays fall exactly perpendicular to the module throughout the day. This increases the power generation by the photovoltaic solar cells in the module, thereby increasing the efficiency. Refer to "Fig"-2.

To achieve this, gear mechanism is used which rotates with a speed is compatible to the speed of movement of the sun. The time duration between the sunrise and sunset is approximately 12 hours and in this duration the sun covers an approximate angle of 180° . So the speed of rotation of the gear mechanism is to adjust that it covers 180° in 12 hour and returns by manually. The solar module is mounted on the solar panels so that it can rotate with the gear mechanism, thereby tracking the path of the sun. Thus the sun rays fall exactly perpendicular to the surface of solar module throughout the day and hence efficiency of power generation by the solar photovoltaic cell in the solar module is increase.

The speed of the gear mechanism is adjusted by using the means of dead weight. The weight of the dead weight is proposal to the 15° rotation of gear per hour. Hence we can achieve 180° at the end of the day. So this way we can archive the suitable speed.

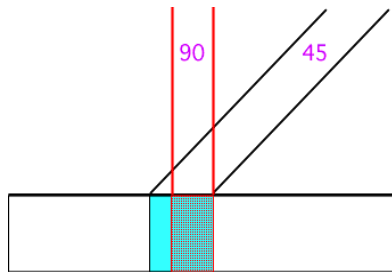
Design of Mechanical Solar Tracking System

Mechanical solar tracking system works on the principle of mechanical clock. Gear train operating system with the help of potential load is employed to rotate the solar concentrator with the movement of the sun. Please refer to "Fig"-3 for arrangement of gears & pendulum.

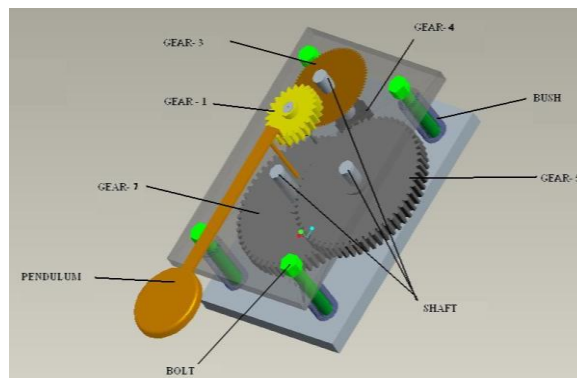
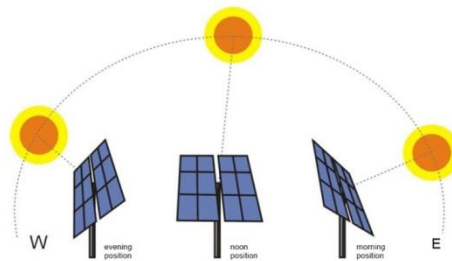
Sun Complete Its Half Revolution (180°) in 12 Hours.

Sun Rotation Per Hour = $180/12 = 15^\circ/\text{Hour}$.

Please refer to “TABLE” – A for detail of materials.



“Fig”-1 intensity of solar rays falling at different angles
 “Fig”-2 tracking sun path 180°



“Fig”-3 Pro-e model for gear arrangement

“Table” – A: Details of Material

SR NO	DESCRIPTION	MATERIAL	QUANTITY
1	GEAR	CARBON STEEL	2
2	PINION	CARBON STEEL	2
3	GEAR	BRASS	1
4	GEAR	STEEL	1
5	FREE WHEEL	BRASS	1
6	PENDULUM	STEEL	1
7	BEARINGS	STEEL	6
8	BOLT	MILD STEEL	4
9	NUT	MILD STEEL	4
10	SHAFT	MILD STEEL	3
11	PLATE	MILD STEEL	2
12	BUSH	MILD STEEL	4

II. CONCLUSION

The comparison between the “MECHANICAL SOLAR TRACKING SYSTEM” and “Electro-Mechanical Solar Tracking System” shows that it consumes zero energy from the produced energy and thereby, increasing the overall efficiency.

It can be concluded that “MECHANICAL SOLAR TRACKING SYSTEM” is more efficient than “Electro-Mechanical Solar Tracking System”. “MECHANICAL SOLAR TRACKING SYSTEM” can be cheaper, require unskilled worker, easy to maintain and can be placed at hilly areas, remote or dusty or rainy place to develop electrical energy or to produce heat energy for different applications.

Due to unavailability of Solar Concentrator we fail to conduct Radiation Test for our system and also we cannot determine the increase in efficiency.

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