

Review on Mechanism for Solar Tracking of a Parabolic Trough Collector

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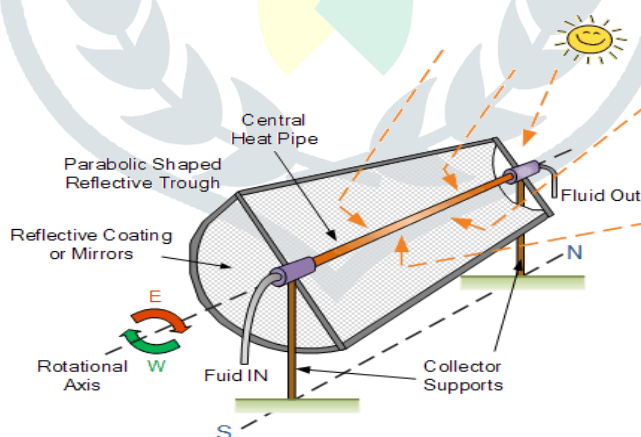
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Abstract: This paper presents the design and performance study of single axis Parabolic Trough Collector. The Parabolic Trough concentrates the incident solar beam radiation energy at its focus and heats up the working fluid, thus increasing the temperature of the working fluid. Parabolic trough collectors assembly consists of a concentrator, a mirrored trough with a parabolic shaped cross-section and uses a tracker device to track the course of sun, so that the incident radiation is concentrated along the focal line on the absorber tube or receiver tube. Solar tracking system is used to increase the efficiency of parabolic trough collector. Open loop drive type tracking system is used, where the position of the sun throughout the year is already recorded and programmed accordingly, so no sensors are required. The setup is mounted in North-South direction and the sun is tracked from East to West. A lead screw and link mechanism is used instead of actuators and belt drives.

Keywords- Solar Tracking, Lead screw, Parabolic Trough Collector, Links

I. INTRODUCTION:

A parabolic trough is a parabolic shaped collector made of reflecting materials, which reflects the incident solar radiation onto its receiver which absorbs the concentrated solar energy to raise the temperature of the working fluid. Parabolic Trough Collectors are suitable for heating between 100 and 250 degrees. Parabolic Trough power plants are most mature of Concentrating Solar Power technologies. More than 95% of the commercially solar thermal power plants are Parabolic Trough Collector systems. To increase its efficiency to its maximum thermal efficiency of 60%-80%, they are mounted on a tracking system to follow the sun. Given below is the ideal Construction of a Parabolic Trough Collector .



[1] Ideal Parabolic trough Collector

To obtain the maximum energy from the sun, the system requires to track the sun through out the day and according to changing seasons. Different types of solar collector and their location require different types of tracking mechanism. As the sun's position varies with both seasons and time of the day, thus there are also two types of tracking mechanism:

Single Axis Tracking:

Either tracks the sun with horizontal axle or vertical axle, depending on the location of the region. Horizontal tracking is used where days are short but the sun is intense at noon, whereas vertical type of tracking is used where days are long but sun does not go high. It gives about 30% more efficiency than normal stationary system.

Dual Axis Tracking:

Dual axis trackers are so designed at they can track the sun's apparent motion exactly anywhere. They have the ability to track the sun in horizontal as well as vertical axle. They give more power output and approx 10% more efficiency than normal tracking.

A dual axis Parabolic Trough has the disadvantage of losing thermal energy and the system is complicated and not cost efficient .Because of this we have decided to use a single axis traking system.

Futher, the solar tracking drives can be divided into three basic categories depending upon type of sensors they use , type of drive and position;

Passive Trackers : They use the sun's radiation to heat the gases that moves the trackers;

Active Trackers: They use sensors which send the signals to electric or hydraulic drives and some type of gearing and actuator to move the trackers;

Open Loop Trackers: There is no sensing equipment but instead they determine the position of the sun through pre-recorded data.

Here we are using open loop tracking, where the position of the sun is already recorded and is programmed accordingly. It gives accurate tracking according to the suns position and assures no failing of sensors when it is cloudy or rainy.

Setup orientation and tracking mechanism also plays a major role in the tracking efficiency, it is different for different location. The tracking method can be divided into two types;

East-West orientation with respect to North-South Tracking;

North-South orientation with respect to East-West Tracking.

East-West orientation does not require continuous tracking; whereas North-South orientation requires the tracking of sun throughout the day.

According to South African Journal of Science(Optimising position control of parabolic trough); An East-West alignment provides a more constant output throughout the year, whereas a North-South alignment provides slightly more energy per year than east-west orientation.

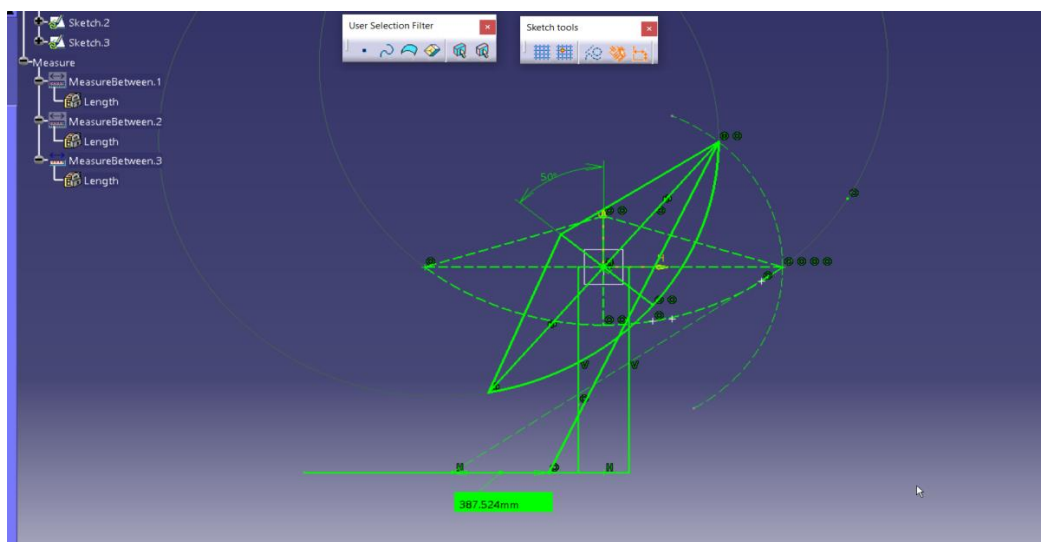
The optical loss of the Parabolic Trough is dependent upon the local latitude, either for East-West or North-South orienting troughs. Based on the basic transform between solar coordinate and the earth surface coordinate, the cosine loss for both the East-West and North-South parabolic troughs are calculated according to local latitude. The optical loss for East-West through almost keeps a constant loss of 16% and the optical loss for North-South is highly dependent on local latitude.

The collectors are aligned in north-south orientation, so after sunrise the low-lying sun in the east is almost vertically incident on the parabolic trough. And as the sun moves throughout the course of day its light falls at an increasing oblique angle on the collector. The sunrays continue to focus through onto the absorber tube but are reflected back across a longer distance. Ultimately, because of the inclined incident sunlight, the radiation energy captured per unit area corresponds to reduced relative to the cosine of the incident angle,known as cosine effect. In addition, the inclined reflected sunrays on the end of the collector miss the absorber tube.This losses are known as end losses.Here we are orienting the PTC in North-South direction and tracking the sun from East to West direction.According to the experiment carried out, the setup was kept in North-South orientation the temperature rise was more than that of East-West orientation.

II. TRACKING SYSTEM:

Here we are using a single axis tracker which is basically an open loop tracking, which means there will be no use sensors. It will be programmed as per astrologically data. The mechanism involves lead screw and link setup which will be actuated by motor.

Tracker will track the sun only during peak time of the day inorder to give maximum output.Also, the energy required for tracking the sun throughout the day is reduced.



[2]Drafted model of the tracking Mechanism

Mechanism:

We are using a lead screw and link mechanical. Lead screw will be mounted on the base and a link is connected to the lead nut and the trough. Linear moment of the lead screw cause the angular moment the trough.

Lead Screw: A lead screw turns rotary motion into linear motion combining a screw and a nut where the screw thread is in direct contact with the nut thread.

Arduino Programing:

As we have decided to go for open loop tracking, the arduino program consists of predetermined data of the position of the sun. The arduino gives the instructions to the motor. The motors is activated after every 10 mins and the suns position is tracked.

III.LITERATURE REVIEW

A. Walter Nsengiyumva, Shi Guo Chen, Lihua Hu, Xueyong Chen

Solar trackers are compact solar energy collecting systems that are used to increase the amount of collectible solar energy of the PV systems by tracking the position of the sun across the sky at all times. These systems are aesthetically attractive, environmental friendly and are increasingly becoming cost effective with the development of the computers and control systems technologies. The integrated features make these systems suitable for green and large scale domestic and industrial power generation applications. In this article, different types of STS are reviewed emphasizing on their designs, thermal and electrical performances as well as the factors influencing the heat loss during their operation.

B. Ali Jaber Abdulhamed, Nor Mariah Adam, Mohd Zainal Abidin Ab-Kadir, Abdul Aziz Hairuddin

The current review focused on energy crisis that improved the innovative study especially of renewable energy. Solar energy is the ideal strategy to meet the present increasing power demand, which is projected to further increase in the future. This paper also presents a review of PTC models throughout the history of technology, brief applications, commercial availability, mentioning their main features, manufactures, and their development. Solar collectors contribute to more improvement in thermal applications. The PTC can be produced up to 400 °C temperature of heat.

C. Fabio Moacir Hoffmann, Rolf Fredi Molz, Joao Victor Kothe

This work presented as a first contribution the structural design for a solar tracker, which is characterized by the independent rotational movement of two perpendicular set of engines, being one for north/south direction (for solar inclination) and the other for east/west direction (for azimuth angle variation). The angular amplitude achieved with this approach covered the majority of the possible solar positions. The obtained results validated the proposed design, considering different climate profiles for days.

IV.CONCLUSION

The enabling of the tracking of the solar Parabolic Trough increases its efficiency by 30%.The links used as the mechanism for the solar tracking are a simple method to generate the oscillation of the trough according to the East to west motion of the sun. Precalculated positions of the sun will be used for the simple programming of the arduino.

This paper is regarding the optimization of the parabolic trough collector using a simple linkage tracking system.

ACKNOWLEDGMENT

It gives us great pleasure a project on “Single axis tracking for Parabolic Trough Collector”. In preparing this project report, number of hands helped us directly and indirectly. Therefor, it becomes our duty to express our gratitude towards them.

We are very much obliged to our Head of Department, Dr. N. P. Sherje, Department of Mechanical Engineering, for helping and giving proper guidance. His timely suggestions made it possible to complete report for us. All our efforts might have gone in vane without his valuable guidance.

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