A Review Solar Tracking System With Reciprocating Pump

Sapna Wagh¹, Prasad Wagh², Amit Mawale³, Akshay Agarkar³, Sateesha Patil⁴

¹,²,³ Student, Mechanical Department, P K Technical Campus, Chakan.
⁴ Guide, Mechanical Department, P K Technical Campus, Chakan.

Abstract — In present day, people need more and more power for driving instrument. A solar based reciprocating pump is a pump, running on electricity generated by solar cell, available from collected sunlight as opposed to grid electricity or diesel run water pump. Nowadays many types of pump are available such as, positive displacement pump, impulse pump, velocity pump, gravity pump, steam pump, valve less pump. A reciprocating pump is class of positive displacement pump, is used for variety of purpose such as, car washing, irrigation, color spraying, extraction of oil from bottom of the earth, large fountain, garden water pump, etc. A solar reciprocating pumping systems is believed to be applicable to many remote and domestic irrigations applications without access to electricity relaying diesel power and having insufficient wind for pumping and to be cost competitive, locally manufactureable alternative to photovoltaic. This system consists of solar collector, battery, motor, crankshaft, reciprocating pump, valve, and tank. In this project work, we are planning for design and developing a solar tracking system which will utilize mechanical energies for the tracking operation. At present, the solar tracking system use electrical energy for tracking operations and this electrical energy for operations is supplied by same solar panels or by external electrical storage or supply lines, this reduces efficiency of the solar panels. Using mechanical energy for tracking will increase the output of solar panels and the energy will be used for driving the reciprocating pump.

Keywords- Solar Energy, Hydraulic piston, Sunlight, Battery, Solar PV Panel, Reciprocating Pump.

I. INTRODUCTION

Most of the increase in the area of irrigated land in the world has been through the increasing use of engine-driven pumps. However, the increasing price of oil-based fuel has reduced the margin to be gained by farmers from irrigation, since food prices have generally been prevented from rising in line with energy costs. Despite present short-term fluctuations in oil prices, conventional oil-based engine-driven power sources and mains electricity are expected to continue to increase in the longer term. If we are to decrease our dependence on imported oil, we have to find methods for energizing irrigation pumps that are independent of imported oil or centralized electricity.

To optimize solar efficiency that is collected it is essential follow the position of the sun. This is due to the fact that solar radiation essentially follows a straight line. Current solar tracking systems are costly. In this report several different solar tracking designs were evaluated for feasibility. The early concept designs are called Angled Solar Tracker, Nitinol Solar Tracker, Hydraulic Solar Tracker, Half Cylinder Solar Tracker, Water Clock Solar Tracker and the Solar Panel Array. Using two different decision matrices the designs were evaluated. The first decision matrix evaluated whether a passive or active design should be used. The second decision matrix evaluated the designs on cost and ability to track the sun. Three highest scoring designs the Angled Solar Tracker, Hydraulic Solar Tracker and Solar Panel Array were then chosen to be analyzed. Each of the designs were analyzed to find the primary area of failure. The Angled Solar Tracker had each of its components broken up and the forces acting along the member were determined. The Hydraulic Solar Tracker analyzed principle stresses throughout the design. The Solar Panel Array analyzed the stresses, gear ratio required and minimum distance to prevent shading from other solar panels. In the analysis the angles that the solar panel will have to be at during certain times of the day were calculated. Using these angles the required torque to move each solar panel was estimated. Using these torque calculation the motor that satisfied these requirements were found. These motors were then added to the overall cost of the product. Then to find the final cost of our design the team made a list of materials required and the cost of shipping. This cost was added up and found to be $2271. The labor was approximated since most of the labor would be handled by members within our team.

Solar radiation as a source of energy is of course, the epitome of the clean. Sustainable energy technology except for residues possibly arising out of the manufacture of solar component (e.g. semiconductors), solar technology have very low environmental impacts. The environmental impacts of solar system in operation are very low and the source is, for us inexhaustible.
Problem Statement:
The position of the sun keeps on changing every day. Solar panels as we know are entirely dependent on the sun. The more sun rays fall on the panels the more outcomes we get and it serves our purpose of installing a solar panel. The challenge nowadays is to keep a track of the position of the sun so that we get the maximum output from the panels. We hope to achieve this with a solar tracking system.

Objectives:
After identifying the important needs associated with this design, the team further interpreted the information retrieved from the interview. Upon doing so, the team discovered that the client has a set of specific guidelines that must kept in mind and met while designing the solar tracking device. The objective acknowledged by Dr. Acker consists of the following:

- To design and construct a solar tracking device that will be all-seasonal.
- To design a system that will track the sun as the day progresses.
- To maximize the efficiency of the device.

![Fig 1: Solar based Reciprocating Pump](image)

METHODOLOGY

The methodology of design for the design of mechanical tracking system is explained by following steps,

- Determining sunray orientation and time range to which the panel has to be tracked.
- Calculating the required angular velocity of the panel.
- Calculating the system pressure and cylinder (actuator) discharge.
- Calculating the weight/force required to create the required pressure.
- Selecting cylinder of suitable diameter and stroke length.
- Selecting the suitable grade of hydraulic oil.
- Calculating the capacity of reservoir.
- Selecting required mechanical components of suitable dimensions and material.
- Preparing production drawings and fabrication of mechanical elements.
- Assembly of the device.
- Demonstration.
II. LITERATURE REVIEW

Ajinkya Patil et al.[2015] “Tracking of Solar Panel By Hydraulic System”, They developed a solar tracking system which will utilize mechanical energies for the tracking operation. At present, the solar tracking system use electrical energy for tracking operations and this electrical energy for operations is supplied by same solar panels or by external electrical storage or supply lines, this reduces efficiency of the solar panels. Using mechanical energy for tracking will increase the output of solar panels and remove the constraint on the location of the tracking system.

Brian D. Vick et al.[May 2009] “Determining the Optimum Solar Water Pumping System for Domestic Use, Livestock Watering or Irrigation” For several years they have field tested many different types of solar powered water pumping systems. In this approach, several steps are given to select a solar-PV water pumping system. The steps for selection of stand-alone water pumping system were: deciding whether a wind or solar water pumping system would be best, determining the type of PV module, how controller can affect the decision, selecting pump type (diaphragm, piston, reciprocating, helical, or centrifugal), and analyzing the monthly water demand requirement. Three case studies were also included to demonstrate how to determine PV array size, motor/pump rated power, and type of pump.

Dave Umang Y et al.[June 2016] “Solar Powered Reciprocating Pump”, Now a days many types of pump are available such as, positive displacement pump, impulse pump, velocity pump, gravity pump, steam pump, valve less pump. A reciprocating pump is class of positive displacement pump, is used for variety of purpose such as, car washing, irrigation, color spraying, extraction of oil from bottom of the earth, large fountain, garden water pump, etc. If 50% of the diesel were replaced with solar PV pump set, diesel consumption could be reduced to the turn of about 225 billion liter/year. A solar reciprocating pumping systems is believed to be applicable to many remote and domestic irrigations applications without access to electricity relying diesel power and having insufficient wind for pumping and to be cost competitive, locally manufacturable alternative to photovoltaic. This system consists of solar collector, battery, motor, crankshaft, reciprocating pump, valve, and tank.

M. Belarbi et al. [2006] “Modeling and simulation of photovoltaic solar panel” they presented a new approach for estimating the model parameters of a photovoltaic solar panel according to the irradiance and temperature. The parameters of the one diode model were given from the knowledge of three operating points: short-circuit, open circuit, and maximum power. In the first step, the adopted approach concerned the resolution of the system of equations constituting the three operating points to write all the model parameters according to series resistance. Secondly, they made an iterative resolution at the optimal operating point by using the Newton-Raphson method to calculate the series resistance value as well as the model parameters. Once the panel model is identified, they had considered other equations for taking into account the irradiance and temperature effect. The simulation results showed the convergence speed of the model parameters and the possibility of visualizing the electrical behavior of the panel according to the irradiance and temperature.

Nader Hajj Shehadeh [2014] “Solar - Driven Water Pumping: An Untapped Resource for Lebanon”, Water is a basic necessity of life. Be it for drinking, irrigation, livestock, or domestic use, there is nothing of such a crucial importance to human health and well-being. Millions of cubic meters are pumped every day all over the world for rural applications, with electricity and onsite generators being utilized as the primary sources of power. Renewable energy started to become more and more of a feasible solution in the recent years given the combination of high energy prices and lowering costs of renewables, especially solar PV technologies, providing farmers and rural residents with environmentally friendly power sources to pump water with clear competitive advantages over traditional fuel-driven generators.

Morales T. [2010] “Design of Small Photovoltaic (PV) Solar-Powered Water Pump Systems”, The intent of this technical publication is to provide general guidance on the design of small solar-powered water pump systems for use with livestock operations or irrigation systems. This document provides a review of the basic elements of electricity, a description of the different components of solar-powered water pump systems, important planning considerations, and general guidance on designing a solar-powered water pump system. This publication also provides design examples for typical design scenarios and standard drawings for use by the reader. However, this technical note is not intended to be used as a standalone document. Instead, users are encouraged to consult the NRCS National Engineering Manual (NEH 210) on hydraulics and irrigation engineering for additional assistance in the design of water delivery systems.

Atlas solar tracking by Mechatronics Company manual: Atlas system can achieve up to 40% more output power than fixed tilt systems. It ensures that the PV panels are optimally orientated towards the sun, converting efficiently direct and indirect solar radiation into electricity.

Rockwell automations solar tracking application manual book: Concentrated applications like concentrated photovoltaic panels (CPV) or concentrated solar power (CSP) require a high degree of accuracy to ensure the sunlight is
directed precisely at the focal point of the reflector or lens. Non-concentrating applications don’t require tracking but using a tracker can improve the total power produced by the system. Photovoltaic systems using high efficiency panels with trackers can be very effective. There are many types of solar trackers, of varying costs, sophistication, and performance. The two basic categories of trackers are single axis and dual axis.

III. CONCLUSION

It is observed that the designed mechanical tracking system is a system, which consumes no energy for operation and contributing towards increasing the productivity of the solar panel. This is the first attempt made towards utilizing the gravitational energy as a driving force for solar tracking systems and also in providing a suitable tracking system for the remote places. The solar energy is converted into electrical energy and the energy which is produced through the solar PV panel is used to drive the reciprocating pump.

REFERENCES


