International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 11 | Nov - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

DESIGN AND FABRICATION OF SOLAR COOKER WITH TRACKER

Monika Y1 , Parinitha S2, Dr. Sharanraj.V3*, Dr. Vasantha Kumar4

1 Senior Grade Lecturer, Dept. of Mechanical Engineering, S.J. (Govt.) Polytechnic, Bangalore-560001

2 Lecturer, Dept. of Mechanical Engineering, Government Polytechnic, Ramanagar- 562159

3* Senior Grade Lecturer, Dept of Mechanical Engineering (W&SM), S.J. (Govt.) Polytechnic, Bangalore-560001

4 Associate Professor & Head, Department of Mechanical Engineering, Bearys Institute of Technology, VTU, Mangalore - 574153

ABSTRACT

Fossil fuels are a relatively short-term energy source; consequently, the uses of alternative sources such as solar energy are becoming more wide spread. The following report details the research and development of an Automatic Solar Radiation Tracker.To make solar energy more viable, the efficiency of solar array systems must be maximized. At present, the efficiency ranges from 8 to 15%. A feasible approach to maximizing the efficiency of solar array systems is sun tracking. Proposed in this report is a system that controls the movement of a solar array so that it is constantly aligned towards the changing direction of the sun for maximum heat transfer.

INTRODUCTION:

Solar energy potential:

India is located in the equatorial sun belt of the earth, thereby receiving abundant radiant energy from the sun. The India Meteorological Department maintains a nationwide network of radiation stations, which measures solar radiation, and also the daily duration of sunshine. In most parts of India, clear sunny weather is experienced 250 to 300 days a year. The annual global radiation varies from 1600 to 2200 kWh/m2, which is comparable with radiation received in the tropical and sub-tropical regions. The equivalent energy potential is about 6,000 million GWh of energy per year. Fig 1 shows map of India with solar radiation levels in different parts of the country. It can be observed that although the highest[1].

The solar option

There have been shortages of oil in many parts of the world and the price of this commodity has increased steeply. In India the energy problem is very serious. The price paid for import of crude oil is more than INR 5000crores. This amount forms a major part of India's import bill. The need for developing energy alternative is thus evident and considerable research and development work is already in progress in this direction.[2].

Solar radiation

The sun radiates energy in the form of heat at a rate of 3.8x10^20 MW. Out of which earth receives approximately 1390 MW per sq. km. outside the earth's surface. About 30% of this energy is reflected back to atmosphere, while 20% energy is absorbed by the atmosphere[3].The earth's surface received on the average energy of 695 MW/sq. km, out of which 2% is absorbed by oceans. Another small fraction is absorbed by plants, and converted to chemical energy. Thus the energy we use is actually solar energy converted to chemical energy by plants[4].

Background

With rising fuel costs, climate change concerns and a growing demand for electricity, renewable -energy resources such as solar power and wind power are becoming an increasingly valuable part of the world's energy mix. Around the globe, businesses and homeowners are harnessing the power of the earth's most abundant natural resource – sunlight – to provide energy using solar power. Most widely used solar energy harnessing is done through solar panels.

Objective of Work

The solar cooker needs to face the sun continually in order to absorb the maximum energy from Sun. One way to do this, of course, is by hand. However, keeping a solar reflector facing the sun throughout the day is not a very efficient way. Going outside to a solar cooker every hour to turn it toward the sun might be possible, but this would still not be an efficient method because it mandatorily requires a person to attend to it constantly. Thus, to overcome this difficulty the report describes a mechanism which helps in the automatic movement of the cooker reflectors along the path of the sun.

MATERIALS AND METHODS:

Material requirement:

The properties that must be considered in the selection of materials are

- Structural material
- Insulation
- Transparent material
- Moisture resistance

Structural material

Structural materials are necessary so that the box will have And retain a given shape and form, and be durable over time. These include cardboard, wood, plywood, bamboo, metal, cement, bricks, stone, glass, fiberglass, woven reeds, rattan, plastic, clay, rammed earth, metals, tree bark, cloth stiffened with glue or other material.

Many materials that perform well structurally are too dense to be good insulators. To provide both structural integrity and good insulation qualities, it is usually necessary to use separate structural and insulating materials.

Insulation

In order for the box to reach interior temperatures high enough for cooking, the walls and the bottom of the box must have good insulation (heat retention) value. Good insulating materials include: aluminum foil (radiant reflector), feathers (down feathers are found to be the best), spun fiberglass, rockwool, cellulose, rice hulls, wool, straw, and crumpled newspaper.

When building a solar cooker, it is important that the insulation materials surround the interior cooking cavity of the solar box on all sides except for the glazed side – usually the top. Insulating materials should be installed so that they allow minimal conduction of heat from the inner box structural materials to the outer box structural materials. The lower the box heat losses, higher are the cooking temperatures.

Transparent material

At least one surface of the box must be transparent and face the sun to provide for heating via the "greenhouse effect." The most common glazing materials are glass and high temperature plastics such as oven roasting bags. Double glazing using either glass or plastic affects the heat transfer in either direction. Depending on the material used, the solar transmittance – heat gain – may be reduced by 5-15%. However, because the heat loss through the glass or plastic is cut in half, the overall solar box performance is increased.

Moisture resistance

Most foods that are cooked in a solar box cooker contain moisture. When water or food is heated in the solar box, a vapor pressure is created, driving the moisture from the inside to the outside of the box. There are several ways that this moisture can travel. It can escape directly through box gaps and cracks or be forced into the box walls and bottom if there is no moisture barrier. If a box is designed with high quality seals and moisture barriers, the water vapor may be retained inside the cooking chamber. In the design of most solar box cookers, it is important that the inner-most surface of the cooker be a good vapor barrier. This barrier will prevent water damage to the insulation and structural materials of the cooker by slowing the migration of water vapor into the walls and bottom of the cooker.

Model: Box Cooker

This box cooker takes one to two days to make. It cooks two to three pots of food. If rocks or bricks are heated alongside the pots, the box cooker will maintain heat for a couple of hours after sunset with the lid closed.

Construction steps and materials used:

• Two large, shallow square boxes, nestable as follows:

An INNER BOX made of sheet metal should be preferably little bit of greater height than the cooking vessel.

An OUTER BOX made of wood, is a little larger in all dimensions and having at least 3 centimeters space from the inner box on all sides when nested. Ideal proportions: one unit high by two units long (front to back) by three units wide (side to side). Cookers that are too tall create shadows across the vessel and increase heat loss through walls.

• Glass frame: longer and wider than the inner box. Transparent heat traps let in sunlight and hold in heat.

•A frame consisting of two white glasses with a gap in between the two is placed on the inner box. This is done so to increase the intensity of the incident sun rays.

• Inner box is made of a thin, metal sheet and painted black (dull paint) on the inner side as black color absorbs and retains most of the heat radiations emitted by the sun incident on it.

• Two reflectors which are hinged opposite to each other on ends of the outer box to capture extra sunlight. The reflectors are made of mirrors which help in reflecting most of the sun rays on to the inner box. Reflectors are shiny, fairly rigid, and not easily damaged.

• The insulation gap is filled with cotton which helps in insulating the solar cooker. Insulation materials must be poor conductors of heat and tolerate high temperatures without melting or giving off fumes.

• Paintbrush to paint the setup.

• Pencil, pen or other marking device to mark the angles of reflectors and required dimensions.

• Large ruler or other straight to draw lines.

• Aluminium vessels are used to cook the food as they are highly resistant to corrosion and they are non toxic. Aluminium vessel is painted black on the outer side only.

SAMPLE PREPARATION:

Day 1 (April 15) – Without Tracker

Time duration: 180 minutes

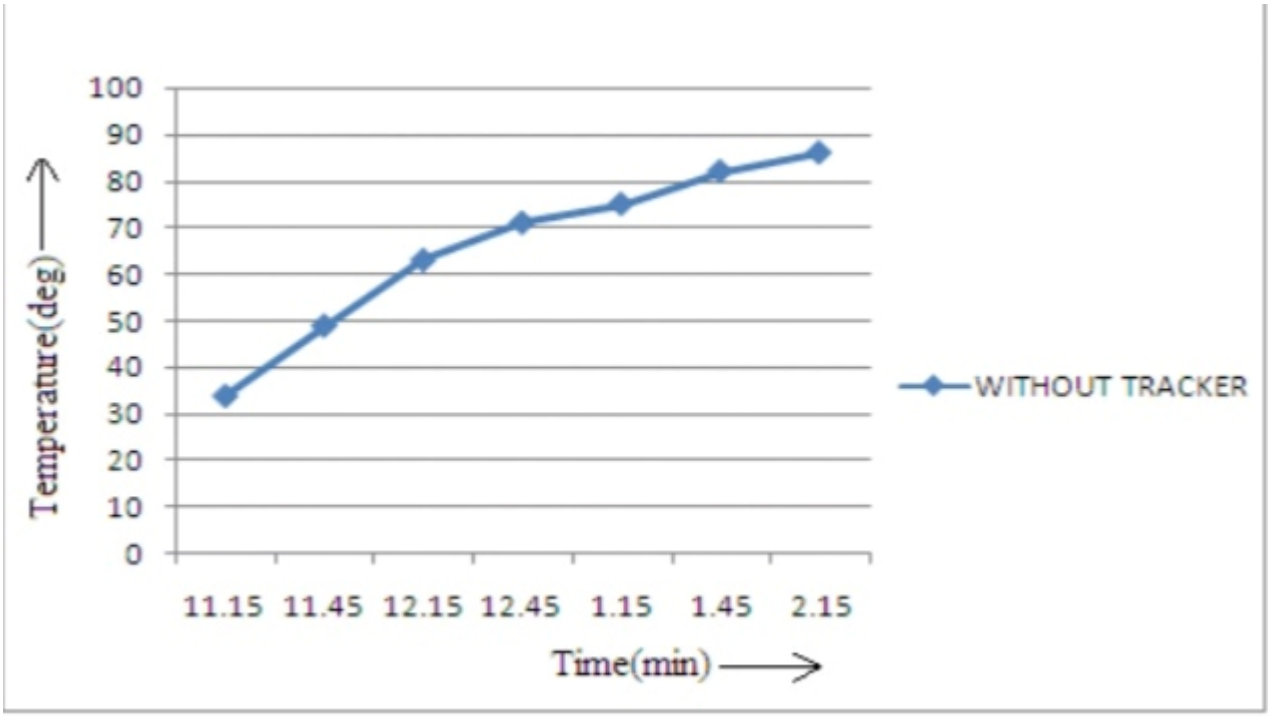
Quantity of water: 500ml of water (approximately 0.5 kg).

Tabulation for readings of temperature and intensity for solar cooker without tracker

TIME	TEMPERATURE(C°)	INTENSITY (W/m2)
11:15 AM	34	972
11:45 AM	49	1077
12:15 PM	63	652
12:45 PM	71	655
1:15 PM	75	1055
1:45 PM	82	986
2:15 PM	86	927

Average Intensity: 903.42 (W/m2)

Graph 1 Indicating the change in temperature of the solar cooker without tracker



Fig(1):Indicating the change in temperature of the solar cooker without tracker

RESULTS:

Solar cookers concentrate sunlight onto a receiver such as a cooking pan. The interaction between the light energy and the receiver material converts light to heat and this is called absorption. The conversion is maximized by using materials that absorb, conduct, and retain heat.Solar cooker works on the principle that sunlight warms the pot, which is used for cooking the food. Now, this warming of the pot occurs by converting light energy to heat energy. Concave mirrors are used in these types of cookers because these mirrors reflect sunlight into a single focal point.

CONCLUSION:

In this project, the sun tracking system was implemented based on dripper mechanism. After examining the information obtained in the data analysis section, it can be concluded that the proposed sun tracking solar array system is a feasible method of maximizing the energy received from solar radiation. The tracker used to implement this system has been designed with minimum number of components and has been made into a simple assembly.

The automatic solar radiation tracker is an efficient system for solar energy collection. It has been shown that the sun tracking system can collect about 7% more energy than what a fixed panel system collects and thus high efficiency is achieved through this tracker.

REFERENCES:

1. Akshay Urja, 2005, September–October 2005 Issue 5
2. Solar Cookers International 10th edition, 2004
3. Kundapur Ashok (1988). Review of Solar Cooker Designs. TIDE, 8(1) 1-37.
4. Funk, P.A. (2000). Evaluating the international standard procedure for testing solar cookers and reporting performance. Solar Energy, 68(1) 1-7.