INTERNATIONAL JOURNAL OF ADVANCED RESEARCH IN ENGINEERING, SCIENCE & MANAGEMENT

PROPOSED DESIGN OF BOX TYPE SOLAR COOKER TO INVESTIGATE OPTIMUM SLANT ANGLE

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Abstract*: This proposed design for experimental set up is to investigate the optimized slant angle. The slant angles provide transparent side to the box type solar cooker. Slant transparent side gives more radiation which results in increased temperature of inner box of solar cooker. In this proposed design, heat is loose due to conduction through transparent side walls. Optimum slant angle can increase radiation and decrease heat loose through conduction. So, Optimum slant angle is required to increase solar radiation on box type solar cooker. In this study Different design of solar cookers has been proposed to obtain optimum slant angle.

Keywords: **Box type solar cooker, Optimum slant angle, solar thermal, Proposed design of different solar cooker.**

I. INTRODUCTION

Solar cooker is a device which cooks food without any conventional cooking fuel energy like cow dung, wood, coal, gas, kerosene or electricity. It converts sunlight into heat energy and cooks the food. Solar cooking presents an alternative energy source for cooking. It is a simple, safe and convenient way to cook food without consuming fuels, heating up the kitchen and polluting the environment. Solar cookers can also be used for boiling of drinking water, pro- viding access to safe drinking water to millions of people thus preventing waterborne illnesses. Solar cookers have many advantages, on the health, time and income of the users and on the environment.

In present solar cooker only top side is kept transparent for solar radiation. In this proposed design three sides are partially transparent to gain maximum solar radiation. But in this proposed design heat is lose due to conduction through transparent sides. So, here it is required to design optimum area of transparent sides which depends on slant angle to reduce heat lose.

Basic Principles of Solar Cooker:

Principles of operation of solar cookers the principle of solar cooking is that rays of sun are converted to heat and conducted into the cooking pot. The ability of a solar cooker to collect sunlight is directly related to the projected area of the collector perpendicular to the incident radiation. In this regard, the geometric concentration ratio is defined as

$$CR = At / Arc \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where At is the total collector area and Arc is the area of the receiver/absorber surface. In the case of the simple box with no reflectors, the energy entering the aperture can be given simply as

$$Qc = Ap\ \tau g\ I \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where Aa is the area of the surface of glazing material facing the sun (assumed perpendicular), τg is the transmissivity of the glazing material, and I is the value of the global solar radiation perpendicular to the collector.

Equation (2) assumes that the collector is normal to the incident radiation. The variation of the apparent area of the collector with the angle of the sun is given by equation

$$Aap = Ap\ Cos(\theta)\ Cos(\varphi) \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where Aap is the apparent area of the collector; Ap is the area of the collector assuming the solar radiation is perpendicular to the surface; θ is the solar azimuth angle, and φ is the difference between the solar elevation angle and the collector tilt angle.

II. LITERATURE SURVEY

Some of the authors that work in this area include :(Ali, 2000), Design and carried out series of test in nine days in other to make comparison of the Sudanese box type solar cooker against the Indian designs. Sudanese solar cooker showed a better thermal performance. [1]

(Ibrahim, 2005), Conducted an experimental testing of box type solar cooker using the standard procedure of cooking power. The box type solar cooker was tested to accommodate four cooking pots in tatna (Egypt) under prevailing weather conditions. The experiment was performed in July 2002.the cooker was able to cook most kind of food with an overall utilization efficiency of 26.7 %. [2]

(Ammer, 2005), carried out research on the title, theoretical and experimental assessment of double exposure solar cooker. The solar cooker is exposed to solar radiation from the top and bottom sides with a set of plane diffuse refection is used to direct radiation on to lower side of the absorber plate. [3]

The performance of the cooker and the convectional box type solar cooker were investigated. Result under the same prevailing conditions show that the absorbers of the box type solar cooker and the double exposure solar cooker attain stagnation temperatures of 140°C and 165°C respectively.

(Hussein, 1997) work on the performance of the box type solar cooker with an auxiliary heating. The performance of the cooker was studied and analyzed. It was done with the help of a built in heating coil inside the cooker. It was found that the use of auxiliary source allow cooking on most cloudy days. [4]

(Nahar, 2003) work on performance and testing of hot box storage solar cooker. He designed fabricated and tested a hot box solar cooker with used engine as storage materials so that cooking can be performed in late evening. The performance and testing of a storage solar cooker was investigated by measuring stagnation temperatures and conducting cooking trials. The efficiency of the hot box storage solar cooker was found to be 27.5%. [5]

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III. DESIGN OF BOX TYPE SOLAR COOKER

This one is simple box type solar cooker. This type of solar cooker is available in the market. Length of this solar cooker is same as the proposed solar cooker. But height of this solar cooker is different from the proposed solar cooker. Height is less compared to proposed solar cooker. Other dimensions are same. Different view of this type of solar cooker is shown in figure I.

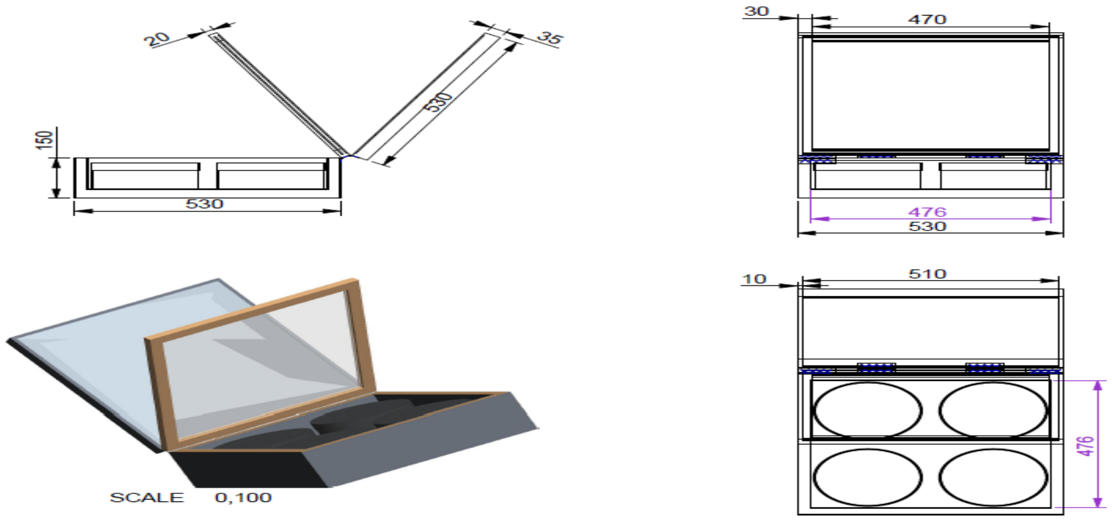

Figure I: Regular Box Type Solar Cooker

IV. DESIGN OF PROPOSED SOLAR COOKERS

Solar Cooker of β=16º:

This type of solar cooker is not available in the market. Length, width and height of this solar cooker are same as the modified solar cooker. But in this solar cooker we are using partial side wall and partial front wall. This partial side wall is inclined at angle of 16º. Different view of this type of solar cooker is shown in figure II.

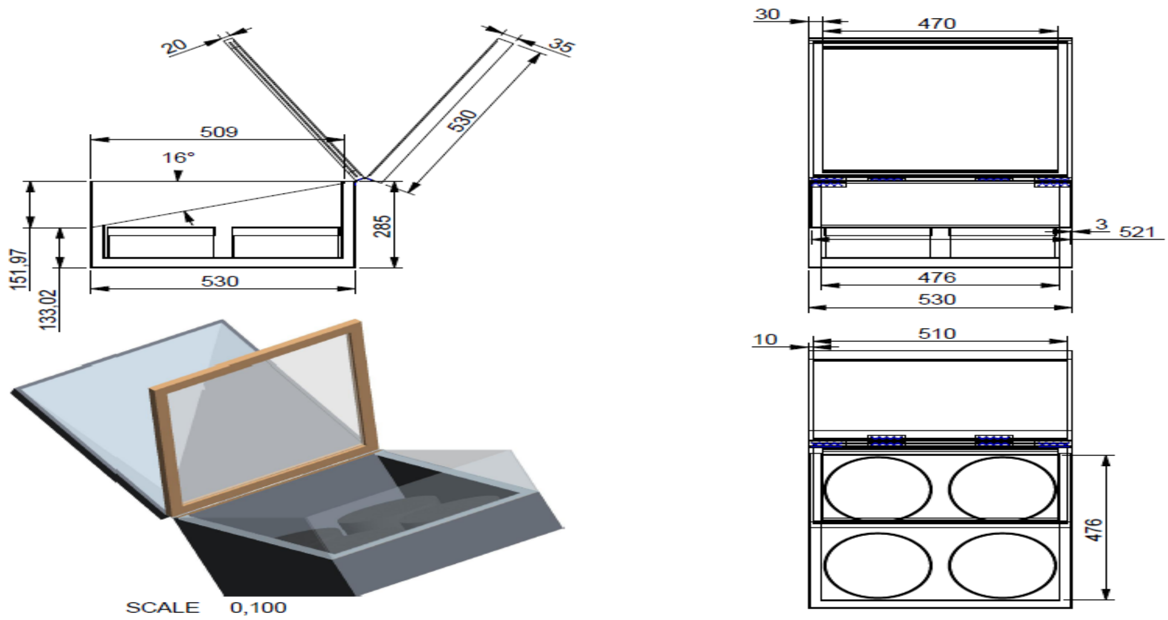

Figure II: Solar Cooker of β=16º

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Solar Cooker of β=17º:

In this type of solar cooker partial side wall is inclined at angle 17º. Other dimensions are same as the modified solar cooker. Different view of this type of solar cooker is shown in figure III.

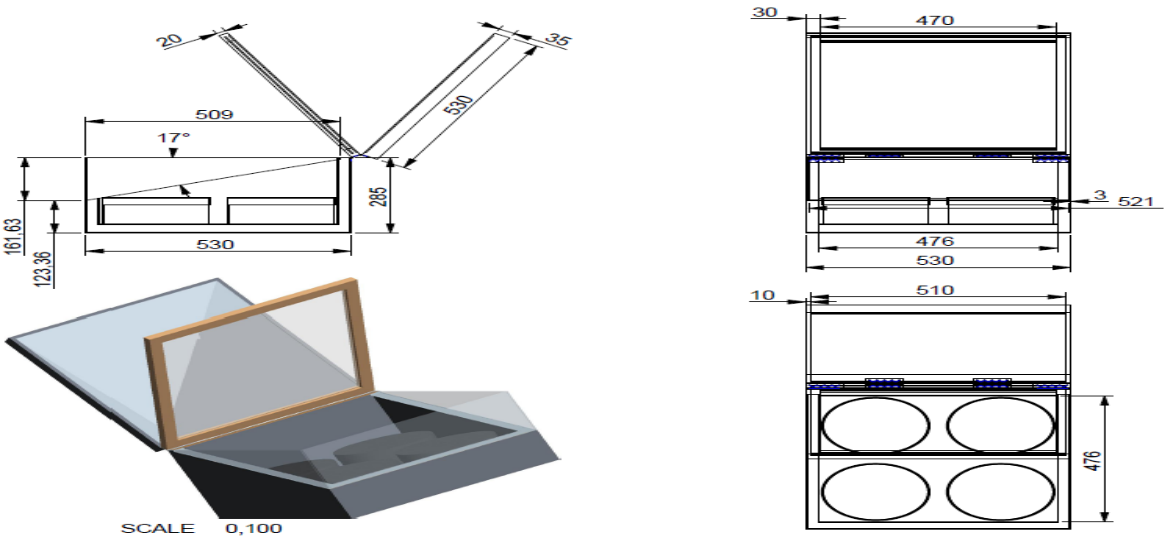

Figure III: Solar Cooker of β=17º

Solar Cooker of β=18º:

In this type of solar cooker partial side wall is inclined at angle 18º. Other dimensions are same as the modified solar cooker. Different view of this type of solar cooker is shown in figure IV.

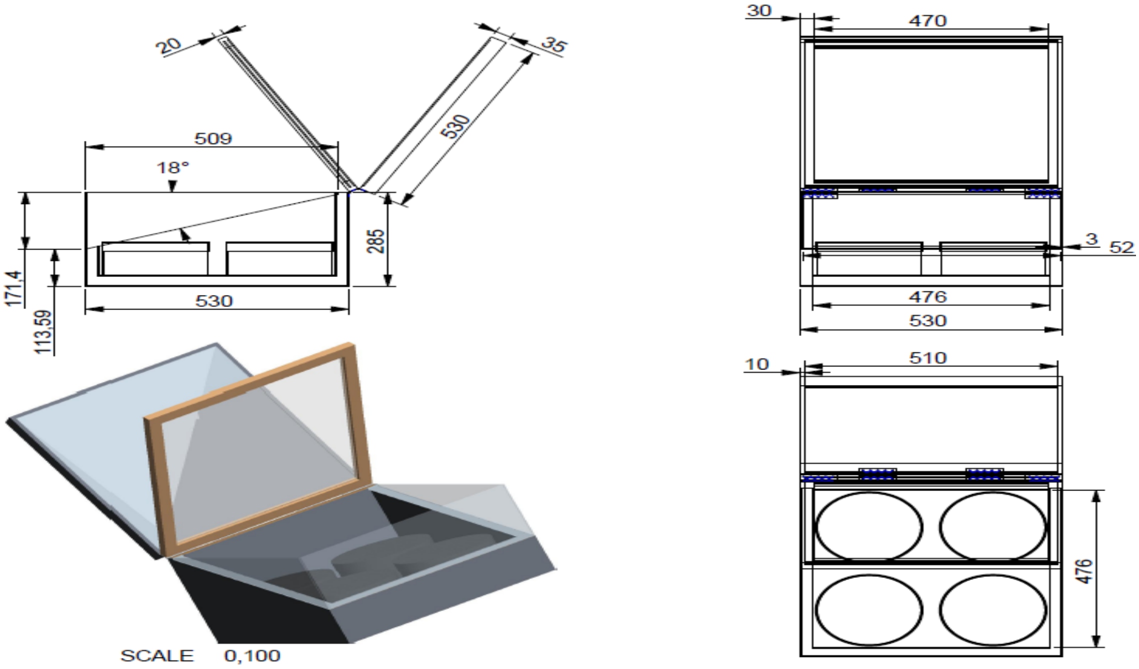

Figure IV: Solar Cooker of β=18º

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V. CONCLUSION

- Experimental set up of box type solar cooker can be developed form proposed design.
- Experimental investigation will be done to find out optimum slant angle out 16^0, 17^0, 18^0.
- In experiment two different methods used to find out optimum slant angle. One is to measure temperature of water in cooking port of each cooker using thermocouple at regular time interval of 30 minutes for whole day.
- Second method is to measure time taken by each cooker to rise unit temperature.

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