

# Analysis of Different Cooking Pots in Box Type Solar Cooker with Outer Reflectors

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**Abstract**— This paper presents a research on the box type solar cookers, with an analysis of different cooking pots i.e. finned and un-finned cooking pots. In this study, a box type solar cooker was fabricated and tested under Lucknow city (Uttar Pradesh) prevailing climate conditions. The presented cooker is the box type solar cooker with four aluminum foil reflectors. The testing was conducted at Lucknow city in Kirti Solar Limited. The two pots are identical in shape and volume, with one of the pots external surface provided with fins. The result of two tests of water heating, revealed that Test.1 held on 7th April with 1 Liter of water was raised to 94°C in 112 and 124 minutes for finned and un-finned cooking pot respectively. These figures represent 9.6% reduction in heating time. Similarly Test 2 held on 5th May with 1 Liter of water was raised to 94°C in 97 minutes and 114 minutes for the finned and un-finned cooking pots respectively. And these figures represent 15% reduction in heating time. This clearly demonstrates that fins improved the heat transfer from the internal hot air of the cooker toward the interior of the pot where the water to be heated in different periods of months.

**Key words:** Cooking Pots, Solar Cooker, Outer Reflectors

## I. INTRODUCTION

The first Scientist to experiment with solar cooking was a German Physicist named Tschinhausen (1651-1708). He used a large lens to focus the sun's rays and boiled water in a clay pot. His experiment was published in 1767 by a Swiss Scientist Horace de Saussure who also discovered that wooden "hotboxes", he produced enough heat to cook fruit. French Scientist Ducurla improved on the hot box design by adding mirrors to reflect more Sunlight and insulating box.

- 1) The Solar cookers are needed due to – High cost or Unavailability of commercial fuels – Kerosene, Coal, cooking gas and Electricity.
- 2) Deforestation caused by increasing firewood consumption.
- 3) Use of dung and agricultural waste as fuels, instead of for soil enrichment.
- 4) Diversion of human resources for fuel collection.

## II. METHODOLOGY

### A. Introduction

In this study a box type solar cooker with four reflectors using different cooking pots i.e. finned and un-finned cooking pots were analyzed and tested. The solar cooker consists of a double-walled hot box, i.e. a box within a box, different cooking units, reflectors and a glass cover.

### B. Design Procedure

#### 1) Outer Box:-

This box is made up of wood and the dimensions of outer box are 60.5cm×39.5cm×20cm.

#### 2) Inner Box:-

The dimensions of the inner box are 55cm×34cm× 18.5cm and the inner box also known as the absorber plate is made up of steel sheets. The upper surface of the absorber plate is painted by black colour coating, for increasing the capability of absorbing incident solar radiation.

The working drawing of the present box solar cooker with the respective dimensions is shown in figure 1.

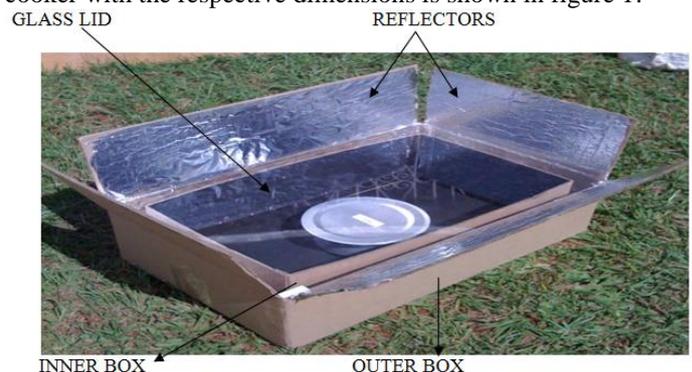


Fig. 1: A filed photograph of the box-type solar cooker under-consideration

#### 3) Glass Lid:-

The top of the box is covered with a clear window glass with a thickness of 4mm, and rubber gasket is also provided to prevent the leakage.

#### 4) Reflectors:-

There are four reflectors attached with the solar cooker. These reflecting are adjusted to an angle of 45°C, so that solar radiations falls direct in the solar cooker.

#### 5) Finned and Unfinned Cooking Pots:-

They are made up of aluminum and are painted black, the pots are cylindrical in shape and have flat base. Both the cooking pots i.e. finned and un-finned cooking pot have identical lid, with a diameter of 16cm and height of 8cm. The lateral external surface of one of the cooking vessel was provided with fins made of galvanize iron and was painted black. The fins used are rectangular in shape with a cross reaction of 5.5cm by .05cm and have a length of 2.2cm, with spaced at 1.5cm.

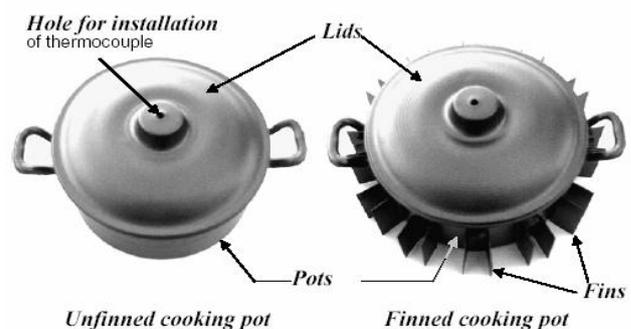


Fig. 2: Finned and Un-finned cooking pots

C. Working Process

When the box type solar cooker is placed in the sun the cooking vessels starts absorbing solar radiations coming through the glass cover .The inside temperature began to rise because of the input energy which is much greater then the loss of heat. After some time the equilibrium temperature will be reached, the amount of incident energy was increased by the reflector, which could focus an additional amount of solar energy inside the box type solar cooker.

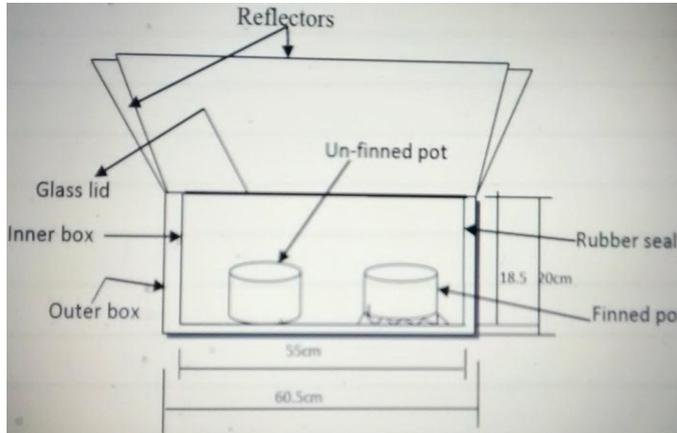


Fig. 3: Front working drawing of the solar cooker with under consideration.  
(All dimensions in cm)

D. Experimental Methodology

During each test, both cooking pot were placed side by side on the absorber of the box type solar cooker and loaded with the same mass of water i.e. 1 liter at the same initial temperature for water heating test. The temperature of the water in each pot as well as solar radiation were recorded at 15 minute of intervals ,during the day from 11am to 2pm. The temperature measurements were carried out by using K-type thermocouples coupled to digital thermometer with range from -50°Cto 150°C. Thermocouple connections in the box type solar cooker with three thermocouples at different locations- (a) Metallic pot side temperature,(b) Outer glass temperature, and (c) water temperature inside the pot are installed. The Solar intensity radiation was measured by ‘Kipp and Zonen Pyranometer’ and fixed at a horizontal position. Both the two pots were filled with water was placed in the cooker, and was closed with glass cover until test end. The two thermocouples were immersed centrally in each pot and secured above the pot bottom, 20mm below the water level. The following data were taken after every 15minutes-i.e. cooking pot temperature, water temperature in each pot, the ambient temperatures, absorbing plate temperatures, the solar radiation intensity and the temperature of air inside the cooker. During the experiments, the cookers was manually alined hourly or when the shadow appears in the absorber plate in order to track the sun.

III. RESULT AND DISCUSSIONS

A. Water Boiling Test (1):

Time	Ambient Temperature (°C)	Water in finned vessel temp. (°C)	Water in un-finned vessel temp. (°C)	Plate temp. (°C)	Solar radiations w/m <sup>2</sup>
11:15	32.1	35.3	35.3	65.3	564
11:30	32.8	52.6	50.8	79.4	597
11:45	33.2	66.7	62.5	85.5	651
12:00	33.7	75.7	71.8	92.6	665
12:15	34.3	79.2	74.4	96.6	653
12:30	34.8	85.9	79.8	104.7	661
12:45	35.2	90.0	85.5	106.6	668
01:00	35.9	92.5	91.0	114.4	644
01:15	36.5	95.7	93.8	120.6	615
01:30	36.8	97.8	94.4	124.6	605

Table 1: Temperature distribution at various point of cooker for water heating test on 7<sup>th</sup> April, 2015

Mean ambient temp. (°C)	34.4
Initial water temp. (°C)	35.3

Water boiling time with un-finned pot (Min)	124
Water boiling time with finned pot (Min)	112

Reduction in time (min.)	12
Percentage reduction in Boiling time (min.)	9.6

Table 2: Result of 1 liters of water heating Test 1

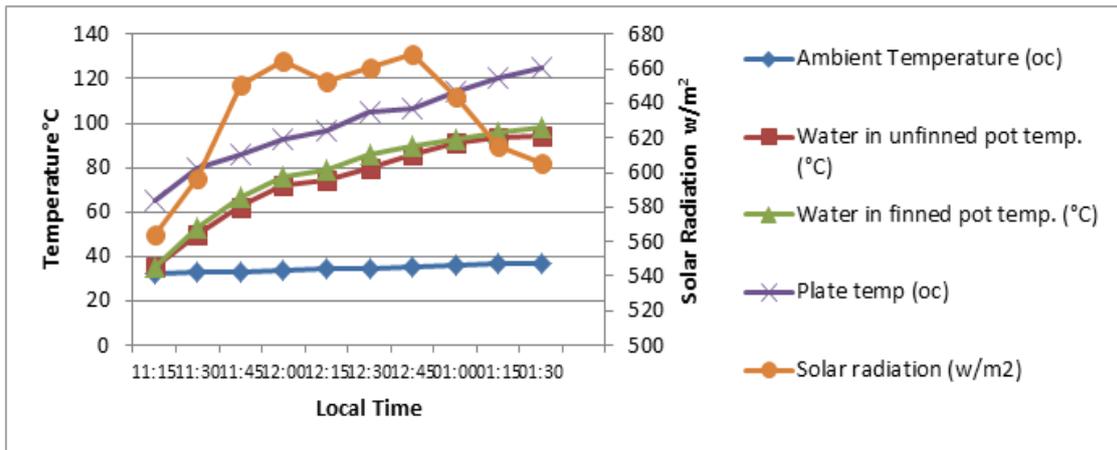


Fig.5: Water boiling test. 1 Comparison between water temperature in the finned cooking pot and the water temperature in the Un-finned cooking pot

B. Water Boiling Test (2):

Time	Ambient Temperature (°C)	Water in finned vessel temp. (°C)	Water in un-finned vessel temp. (°C)	Plate temp. (°C)	Solar radiations w/m <sup>2</sup>
11:15	33.2	36.1	36.1	69.8	572
11:30	33.6	55.2	53.8	79.9	605
11:45	34.1	68.8	63.2	86.8	660
12:00	34.7	78.2	73.5	95.6	670
12:15	35.2	81.5	77.1	98.4	672
12:30	35.9	89.6	82.5	109.3	667
12:45	36.2	92.8	87.2	111.6	678
01:00	36.6	95.2	92.6	120.9	654
01:15	37.3	97.4	94.8	126.4	635
01:30	37.8	99.8	96.2	132.6	620

Table 3: Temperature distribution at various point of cooker for water heating test on 5<sup>th</sup>May, 2015

Mean ambient temp. (°C)	35.4
Initial water temp. (°C)	36.1
Water boiling time with un-finned pot (min.)	114
Water boiling time with finned pot (min.)	97

Reduction in time (min.)	17
Percentage reduction in Boiling time (Min)	15

Table 4: Result of 1 liters of water heating Test 2

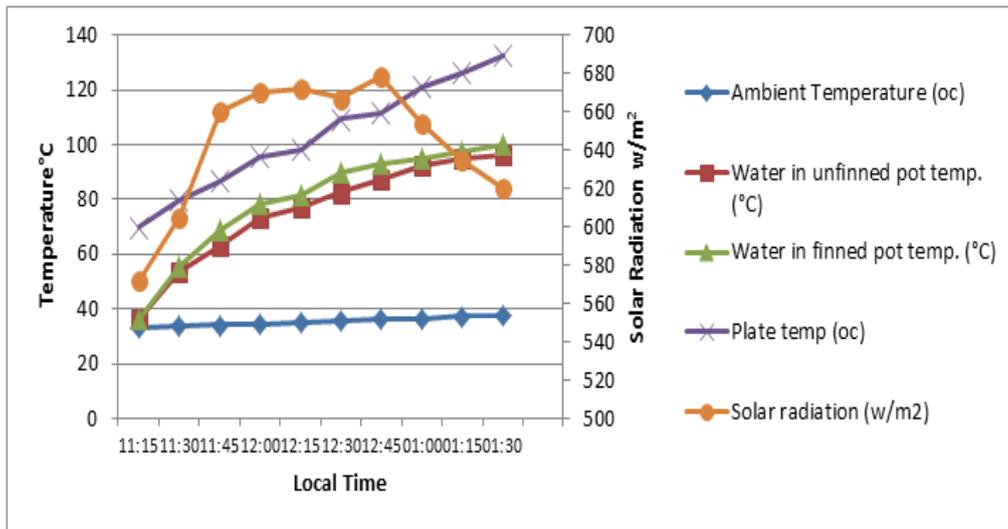


Figure 6: Water boiling test.2 Comparison between water temperature in the finned cooking pot and the water temperature in the UN finned cooking pot

Time	Solar radiations w/m <sup>2</sup> (7 <sup>th</sup> April)	Solar radiations w/m <sup>2</sup> (5 <sup>th</sup> May)
11:15	564	572
11:30	597	605
11:45	651	660
12:00	665	670
12:15	653	672

12:30	661	667
12:45	668	678
01:00	644	654
01:15	615	635
01:30	605	620

Table 5: shows the variation of solar radiation intensity with time for the two test held on 7<sup>th</sup> April, 2015 and 5<sup>th</sup> May, 2015

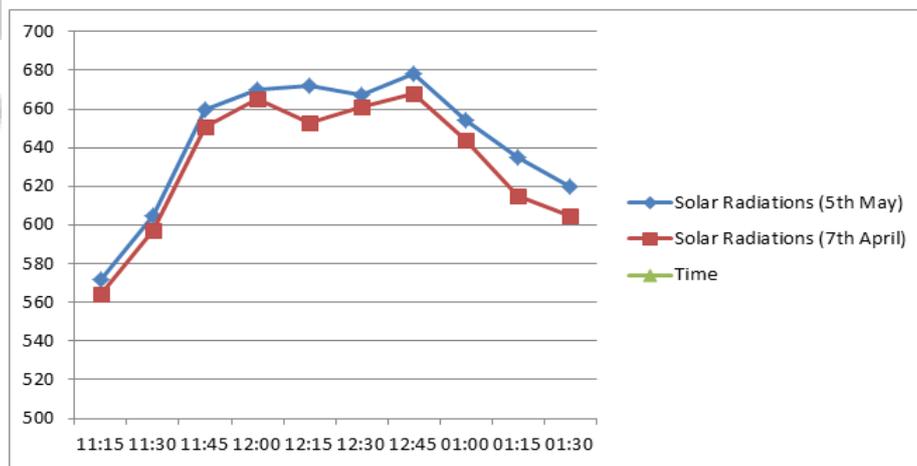


Fig. 7: Measured Solar Radiation on 7<sup>th</sup> April and 5<sup>th</sup> May 2015

#### IV. OBJECTIVE

The objective of this study is to analyze the performance of Box Type Solar Cookers under Uttar Pradesh Climate Condition (Lucknow) in Summer, in the month of April and May to improve the workability of cooker by using different cooking pots i.e. the finned and un-finned cooking pots. The readings obtained from the conducted tests have been evaluated and the results and graphs are compared.

#### V. CONCLUSION

The present solar cooker is inexpensive, easy to fabricate locally and simple to use. The comparison between water temperature in the finned cooking pot and the water temperature in the un-finned cooking pot under the same test conditions held on April 7<sup>th</sup>, 2015 and May 5<sup>th</sup>, 2015. It was found that the temperature of the water in the finned cooking pot was always higher than the temperature of water in the un-finned cooking pot. This result clearly demonstrates that fins improved the heat transfer from the internal hot air of the cooker toward the interior of the pot

where the water to be heated in different periods of months. The investigation has revealed that cooking time can be reduced and cooker temperature can be increased by using a finned cooking pot.

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