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## PERFORMANCE STUDY OF PARABOLIC CONCENTRATOR TYPE SOLAR COOKER

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### Abstract:

*The energy from sun is Solar energy and is really powerful ,renewable and free. We can use it to make electricity, to heat buildings and to cook. The field of cooking consumes many fossil fuels such as gas and wood. Million people cannot find enough gas and/or wood to cook, so use solar cookers is a good idea. During this work, we designed, built and studied a parabolic solar concentrator type solar cooker. Various designs of the solar cookers were studied in order to optimize their performance. They vary by the geometrical form and the place of the cooking pot. The characteristic of parabolic concentrator type solar cooker are studied and the experimental results are given.*

### KEYWORDS:

Parabolic Solar Cooker, Cooking, Performance..

### I) INTRODUCTION :

In this paper attempt is being made to trace the path of how solar concentrator evolved and to present the vision as to be the use of these solar concentrator for the tribal peoples. Due to depletion of fossil fuel there is need of new sources of energy such as non- conventional energy sources like solar energy, wind energy ,geothermal energy, tidal energy etc. ,out of these solar energy forms the promising future energy source. Solar energy can be harnessed by using different types of ways such as photovoltaic, photo-thermal and photosynthesis. By using different types of collectors we can utilize solar energy photothermally. In this paper we tried to utilize solar cooker for cooking purposes. The aim is to make solar cooking as comfortable as possible and it should be similar to conventional cooking system. The use of parabolic concentrator type solar cooker permits all the operations like boiling ,stewing ,steaming, roasting and frying with relatively high capacity . Box type solar cooker will able for boiling and steaming only. Therefore keeping in view the view the food habits of tribal people and their energy needs for cooking purposes, parabolic concentrator type solar cooker was fabricated.

### II) OBJECTIVES OF THE STUDY :

- a)To construct and fabricate parabolic concentrator type Solar Cooker.
- b)To measure temperature at the focus of the constructed parabolic concentrator type Solar Cooker.
- c)To study the losses during cooking process.
- d)To measure the time required for cooking of different food materials. ( Dal & Rice)

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- e) To calculate cooking efficiency of Solar Cooker.
- f) Ease of operation.

**III) TECHNICAL SPECIFICATIONS OF CONSTRUCTED PARABOLIC CONCENTRATOR :**

1) Aperture Diameter	2.3 m (length wise), 2.3 (width wise)
2) Reflector surface area	12.65 Sq.m
3) Aperture area	8.54 Sq.m
4) No of mirror facet	44
5) Size of each mirror facet	13cm (lower), 13.5cm (length), 16.5cm (upper)
6) Material of construction of mirror	Anodised Aluminium
7) Focal length of concentrator	40cm
8) Size of focal spot of reflector	30cm
At the bottom of vessel (Diameter)	
9) Type of Tracking	Manual
10) Reflectivity of the mirror facet	78%
11) Type & size of vessel used	Pressure Cooker

**IV) EXPERIMENTAL SET-UP :**

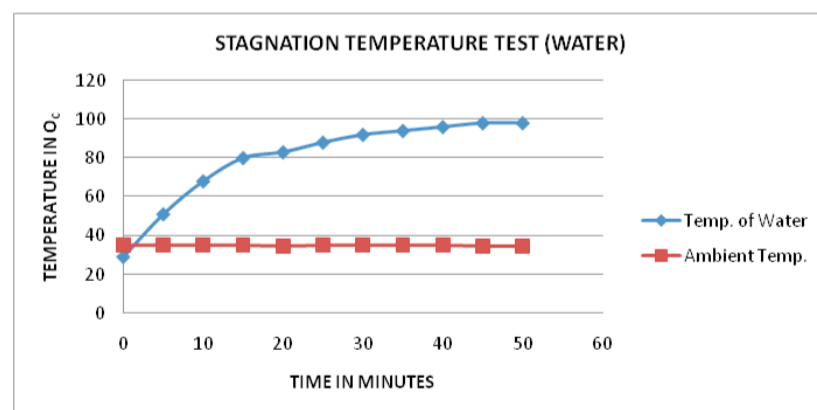
The performance of the parabolic concentrator solar cooker is quite sensitive to design parameters and operational conditions, and therefore cooker was tested for its thermal performance and cooking abilities by conducting following tests during clear sun days.

1. Stagnation Temperature Test- The water and oil heating test was conducted by placing a utensil with two litre water and oil separately at room temperature on the cooker. By using blackened and un-blackened utensils, stagnation temperature tests are carried out for water and oil.
2. Cooking Test – This was done to evaluate the time taken to cook a certain quantity of food items like rice, dal etc. The equal quantity was cooked individually on solar cooker for using blackened and un-blackened utensils.
3. Efficiency of Solar Cooker- Efficiency of Solar Cooker was calculated by using standard formula. To measure the Insolation standardised Suryamapi was used and For the measurement of temperature, Cr-Al thermocouple was used.

**V) RESULT AND DISCUSSION :**

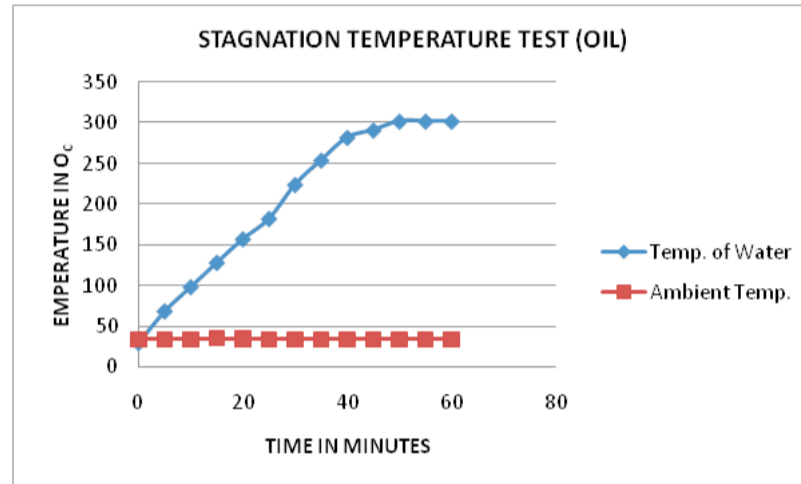
**1. Stagnation Temperature Test:**

The utensil containing two liter water was kept at the focus of parabolic solar cooker. The utensil was aluminum pressure cooker and is coated with black paint. The maximum temperature recorded at focus was 98 O° . and average ambient temperature as 35 O° see graph 1. The average solar insolation was 825 W/m<sup>2</sup>.



Graph 1: stagnation Temp. Test for water at average Insolation 825.00 W/m<sup>2</sup>

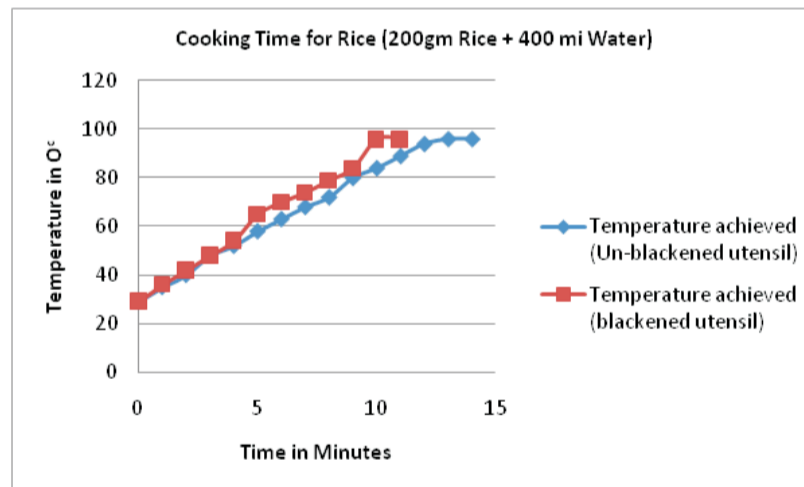
The utensil containing two liter oil was kept at the focus of parabolic solar cooker. The utensil was aluminum pressure cooker and is coated with black paint. The maximum temperature recorded at focus was 302 O°, The average ambient temperature as 34 O° see graph 2. The average solar insolation was 855 W/m<sup>2</sup>.



Graph 2: stagnation Temp. Test for oil at average Insolation 855.00 W/m<sup>2</sup>

**2. Cooking Test:**

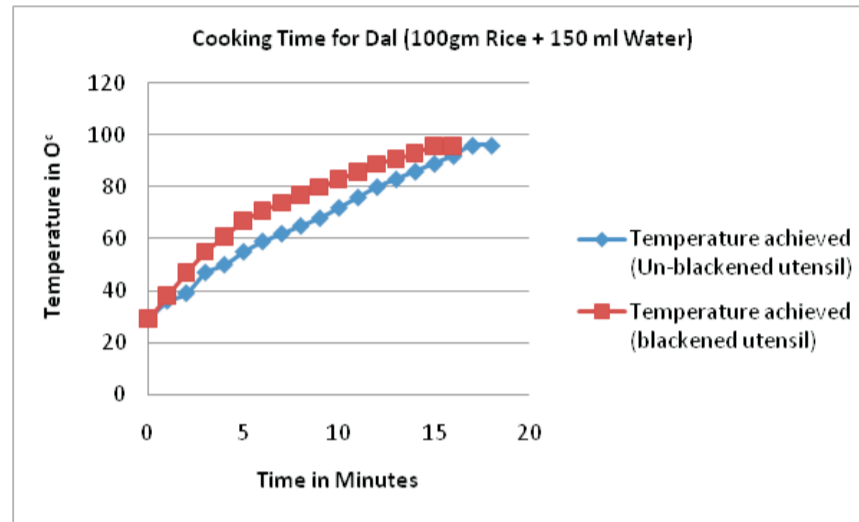
The utensil containing 200 gm Rice and 400 ml water was kept at the focus of parabolic solar cooker. The utensil was aluminum pressure cooker. The maximum temperature recorded at focus was 96 O°, The average ambient temperature as 35 O°. The time for cooking was 13 minutes when un-blackened utensil was used and 11 minutes when blackened utensil was used, see graph 3. The average solar insolation was 835 W/m<sup>2</sup>.



Graph 3: Cooking Test (Recipe- Rice) at average Insolation 825 W/m<sup>2</sup>.

The utensil containing 100 gm Dal and 150 ml water was kept at the focus of parabolic solar cooker. The utensil was aluminum pressure cooker. The maximum temperature recorded at focus was 96 O°, The average ambient temperature as 35 O°. The time for cooking was 17 minutes when un-blackened utensil was used and 15 minutes when blackened utensil was used, see graph 4. The average solar insolation

was 835 W/m<sup>2</sup>.

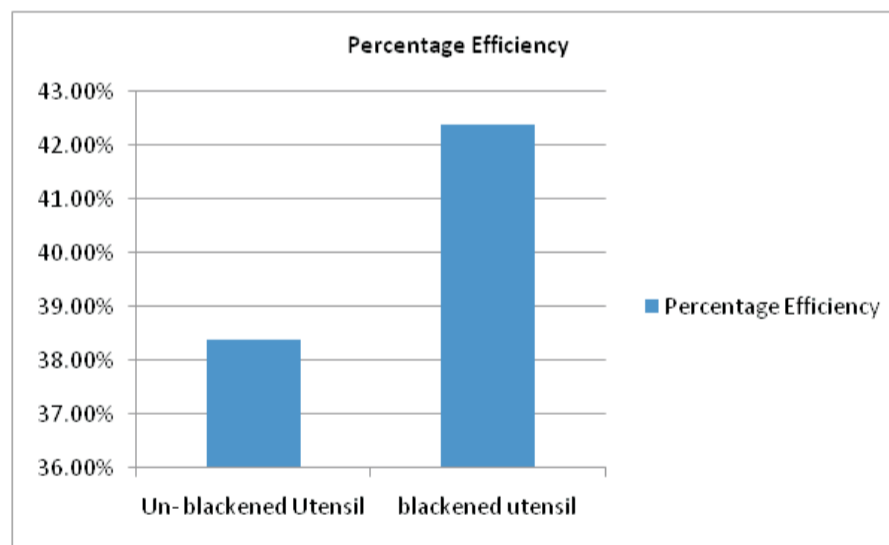


Graph 4: Cooking Test (Recipe- Dal) at average Insolation 825 W/m<sup>2</sup>.

It was also cleared that the time required for cooking was less with respect to increased insolation. The time required for cooking in case of Rice and Dal varies in accordance with the food material. Solar Cooking by using blackened utensil was found more than using un-blackened utensil. It was interesting to note that the cooking process of food material was completed when the cooking temperature was found constant. Due to considerably high temperature at focus, heat losses are pronounced as compared to heat losses due to conduction and convection. It is found that there was cooking time difference between two cases. The time difference was about two minutes. It is inferred from this that the heat absorbed by blackened utensil is more as compared that by un-blackened utensil.

**2.Efficiency:**

The efficiency of parabolic Solar Cooker using blackened utensil was found more than using un-blackened utensil, see graph 5. In the blackened utensil amount of heat absorbed must be more and heat losses are less. The loss of heat due to emittance is reduced.



Graph 5: Percentage Efficiency at average Insolation 825 W/m<sup>2</sup>.

The focal point is very bright and is at high temperature. It is troublesome to see at the focus, so during operating the parabolic solar cooker one must use specific goggles. While handling the utensil some heat insulating hand gloves like asbestos hand gloves should be used. To hold the utensil at focus specific arrangement is required because the position of focal point changes according to sun tracking. The foot stand of the concentrator should remain stable during operation. Instead of manual tracking of the sun, it is better to have concentrator continuous solar tracking system. The concentrator should be perfect according to parabolic design.

#### VI) SUMMARY OF THE FINDINGS :

To improve the efficiency of cooking using parabolic solar cooker following things should be taken in to account.

- 1)The material having good thermal conductivity like copper is to be used for utensil.
- 2)Instead of using matt black paint for blacken the utensil, selective coating may be used.
- 3)Reflectivity of the parabolic surface should be high.
- 4)Cleaning of parabolic reflector surface is required time to time.
- 5)During cooking process the utensil should remain at the focal point and hence continuous tracking is preferred.
- 6)The concentrator should be perfect according to parabolic design.
- 7)Heat losses are strongly influenced by wind.
- 8)Cooking power is influenced by temperature difference. Ambient temperature plays very important role. It is better in between 20 and 35 O°.
- 9)It is strongly recommended that cooking be conducted between 10.00 and 14.00 solar time because solar zenith angle is somewhat constant at midday, and the insolation measured in the plane of cooker aperture and the plane perpendicular to direct beam radiation will be least.
- 10)Safety should be taken while using parabolic concentrator type solar cooker.

#### VII) CONTRIBUTION TO THE SOCIETY :

The standard of living of human being is and hence demand for energy is also increased. More and more energy will be required for better standard of living. The traditional sources of energy like fossil fuels ,hydro energy, nuclear energy etc. have their limitations for their availability. Moreover the extensive use of some of such sources create number of problems like pollution which give rise to eco-imbalance.

Naturally therefore abundant, clean and free of cost sources plays important role for the energy demand. Solar energy, wind energy, ocean energy etc. are the renewable sources of energy. Solar energy is found very challenging source of energy , if used meaningfully. By using solar cookers either box type or concentrator type, we can save fuel wood , natural gas or electricity to be used for cooking or heating the water. It is easy to handle solar cooker and the food quality is adequate. The price is also tolerable and recovery period is about three years. It is durable. Taking into account all such factors it is recommended to use of parabolic concentrator type solar cooker for the physical and economical health of society.

#### ACKNOWLEDGEMENT :

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