Original Research Paper

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Physics

TO DESIGN AND DEVELOPMENT OF A PARABOLIC SOLAR COOKER FOR COOKING

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ABSTRACT There are limitations on conventional energy sources like fossil fuel, coal oil and natural gas. The prices of conventional energy sources are surprisingly high. Therefore it is necessary to search alternative energy sources. The alternative energy sources must be non polluted, low cost, available to all and renewable one. The solar energy is renewable and it is free of cost. Most of part of energy goes for cooking in India. Fuel like firewood, dung cakes, coal, kerosene and agricultural waste are used. Everyone is suffering from energy crisis.

The peoples of rural India are using conventional Chula. The Chula having very low efficiency (10 %) and also causes pollution. Most of people cannot find an adequate amount of gas to cook. To avoid this, efforts are being made to replace our existing cooking fuel with renewable energy source. As a result, use of solar parabolic cooker is a superior initiative. The crucial objective of designing the parabolic solar cooker is that it has many benefits as compare to other designs. Less time for cooking, high efficiency and low cost are few advantages of parabolic solar cooker.

For that reason we designed, built and developed a low cost solar parabolic cooker from locally available material on the terrace of college building (Sangamner College). Parabolic solar cooker based on the principle of reflection and concentration of the solar radiations. The cooking of samples such Moong dal and Rice are tested. The cooked quality of moong dal and rice is good. Cooking is uniform and proper. Maximum temperature achieved at zenith position. The results obtained shows that the efficiency of parabolic concentrator for rice is 47.09% and for mug dal it is 35.08%.

KEYWORDS : Parabolic concentrator, Efficiency, Renewable energy, Cooker.

Introduction

In India most part of energy consumed only for cooking. Various fuels like firewood, dung cakes, agricultural waste coal and kerosene are predominantly used. Everyone from the world affecting from energy crisis. Numerous peoples in rural India can't find enough gas to cook. Solar energy is best option for cooking in tropical region of the country. This can be achieving by using parabolic solar cooker. It works on the principle of concentration of solar radiations. Basically solar cooker is divided into two categories such as box type and parabolic solar cooker. Existing box type solar cookers performance is poor and takes more time for cooking. Sometimes in dilute insolation it can't work. Parabolic solar cooker have abundant advantages over box type solar cooker such as less time for cooking, simple construction and higher efficiency. Quality of food cooked in a parabolic solar cooker is good. Food material is out of danger from burning [1]. Flavours of food remain intact while using it for roasting, baking and grilling. Safer for children, save LPG, trouble free and no emissions of dangerous gases. The proper use of parabolic solar cooker helps to retain softness and moisture of baked food [2]. Also solar energy is renewable and non polluted therefore using parabolic solar cooker there is no pollution.

In present research work a parabolic solar cooker has been designed and developed from locally available materials. Samples like moong dal and rice was tested.

Methodology

Design and Construction

Initially we buy Mr. Hero plywood from local market of Sangamner having size 3m×1m of thickness 6 mm. Plywood was then dipped in ordinary water for 12 hours so that it becomes foldable. Then we cut plywood into symmetrical 20 petals. Each petal is connected to a small circular disc of plywood of radius 10 cm. Further all the petals are bent in parabolic shape and connected to each other uniformly with a fine metal wire. Now it appeared as a flower with petals shown as

Fig: 1.Petals are connected to a small circular disc

Fig: 2 Aluminium reflector is mounted on parabola

Now a reflector of aluminium foil uniformly pasted on the parabolic shape as shown in fig.2. So that the solar radiations are concentrated at the focal point of the cooker.

Using following equation, focal point is located [3].

$$f = \frac{R^2}{4h}$$

Where

f = focal length of parabola, R = radius of curvature of parabola and h = height from bottom to top of parabola.

With the help of drill machine, two holes are made to the aperture of parabola at the focal point. An iron ring was fitted to these drills. The cooking pot placed in the ring. The outer side of cooking pot was painted black since it absorbs maximum radiations and also emits. A strong enough support is given to the parabola so that it will sustain properly in the atmosphere.

Fig: 3 Parabolic solar cooker

Now the parabolic cooker is exposed into solar radiations in north south direction on the terrece of college building. The incident solar radiations are reflecred from aperature and concentrated at focal point i.e on the cooking pot. The blacken cooking pot now absorb the radiations and emits. The emitted radiations are further absorped by the water in side cooking pot. In this way the cooking material was cooked inside the pot. Using equation 2 , the efficiency of parabolic solar cooker was detemined.

$$\eta = \frac{(M_c S_c + M_w S_w)(\theta_2 - \theta_1) \times 4.2}{I \times A \times T} \times 100 \qquad (2)$$

Where

M_c = Mass of container, S_c = Specific heat of container
M_w = Mass of water, S_w = Specific heat of water
θ_2 = Final Temperature, θ_1 = Initial Temperature
I = Insolation, T = Time for exposure and A = Area of parabola

Result and discussion

100 gm of rice and 200 ml water was taken. Both are placed inside the cooking pot. The experiment was performed at noon time since solar radiation at zenith position. Various parameters such as surrounding temperature, temperature inside the cooking pot and insolation were measured after each 10 minutes till the material was properly cooked. The variation of temperature with time for rice is as shown in fig.4.

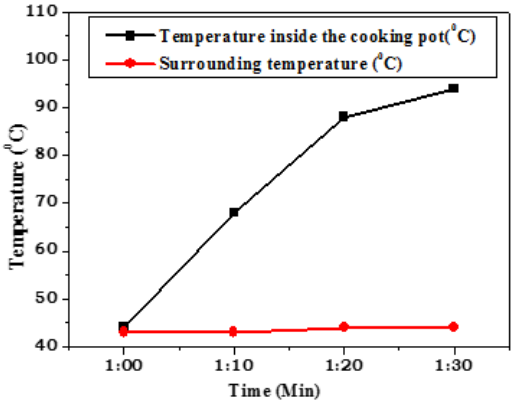

Fig: 4. Temperature time curve for rice

The cooking was started from 1:00 p.m. and continued to 1:30 p.m. at noon time in clear sunny day. The time required for cooking of rice was 30 min in clear sunny day in the month of April. From graph it is reveal that, temperature of cooking pot increases with surrounding temperature and insolation [3, 4]. Temperature inside the cooking pot reached at 94 0C within half hour and at the same time insolation was 430 Watt/m2. Using equation 1, efficiency was calculated. The efficiency was found up to 47.09%.

Similarly 100 gm of moong dal and 200 ml water was taken and both are placed in cooking pot. The variation of temperature with time for moong dal is as shown in fig.5.

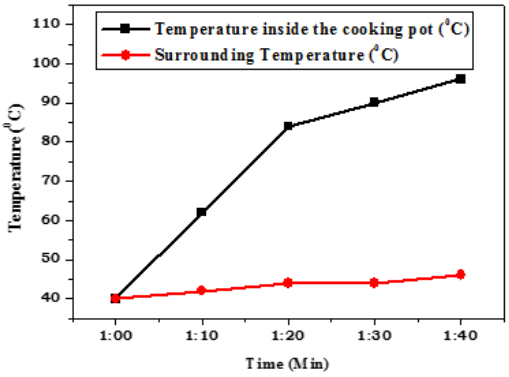

Fig: 5. Temperature time curve for moong dal

The total time required for cooking of moong dal was 40 min in clear sunny day in the month of April. From graph it is observed that, temperature of cooking pot increases with surrounding temperature and insolation [5, 6, and 7]. Temperature inside the cooking pot reached at 96 0C within 40 minutes and at the same time insolation is 460 Watt/m2. Using equation 1, efficiency was calculated. The efficiency was found up to 32.08%.

Conclusions

The cooking time is different for different materials. Temperature of surrounding and inside cooking pot increases with increase in insolation. For parabolic solar cooker, noon time is efficient. The test and quality of cooked materials was found good.

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