

INNOVATIVE 'BALCONY MODEL OF CONCENTRATING SOLAR COOKER'.

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ABSTRACT

In towns and cities of India, middle and higher-middle income groups are growing very rapidly. This class is conscious about energy and environmental issues. Most of these families live in small houses, often in apartments, and do not have access to open sunny yard or to rooftops for practicing solar cooking. Higher speed of cooking attained by solar concentrating cookers, like SK-14, suits their lifestyles and these cookers are affordable to them. But it's almost impossible to accommodate such bulky cookers in the small space available to them. The author¹ has developed an innovative 'balcony model of solar concentrating cooker,' that can satisfy the need of these city dwellers. The balcony solar cooker has a few innovative features like a retractable cooking place and mounting on a railing or parapet wall of the balcony. Different tests indicate the performance of the cooker comparable to that of SK-14.

Keywords: solar dish cooker balcony concentrator parabolic SK-14

1. INTRODUCTION

Major developments in solar cooking gadgets all over the world are focused towards extremely poor communities. Researchers and volunteers all over the world are constantly working on different designs of ovens, panel cookers and concentrators. Cookit, HotPot and different designs of box and panel cookers are successfully designed and being practiced at family level while big concentrators like 'Schefflers' are getting popularity for community cooking. A few concentrators like SK-14 are extremely useful for family cooking but these are not so popular in African and Asian countries as the cookers are expensive. These cookers also require lot of space.

People in rural areas have enough space to accommodate such concentrating cookers, but can not afford the cost of the concentrators. In some areas agro residues and firewood are still available almost free of cost and hence the investment towards solar concentrating cookers is not a priority for poor rural population.

In towns and cities there is a growing middle and higher-middle income group, which is conscious about energy and environment. This class of people live in small houses, most of the time in apartments, and do not have comfortable access to a rooftop or a sunny yard where solar cooking can be practiced. This urban lifestyle demands much higher pace of life. Conventional solar gadgets like box or panel cooker do not match their expectations of speed and convenience. Concentrating cookers like SK-14 do suit their expectations of speed but because of space constraints these cookers are not suitable. The researchers often neglect the need of this environmentally conscious community. If solar gadgets are designed and developed taking in to account the requirement of this class of people then it can boost solar cooking in urban areas, where affordability is not a big issue. The current paper presents one such innovation that can be used for such applications.

2. BACKGROUND

Concentrating solar cookers are an excellent gadget considering the speed and cooking capabilities. Higher cost of such cookers make this option available for people with good income, who are mostly living in urban India. Different expectations from this income class of people as recorded in surveys are:

- a. Compactness of the solar cooker: Most of the urban people live in small spaces, in apartment

systems and they want the systems to be compact to fit in available limited space. Normally people living in apartments and multistoreyed buildings do not have easy access to rooftops or open yards with good sun. Hence these people demand a solar gadget that can be accommodated in the balconies. Most of the balconies are 900 mm or 1200 mm wide, and covered with roof.

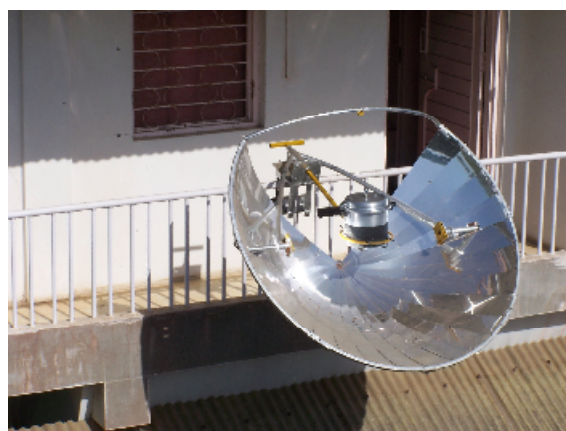
- b. Speed of cooking: Slow cookers do not suit the fast lifestyle of the urban people. Many people wish to have lunch by 10.30 a.m. before proceeding to work. High speed cookers like concentrators can match their expectation of speed.
- c. Convenience : Continuous attention is not feasible for many people because of constraints of time. Solar cooker with minimum setting and attention is required.
- d. If a solar cooker that can cook from within a kitchen is developed then it seems to be a dream product for the urban people.

While taking a look at available established products, it was noticed that there is no product available, matching with the expectations of such city dwellers. A successful effort has been made to develop a balcony solar cooker to meet these expectations.

3. THIS PROJECT

An exercise, to design a new parabolic dish cooker for mounting in balconies, was initiated. Speed of cooking was one of the major requirements and a concentrating cooker was the obvious choice. One has to increase size of cooker to tap more sun energy to improve on speed. Experiences with an SK-14 cooker show that an aperture area of 1.5 sqm can give satisfactory speed of cooking. Any round cooker like SK-14 with 1.5 sqm aperture area would not fit in the balconies of most of the apartments, which have balconies with width of 900 mm to 1200 mm. Moreover in some cases the roof of the balconies casts a shadow on the cooker much before noon. To counter these problems it was decided to design a cooker that will have an overhang outside the balcony. The cooker was designed to fit on the railing or parapet wall of the balcony and to hang outside. This solved the problem of space and shadow cast by the balcony roof. This is one of the most innovative features of this design.

To increase convenience, a deep parabolic design is chosen. Movement of focus onto the pot is for a larger duration of time, normally for 30 minutes, and the food is cooked in this period of time. This reduces the number of trips required to adjust or set the cooker to face the sun. The rear side of the cooker was obstructing the operations and hence the design was amended. Instead of a circular dish, a three quarter dish was designed, which improved accessibility and tracking of the system. The cooker can be conveniently mounted in balconies which are attached to the south or east side of the kitchen. In India traditionally most of the houses will have the kitchen in the south-east corner of the house, which suits most for such design. The design does not give convenience of operating from inside of the kitchen, but even operating it from the balconies attached to the kitchen can be easily acceptable.



Photograph 1: Innovative balcony model of concentrating solar cooker

The following are salient features of the new design.

- i. The new design of cooker fits on the railing or parapet wall of the balcony and overhangs outside the balcony. It does not eat up the working space in the balcony. As the concentrator overhangs outside the balcony, the chance of the balcony roof casting a shadow on the solar cooker is automatically taken care of.
- ii. As the cooker is fitted in the balcony attached to the kitchen, the solar cooker can be reached in few steps from the kitchen. Reduced trip distance can make the product more acceptable.
- iii. Instead of using a full parabolic dish only three quarter of the dish is used. The quarter portion towards the house is removed to facilitate loading and unloading of pots. Providing a tracking mechanism was also feasible because of removal of this quarter.

Three quarters of a 1600 mm diameter dish concentrator is used, which gives an aperture area of 1.5 sqm. Focus of the cooker is set at 320 mm from the base.

- iv. For loading and unloading pots on the concentrator the cook may have to lean outside the balcony, which is dangerous. A retractable telescopic handle is provided, which pulls the cooking place inside the balcony, and loading and unloading of the pots can be done easily. This is one of the most innovative features of this design.
- v. A biaxial manual tracking arrangement is provided. Focus remains on a pot for around 30 minutes and in majority of the cases the food is cooked in this time.
- vi. The author holds intellectual property rights for this product. (Patent pending.)

4. TESTS AND RESULTS

Different tests were performed in-house, on this balcony solar cooker during the months of October to February. These tests were carried out as per protocol followed at different test centers in India. Cooking time was around 11.00 a.m. The results in brief are discussed below.

4.1 Performance Tests

Performance tests reveal the most important information regarding cooking capabilities. Performance tests were carried out on different days in the months from October to February. The sample results are shown in the table 1.

TABLE 1: RESULTS OF PERFORMANCE TEST.

Sr. no.	Recipe	Ingredient in gms.	Water in ml	Time taken in minutes
1	Rice	200	400	15
2	Dal (pulse)	100	150	19
3	Rice	350	650	20
4	Dal (pulse)	200	350	24
5	Rice	300	600	17
6	Dal (pulse)	150	300	20

A pressure cooker of 5-liter capacity was used for the testing. The author¹ cooked rice, pulses and vegetables for a family of four in a single load in 7-liter capacity pressure cooker, and the time required to cook was around 30 minutes.

4.2 Stagnation Temperature Test

400 ml of oil was placed in a 3-liter capacity pressure cooker without a lid. Readings were recorded every 5

minutes. It was noticed that after 40 minutes, the peak temperature of 242°C was recorded. It was stagnant around this temperature thereafter. Average insolation was 760 watts/sqm during the test period.

4.3 Thermal Performance Test

2000 ml of water was loaded in the cooker without a lid. Temperature rise and insolation were noted every 5 minutes. In one hour 580 ml of water were evaporated. Average insolation was 790 watts/sqm. Overall thermal efficiency worked out at 66%. Considering the reflectivity of sheets at 84%, overall thermal efficiency of 66% can be treated as excellent.

All tests and trials on the cooker by University of Pune are in confirmation with the results obtained by in-house and field trials.

5. CONCLUSION

Extensive trials on the balcony cookers are being conducted before commercialisation. One cooker has been used by the author¹ for more than 8 months and two more installations were made for test and review purposes.

Overhang of the cooker outside the balcony is around 1400 mm, which some users feel is on the higher side and may create a problem for acceptance for some people. Another model of balcony cooker, comprised of a paraboloidal dish which is rectangular in plan is being developed. The dimension of the proposed balcony cookers are 1500 mm in length and 1000 mm in width. This design is in the final stages of development and is likely to be commercialised in near future. This design will have an overhang of only 1000 mm and can have wider acceptance, especially in multistoreyed buildings.

This innovative design of balcony solar cooker can bring about revolutionary changes in adoption of solar cooking by masses, especially by city dwellers. Field tests of the last eight months are satisfactory and the product is being commercialised. The technology will be made available to interested entrepreneurs on mutually acceptable terms. Cost and performance of the innovative balcony cooker are comparable to that of the SK-14.