

Performance Investigation of A Box Type Solar Cooker with A Absorber Plate: A Review

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Abstract: *This paper presents the work of various researchers on the performance of solar cooker. In this research used absorber plate bottom surface of solar cooker and the top cover is tilted at 24.57° corresponding to the latitude of Satna. To provide the tilt, the height of the back side will made 24.00 cm while it will made 9 cm for the front one. A two reflector box type solar cooker with a absorber plate will be fabricated and performance compared with a solar cooker without absorber plate.*

Keywords: *solar cooker, Absorber Plate; Latitude angle.*

I. INTRODUCTION

The continuous increase in the level of green house gas emissions and the increase in fuel prices are the main driving forces behind efforts to more effectively utilize various sources of renewable energy. Solar energy is renewable energy & sun is source of solar energy .Today's there is a need to use huge amount of solar energy for our many applications. Using solar energy for cooking has been a historical interest of human beings either by pure curiosity or by the needs for living. People who do not have the luxury of using a lot of electricity or using stoves burning relatively clean fossil fuels like natural gas, kerosene, and coal have long wished to utilize solar energy.

Their primary energy sources for cooking food and heating houses, which frequently causes environmental and health problems. The technological development of solar cooking devices is rather behind the various needs [10]. Cooking is one of the basic and dominant end use of energy in most of the developing countries. Hence, it is very desirable to develop alternative, appropriate and affordable methods of cooking, based upon the renewable energy sources. Use of solar energy for cooking is therefore on the rise in many parts of the world. Solar cookers of various designs are in use in many parts of the world since a long time as environmental friendly and cost effective devices to fulfill the domestic needs. The most common is the conventional box type solar cooker at utilizes a horizontal double glazed top surface made out of transparent glass. Food is placed in the box below this surface, under airtight conditions. A booster mirror, mounted as the lid of the box reflects the sun rays into the box[9]. Solar energy can make a major contribution to the

energy needs for cooking food. This is particularly true for remote and rural areas where solar radiation is available at a large scale and there is a lack of other energy forms. Even when other sources of energy are available, environmental and economic benefits dictate the implementation of new alternative energy techniques. Solar cookers are used primarily to cook food and pasteurize water. Additional uses are continually being developed. However, there are many factors that affect people's approach to solar cooking. Among these factors are access to materials, availability of traditional cooking fuels, climate, food preferences, cultural factors and technical capabilities. Solar cookers are one of two types, box type cookers and concentrating cookers. In concentrating cookers, the radiation is concentrated by a paraboloid reflecting surface. The cooking vessel is placed at the focus of the paraboloid reflector and is, thus, directly heated. These results in a remarkable reduction of cooking time, and temperatures above 200°C can be achieved in such a cooker. The box type cooker is the simplest device to collect the incoming solar radiation and convert it into heat energy. Part of this heat is delivered as useful energy to the cooked food. Box type cookers have the advantage of being simple in design and do not cost much. It requires no tracking, which allows unattended cooking. Also, diffuse radiation contributes to the heat input. Box type solar cookers are suitable mainly for the boiling type of cooking. The cooking temperature is, in this case, close to 100 °C. A large fraction of the mass of most food products is due to water, and more water may be added in the boiling type cooking.

II. LITERATURE REVIEW

Nahar et al. [1] to improve performance of the double reflector box-type solar cooker with transparent insulation material. The use of one more reflectors resulted in an avoidance of tracking towards sun for 3 h so that cooking operations could be performed unattended, as compared to a hot box solar cooker where tracking ahead of the sun is required every hour. The efficiencies were 30.5% and 24.5% for cookers with and without a TIM respectively. The use of this novel solar cooker would help in conservation of conventional fuels. Amer et al. [2] describes and analyzes a double exposure box-type solar

cooker, absorber is exposed to solar radiation from the top and the bottom sides. The predicted values are compared with measurements made under actual weather conditions. Results under the same operating conditions show that the absorbers of the box type cooker and the double exposure cooker attain 140°C and 165°C, respectively. The temperatures of the air inside the two cookers are 132°C and 155°C, respectively. The predicted temperatures agree with measurements under transient conditions within ±1.2 °C for the absorber plate, ±1.8 °C for the oven air and within ±2.5 °C for the glass cover. The time taken for cooking of several foods and for boiling the same amount of water is obtained for the two cookers under the same conditions and at the same location. The double exposure cooker reduces the cooking time by about 30–60 min .

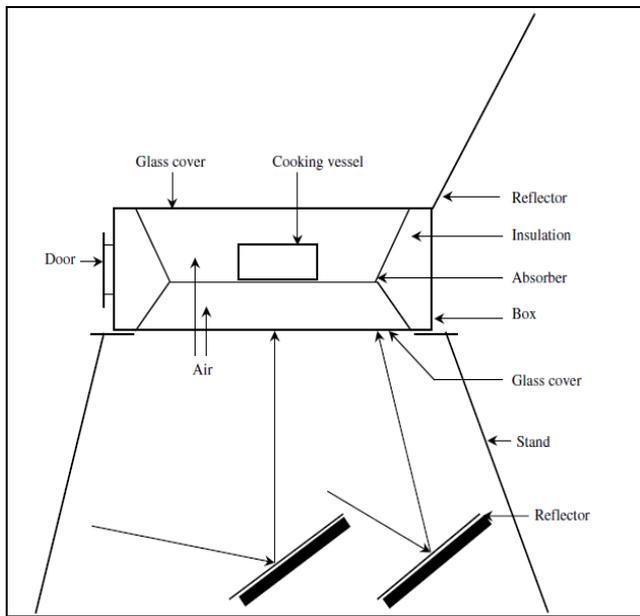


Fig. 1. Schematic sketch of the double exposure cooker[2]

Narasimha Rao and Subramanian [3] have investigated raising the vessel by providing a few lugs will make the bottom of the vessel a heat transfer surface. This change improves the performance of the system by improving the heat transfer rates in both heating and cooling modes. The times for reaching saturation temperature and cooking were noticeably reduced. Raising the vessel above the base plate of the cooker is recommended for universal adoption.

Negi and Purohit [4] conducted an experimental study of a box-type solar cooker with two non-tracking planar reflectors to enhance solar radiation in the box of the cooker. The concentrator, consisting of two planar reflectors suitably positioned in an east–west configuration on an inclined framework, is mounted on the box of the cooker to reflect incident solar radiation on the base absorber of the cooker. The design angle of inclination of the framework is taken equal to the latitude of the location and it is adjusted seasonally. The experimental results obtained show that the concentrator solar cooker provides

a stagnation temperature 15–22°C higher than that of the conventional box type solar cooker using a booster mirror. It is also observed that the boiling point of water with the concentrator cooker is reached faster, by 50–55 min, than with the conventional box type cooker using a booster mirror.

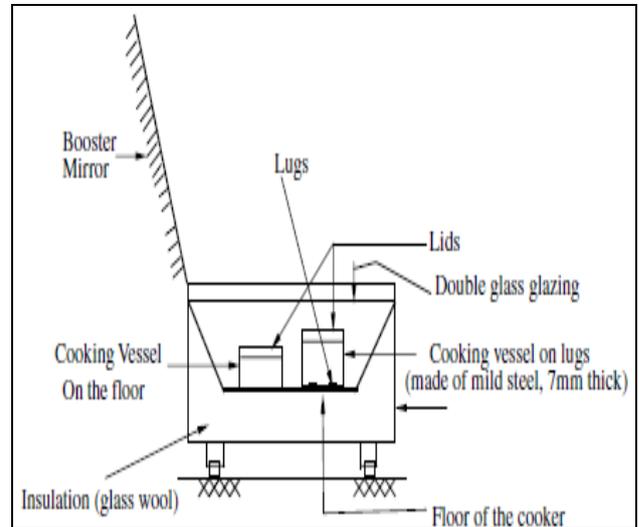


Fig. 2. Box type solar cooker with a cooking vessel on lugs and another identical vessel on the floor of the solar Cooker[3]

Karim MA [5] performed study on flat plate, finned and v-corrugated air heaters were investigated both experimentally and theoretically in an effort to improve the performance of conventional air heaters. Collectors were also tested in double pass mode to investigate the extent of improvement in efficiency that could be achieved without increasing the collector size or cost. A series of experiments were conducted. The performance of all three collectors was examined over a wide range of operating and design conditions. The v-corrugated collector was found to be the most efficient collector and the flat plate collector to be the least efficient. Results showed that the v-corrugated collector is 10–15 and 5–11% more efficient in single pass and double pass modes, respectively, compared to flat plate collectors. The double pass operation of the collector improved the efficiency of all three collectors. The improvement in efficiency for double pass mode was most significant in the flat plate collector and least in the v-groove collectors.

A.V.Narasimha rao et al. [6] focus on an investigates performance of conventional box type solar cookers can be improved by better designs of cooking vessels with proper under-standing of the heat flow to the material to be cooked. The performance of the cooking vessel with a central cylindrical cavity is compared with that of a conventional cylindrical cooking vessel. It is found from the experiments and modeling that the cooking vessel with a central cylindrical cavity on lugs results in a higher temperature of the thermic fluid than that of a onventional

vessel on the floor or on lugs. The average improvement of performance of the vessel with a central cylindrical cavity kept on lugs is found to be 5.9% and 2.4% more than that of a conventional cylindrical vessel on the floor and on lugs, respectively.

Harmim et al.[7] have proposed a new shape for the cooking vessel. It is an ordinary cylindrical vessel by which external side surface is provided with rectangular fins along its circumference. This new configuration increases the heat transfer surface towards the interior of the vessel while keeping an adequate volume to contain the food to be cooked. Their experimental study undertaken with a double exposure solar cooker revealed that the finned

cooking vessel reduces the cooking time considerably. It is clear that the increase in the temperature of the enclosure air in contact with the sidewalls of the cooking vessel will improve performances of the cooker.

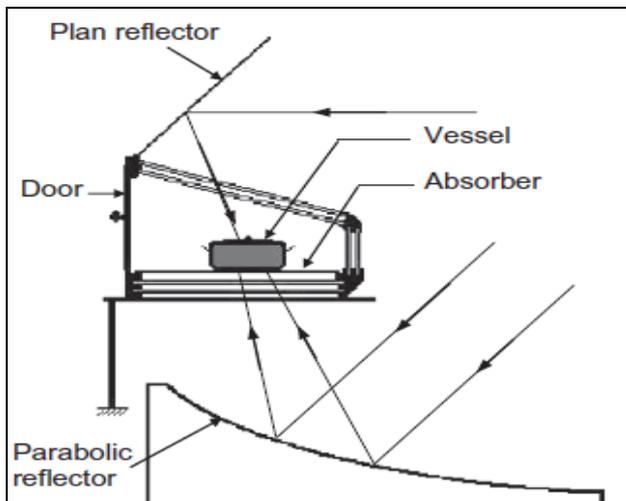


Fig.3.Schematic sketch of the double

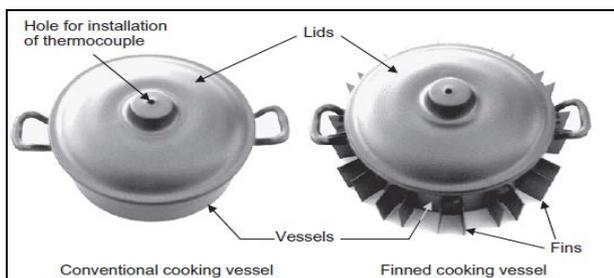


Fig. 4. Photograph of the two cooking vessels

exposure solar cooker[7]used in our comparative study[7]

Harmim A et al. [8] to better improvement performance of a box-type solar cooker equipped with a finned absorber plate to a similar box-type cooker which absorber plate without fins. Fins that have been used in solar air collectors enhanced heat transfer from absorber plate to

air. Experimental tests have been undertaken as part of this project where as applied this phenomenon to a box-type solar cooker. The results of the experimental investigation have been rigorously analysed and showed that the stagnation temperature for box-type solar cooker equipped with a finned absorber plate was about 7% more than box-type solar cooker equipped with an ordinary absorber plate. The time required for heating water up to boiling temperature in both box-type solar cookers was reduced with about 12% when a finned absorber plate was used .

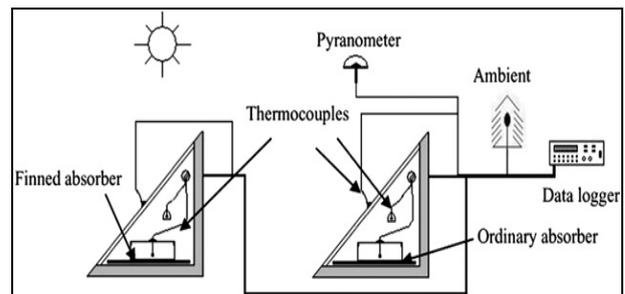


Fig. 5. Schematic diagram of the experimental rig[8]

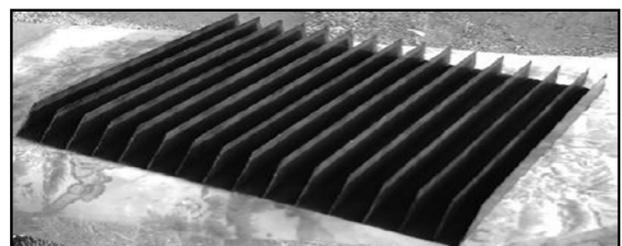


Fig. 6. Photograph of the finned absorber plate[8]

III. METHODOLOGY

The simple box type solar cooker consists mainly of an outer box, with and without finned absorber plate and glass cover fitted at particular latitude angle 24.57° . The gap between the box and the absorber plate is filled with glass wool insulation. Box type solar cookers will be constructed using locally available materials as well as local technical assistance. The three internal lateral sides are covered by aluminium foil and on the opposed side to the aperture area a mirror of 62 cm by 62cm is fixed by screws. we shall performed a comparatively experiment simple solar cooker and second time use two reflector mirror as well as absorber plate. the absorber plate is made of aluminium painted black. its upper surface is provided with rounded Fins. Fins have a length of 5 cm; they are spaced at 4 cm. The attached rounded fins on the absorber plate increase its temperature by radiative absorbance due to different multiple reflections. The temperature improvement of the interior hot air is obtained by the increase in the convective heat transfer plate air surface [8]. the temperature of the absorber plate, temperature of the internal hot air measured at the center of the internal cooker volume.wind speed and ambient temperature will measured by digital anemometer. Solar

irradiation will be measured by precision pyranometer. All temperatures were measured by chromel-alumel (K-type) thermocouples digital panel meter show output given by pyranometer and thermocouples. In the case of water heating tests, the temperature of water in cooking vessel is also measured by the same type of thermocouple introduced. so its type we will find, how much reduce the cooking timing after applied new technical research.

IV. CONCLUSION

The above literature review presents that another researcher developed a box-type solar cooker, in such design the absorber is exposed to solar radiation from the top and the bottom sides. Negi and Purohit conducted an experimental study of a box-type solar cooker with two non-tracking planar reflectors to enhance solar radiation in the box of the cooker. Narasimha Rao and Subramanyam have investigated the effect of keeping the cooking vessel on lugs and also a cylindrical cooking vessel with central annular cavity; they showed by experiments that the cooking vessel with central cavity improves effective heat transfer surface towards the water which is inside and then reduces cooking time. Two identical prototypes of box-type solar cookers have been designed and fabricated, the first one equipped with an ordinary absorber plate and the second one equipped with a rounded finned absorber plate. The principal goal of this experimental study is presentation of a simple box-type solar cooker whose time of cooking is rather long because it is not equipped with reflectors and rounded finned absorber plate but it is used to possibility of reducing the cooking time of solar cookers with the help both ideas are included once a time together. This technical method can be also used in the case of more sophisticated box-type solar cookers like that equipped rounded finned absorber plate.

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