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Performance Investigation of a two Reflector Box Type Solar Cooker with a Finned Absorber Plate : A Review

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Abstract

This review paper presents the work of various researchers on the performance of solar cooker. In this research author used finned absorber plate inside bottom surface of solar cooker and The top cover (Glazing) is tilted at 23.16° corresponding to the latitude of jabalpur (the location of the test site). To provide the tilt, the height of the back side will made 25.47 cm while it will made 10 cm for the front one. Four caster wheels have been provided under the cooker This review paper presents, the work of various researchers on the performance of solar to change orientation of the cooker towards the sun. According to given above specification, A two reflector box type solar cooker with a finned absorber plate will be fabricated and performance compared with a box type solar cooker without reflector mirror and finned absorber plate.

Keywords: solar cooker, Two reflector mirrors, Finned Absorber Plate; Latitude angle.

Introduction

Energy s considered a prime agent in the generation of wealth and a significant factor in the economic growth and sustainable development. 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 enewable energy. Solar energy is renewable energy & sun is source of solar energy .To day'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.

Many people in third world countries still use biomass as 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 andaffordable 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 peoples 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

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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. This results in a remarkable reduction of cooking time, and temperatures above 200°C can be achieved in such a cooker. A common problem in concentrating cookers is food spillage, unless a vapor tight vessel is used. Further, some form of tracking is needed which adds to the cost of the device. 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.

Literature Review

Nahar et al. [1] to improve performance of the double reflector box-type solar cooker with transparent insulation materiel. 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

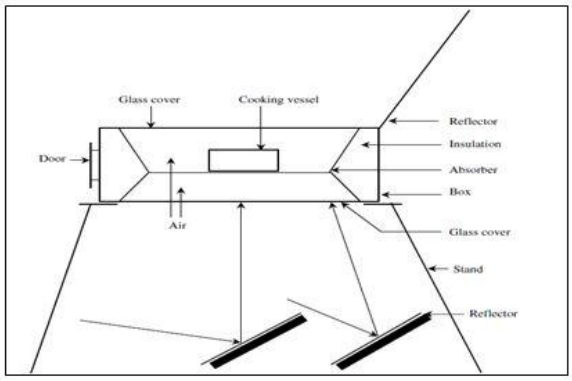

Fig. 1. Schematic sketch of the double exposure cooker[2]

Narasimha Rao and Subramanyam [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.

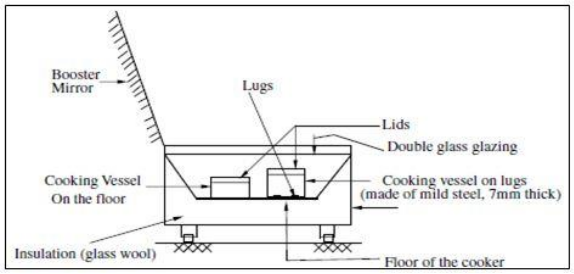

Fig. 2. Box type solar cooker with a cooking vessel on lugs and another identical vessel on the floor of the solar Cooker[3]

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.

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Impact Factor: 1.852

Karim MA [5] performe 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 performence 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.

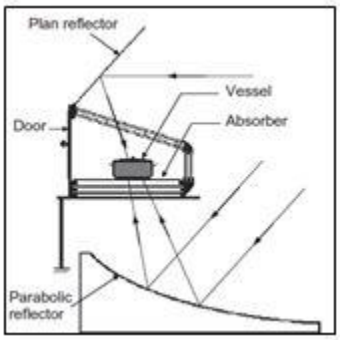

Fig. 3. Schematic sketch of the double exposure solar cooker[7]

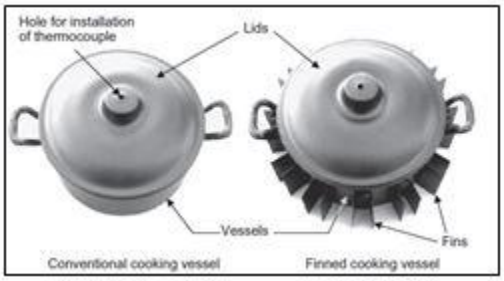

Fig. 4. Photograph of the two cooking vessels used in our comparative study[7]

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

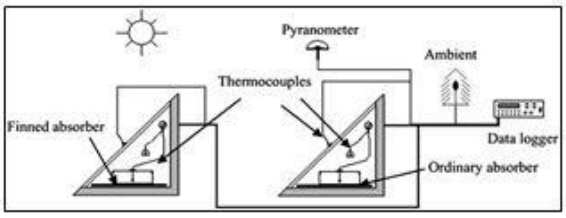

Fig. 5. Schematic diagram of the experimental rig[8]

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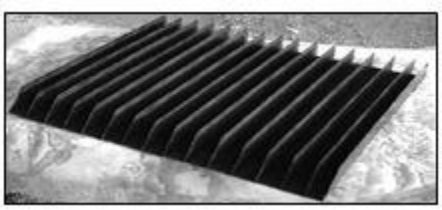

Fig. 6. Photograph of the finned absorbplate[8]

Methodology

The simple box type solar cooker consists mainly of an outer box, with and without finned absorber plate and glass cover (glazing) fitted at particular latitude angle 23.16° (at jabalpur). The gap between the box and the absorber plate is filled with glasswool 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 comparetively experiment simple solar cooker and second time use two reflector mirror as well as finned absorber plate. the absorber plate is made of aluminium painted black. its upper surface is provided with Fins. Fins have a length of 5 cm; they are spaced at 4 cm. The attached fins on the absorber plate increase its temperature by radiative absorptance 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 anemeometer. Solar irradiation will 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 found , how much reduce the cooking timing after aplied new technical research.

Conclusion

A review on the research and development of various types of solar cookers has been carried out. The above literature review presents that another researcher developed a double exposure 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 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 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 togheter. This technical method can be also used in the case of more sophisticated box-type solar cookers like that equipped with two plane reflectors and finned absorber plate.

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