Babylonian Journal of Mechanical Engineering
Vol.2024, **pp**. 19–25
DOI: https://doi.org/10.58496/BJME/2024/004; ISSN: 3006-5410
https://mesopotamian.press/journals/index.php/BJME

Research Article

Review of the non-concentrating solar cookers with innovative absorber plates designs

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ARTICLE INFO

Article History
Received 10 Jan 2024
Revised: 19 Feb 2024
Accepted 21 Mar 2024
Published 15 Apr 2024

Keywords
Box solar cooker
Absorber plate
Absorber angle
Cooking power
Cooking time

ABSTRACT

Preparation of meals has been named as one of the leading factors that affect the consumption of energy consumed globally as well as global emissions of greenhouse gases. Still due to these reasons that solar cooking is cheap and can be done at large scale, it is appropriate. To discuss the plan of cheap solar cookers, this paper gives an introduction of them, namely; box cooker with or without. In a free and natural way without panels, funnels or reflectors. Other designs that encompass virtually all kinds of the solar cooker also included are Fresnel, indirect, and parabolic-dish and parabolic-trough types. Scope is discussed further. Heat conservation tips, performance criteria, cost aspects, and improvement processes for heating systems design. This also brings into focus a high temperature 24 hour indoor solar cooker.

1. INTRODUCTION

We see that solar energy has versatility of uses and some of its uses include but not limited to thermal and photovoltaic related Thermal and photovoltaic based. As it was mentioned, the thermal route is not selective tariffs applicable to a particular band of solar radiation (like photovoltaics), high some research is being conducted in this domain. Even though high and medium temperature uses are making a direct input to energy. the low temperature application such as water heating within the construction sector is expected , cooking, thermal comfort, etc. require definition enhancement because probable potential role in the domestic field, community and at the commercial level. Of them, the most popular and acknowledged appliance is the Solar Cooker. least complex, most efficient, and desirable plan. It provides free and clean cookery, which is appropriate for either the new tendencies of the urban lifestyle, or for a comfort of rural living in the frames of the sphere's development including the developing as well as underdeveloped countries that are struggling with energy crisis.

At present most of the solar cookers in use are not expensive by any measure as it doesn't require any fuel and literally costs the organization nothing to run the operation. Many non-profit hospitals and other organisations across the world are encouraging use of such vehicles to conserve fuel costs, air pollution and, slow down the deforestation, desertification attributed to firewood collection for cooking as well as women rights activism[1]. Solar cooking has been a contemporary practice among the community for several years of area of interest for scientist, researcher and engineers for many years. The first was constructed as a solar collector and then used to cook foods by a Swiss Naturalist in 1767 with two more varieties listed by[2]. Since then, untill the first mass produced solar few studies were conducted.was invented during the 1878 in India and Chinese cooker as well was invented in china[3]. Until the invention of the present day solar cooker of the more recent type of box cooker is the technology experienced many drawbacks[4]. But, in spite of benefits, solar cookers have not gained acceptance as many would wish especially for household cooking even though there are a number of cheap designs around today.[5][6] have noted. There is scarcity of research done on the issue of. increase the usability and feasibility

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of constructing solar cookers for developing; as well as in emerging [7] and developed nations. In several poor nations that experience substantial yearly solar radiation, the use of such devices has lately increased [8]. Researchers have compared solar cookers with conventional cooking methods in Nigeria and India, revealing that family access to LPG stoves is prevalent, while kerosene stoves have been supplanted by solar box cookers, which are now in third place, followed by solar cookers. The concept of focussing cookers is included in the rankings[9, 10] . Recognising its future potential, several review papers have been published, particularly in the recent decade, as will be detailed in the subsequent portion of this paper.

2. SOLAR COOKERS

Bowman's and others are reviews on the solar cookers of the past.[11]. In a way information Strategic planning and information technology strategy are intrinsically interconnected. 'Heaven's Flame' is a seminal treatise on labour, notably authored by [12], and continues to be a distinguished publication. One of the most acknowledged instances of the paradigm predates it significantly. The only reference from the domain of reviews, still referenced today, is [13]. To promote the design of low-cost solar cookers, a cardboard enclosure lined with aluminium foil contains a black pot positioned in the centre of the panel. The thermo-resistant plastic bag known as COOKIT, as noted by [14], operates at temperatures up to 90 °C. [15]. categorised under Space heating/cooling, whereas others have evaluated various latent heat storage options, therefore extending the applicability of cookers beyond daylight hours, with a focus on box cookers. The particular role of phase change material (PCM) in the cooker and the limited study on solar indoor cooking. [16]. Throughout the current decade, various research have focused on design, testing methodologies, performance comparisons, and related aspects. Since its conception, the solar box cooker surpasses all other types of solar cookers. [17] have compiled many designs and highlighted their positive impact on the thermal performance of each component. A thorough prior evaluation by [18] included testing, energy, and exergy analyses, as well as the economic variations of several kinds of box and parabolic cookers. Assessment of the thermal performance of solar cookers and their environmental impact. This study examined measurement, effect, and performance increase as discussed in [19], which also presented evidence of a reduced payback time (> 2 years) and future possibilities.

Box and parabolic cookers are classified as direct kinds. The vacuum tube-based solar cooker, an innovative and important indirect kind, demonstrates comparable energy and exergy performance to large community-based Scheffler cookers [20][21] conducted a socio-economic study to compare different structural designs of box cookers and presented an integrated building design model as the optimal solution. The evaluation methodology and thermal assessment This study examines the testing technique and thermal analysis of a specific material at the author's organisation. Direct type solar cookers contribute to CO2 reduction, a topic discussed by [22], who also explored various tracking methods for concentrating units. An evaluation [23] previously emphasised advancements in thermal storage cookers, various heat storage materials, and performance contour analysis. The final statement addressed the research potential of a high-temperature thermal storage device for solar cooking. Indora and Kandpal have compared the SK-23 type solar cooker with the Scheffler dish solar cooker for those who choose to implement the cooker at the institutional or community level. Estimates indicate that the SK-23 solar cooker can prepare between 39% and 60% of meals annually, while Scheffler's favourable and unfavourable evaluations vary from 59/100 to 85/100. Furthermore, the flexible repayment offers the additional benefits: Firstly, it is more directly associated with the project's original investment cost than with the conventional payback period. Secondly, the flexible payback approach does not accumulate interest, providing an additional benefit compared to the discounted payback method. The duration for SK-23 is seen to be between 6.2 and 9.2 years, but it spans from 9.5 to 11.7 years for Scheffler. The financial appeal of SK-23 is diminished due to suboptimal performance, which may be ascribed to inadequate results, while the capital costs are comparatively high. The specific kind of Scheffler induces financial strain. In a comparable assessment including residential, business, and public sectors, modern concentrating solar systems are deemed superior [24]. for institutional-level culinary applications, such as… ARUN®, parabolic, and Schoffers dishes have been delineated concerning design, construction, and operating facets.

The authors contend that the utilisation of solar energy for institutional cooking is constrained by substantial upfront expenses. expense, insufficient room and/or auxiliary backup, challenges in meal preparation, and inadequate advertising to stimulate meal incentive measures. A review by [25] addresses the economic and environmental impacts of both direct and indirect mail about solar cookers. This research evaluates the correlation between the duration of consumption, payback, and other variables affecting wind power investment, employing data from a survey questionnaire that also addresses the duration and magnitude of CO2 emissions. [26] have detailed the latest advancements and current situation of solar cooking technology, including experimental and analytical socio-economic research on box, focussing, and panel cookers. It was determined that the dent's complement with a parabolic crest adversely affects this form of dent, varying across various planes. Additionally, a dent with a bigger planar area has a more pronounced detrimental impact from the crest, with concentrated cookers exhibiting 97% efficiency, followed by box-type cookers. And at a minimum, this pertains

to panel cookers. Nevertheless, the opposite sequence is indeed applicable in some economic contexts. All prior reviews have predominantly focused on the efficiency and performance of direct and indirect solar cookers rather than on temperature control and the development and testing of low-cost, socio-economically viable technologies for enhanced sanitation designs. Common designs of solar cookers, such as panels and funnels, are notably absent from this location. The panel cooker was introduced in the 1990s. As a result, earlier assessments have not referenced panels, with the exception of [13]. Subsequent reviewers seem unaware of these inexpensive cookers due to the absence of substantial scholarly literature on the subject. The new review book [27] delineates approximately 260 designs, accompanied with pertinent commentary on the majority. Prior evaluations have focused on technical aspects rather than delving into cost-effective design. This evaluation aims to exhibit many designs, focussing on their aesthetic appeal and cost-effectiveness rather than their technical attributes.

3. BOX COOKERS

The first concepts of the solar cooker were box-type, conceived by Swiss naturalist de Saussure in 1767, as corroborated by Garg and Adhikari in their 1998 research. The premises were insulated, including a rectangular design and a glass atrium. The artists of SCI conceptualized the design seen in the following image. Figure 1. Box cooker, 2020. History indicates that de-Saussure's interest in solar cooking was ignited when he discovered that fruits placed in an inverted glass tray and left in the sun ripened effectively. This insight prompted him to create the first solar cooker.

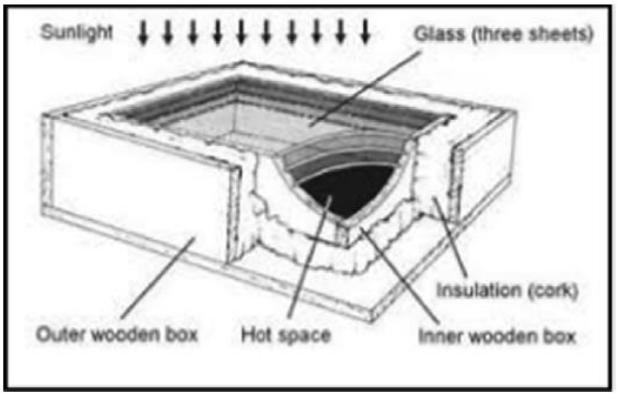

Fig. 1. De-Saussure’s Box cooker

De-Saussure’s design has gained widespread recognition because to its longevity, practicality, and usefulness. It is renowned for being robust, dependable, and user-friendly. The design has garnered enthusiastic support from scientists globally who are endeavouring to quantify energy and exergy efficiency metrics and experimenting with various parameters, such as size and the incorporation of internal or external reflectors, to optimise performance. An inventor, an African guy, has designed a solar cooker enough large to accommodate a whole goat. Proceedings of the 10th International Conference on Applied Energy, pp. 704–711, Singapore, 2020.

The alteration to the antennas was executed by Gosh from India, who introduced a device he referred to as a reflector mirror booster for the preliminary test to improve the efficacy of the box cooker [13]. He also sought to streamline the design. The current design is generally known as 'Gosh design' (Picture 2), which has been certified by the Bureau of Indian Standards (BIS) [28]. This design may represent one of the first solar cooker models globally. The development approach used by Indian businesses is unconventional. Design for manufacturing and marketing is mostly influenced by government support. A notable design of a single reflector solar system is an examination of lens design for solar concentrators. Among the several types of box cookers, there exists the Lazola Cooker from Germany [27] (Fig 3). A straightforward and exemplary design modification has been shown here. Regardless of the season—summer, winter, rainy, or dry—individuals engaged in the aforementioned occupations must ensure they wear appropriate work apparel and protective clothing as mandated by their employer. The 'Solar Cooker' may gather sunlight from early morning until late afternoon, particularly when the sun's angles are low, irrespective of the season. The sunlight is directed into the box by modifying the Tulsi Cooker, and Davis of the US Sun Focus [27] included one big reflector and two smaller reflectors on the sides for reduced light levels (Fig. 6).

Fig. 2. Gosh Box cooker (Ashok, 1998).

Fig. 3. Lazola cooker (Ashok, 2018).

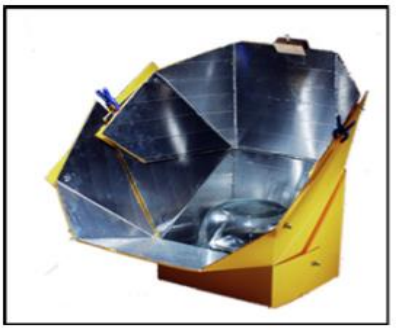

Fig. 5. Jim's All Season Solar Cooker (La Joie, 1

Fig. 6. Jose sol cooker (Ashok, 2018).

They also provided an electric coil as a second booster for the stove's heat producing system which is activation on the days when the sky is overcast. But larger solar ovens, such as the Villager Cf using propane gas burners as the back up on cloudy conditions. Most box cookers in the market are a bit on the higher side in terms of cost which makes many innovators have proposed basic modifications to make them from them using cardboard boxes, one of the them being a Pizza box. One such simple design, the Koyoto Solar Cooker or also known as Ashok [13] received a prize because its creation was universally obvious and profound (Fig. 4). Such simple cookers would work better if two boxes, namely, the input box and the output box, were developed one is large and another is small and the intervening space is coated even with hay or other such locally available insulating material as such an insulation would not serve much purpose. However, the reflectors should be taller, bigger than the cover As big as the flaps and are as big as the size of the box, in order to enhance the performance of the design being utilized on the unit.

(a) Sun Cook two mirror

(b) Rohatgi three mirror

(c) Heaven's Flame four mirror

(d) Sharma's five mirror

(e) Telkes's four+four mirror

(f) Villager model

Fig. 4. Number of reflectors added to box cooker over the years (Ashok, 2018).

4. TESTING OF SOLAR COOKER

The majority of scientists have not yet adhered to the standards established by BIS-based recommendations or those proposed by various other organisations regarding the testing and assessment of efficiency [27][29]. reference the efficiency using the 'Figure of Merit' F1, estimated in 2017, and F2. New testing methodologies, the creation of which has been advocated by many, include the following. Nevertheless, as the solar cookers are used by individuals without technological expertise, the duty of focusing is performed manually, resulting in the observation of the following advantages during operation. As early as 1979, Bowman highlighted that several populations have proposed integrating many fundamental factors to provide test results in a manner comprehensible to users with a basic grasp of operating systems. Consequently, advocating for a new suggestion regarding global standards for operating such cookers [30]. Nevertheless, a definitive worldwide standard for this domain has yet to be established. Meanwhile, SCI scientists have constructed an instrument bundle including many very sensitive sensors capable of simultaneously requesting data from two solar cookers for comparative analysis. However, it is a protracted endeavor to implement this inclusion along with the majority of the other suggestions presented in this article and by several others.

5. CONCLUSIONS

This study aims to assemble and provide a substantial collection of low-cost solar cookers, namely panel and funnel varieties. These designs are cost-effective, simple to produce, and fulfil their roles and jobs well. The efficiency of the Panel cooker is said to be between 60–70% of the fuel's calorific value, as stated by the manufacturer, who claims it achieves 70-75% of the efficiency of a Box Cooker, but at a far lower cost. Funnel cookers, which are similarly inexpensive, would likely exhibit the same characteristics. Nevertheless, many of the low-cost solar cookers have been addressed in prior studies. The document seeks to engage solar scientists and inventors in the development of a simple and efficient solar cooker capable of preparing any meal, including supper. Nonetheless, as previously said, there is an urgent need to improve the designs and materials used in these low-cost solar cookers, which will be addressed in this study.

This implies that research should focus on improving the efficacy of low-cost solar cookers. Part types encompass various materials utilised in the construction of solar cookers, such as reflector films, insulation, and greenhouse covers, which necessitate focused attention and further research, particularly concerning their efficiency and durability in outdoor conditions over extended periods. Such data would be critically important to millions of users and might significantly aid in preventing millions of tonnes of emissions resulting from this essential human activity. This endeavour will also bolster the trust of NGOs and align all entities that assist adoption, including government funding organisations, towards these sorts of cookers. Increased effort is required to build an efficient but cost-effective indoor cooking system that can be used by personnel working around the clock to prepare various types of meals. The use of photovoltaic technology to harness solar energy via power panels for battery storage is anticipated to be a forthcoming trend. Nevertheless, the price of around INR 18,000 (USD 240) for such a stove remains unattainable for most middle-class homes. The creation of cost-effective photovoltaic cells seems to have found a solution for continued progress in this area.

Conflicts Of Interest

The author's paper explicitly states that there are no conflicts of interest to be disclosed.

Funding

The author's paper clearly indicates that the research was conducted without any funding from external sources.

Acknowledgment

The author acknowledges the institution for their commitment to fostering a research-oriented culture and providing a platform for knowledge dissemination.

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