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Thermal Performance Evaluation of Trapezium Solar Cooker with Hexagonal Solar Cooker

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Abstract: ***Energy has become the utmost necessity of our life. It is required from dawn to dusk to fuel the world. Energy is scattered everywhere around the Earth. Energy has always been an inextricable part of human life. The existence of living organisms on the earth is possible due to the solar radiations reaching the earth and the ozone layer that makes the most favorable temperature required for the functioning of enzymes and led to the existence of life and other sources required for supporting the survival of life. The present work aim on fabrication of trapezium and hexagonal cooker and their thermal performance comparison to evaluate based on their temperature values using K type thermocouples.***
Keywords*: Trapezium Solar Cooker, Hexagonal Solar Cooker, K-type thermocouples. Solar Energy, Temperature, Renewable Energy.***

I. INTRODUCTION

Solar energy, whether directly or indirectly, represents the primary source of renewable energy available to humanity. In the field of solar engineering for thermal processes, a variety of methods are widely employed to enhance the performance of heat exchangers. However, in most cases, commercially available methods for improvement are currently inadequate. Furthermore, an effective energy management program must incorporate energy storage to accommodate shifting demands and achieve optimal performance from the primary power source. Solar-resistant water heaters are promising candidates for improving heat transfer. Recent studies have focused on the development of solar water heaters. Solar energy is derived from the sun, which generates energy through a process known as nuclear fusion. During this process, four hydrogen nuclei combine to form a helium nucleus, releasing energy in the process. This energy is emitted into space as solar radiation, with a small fraction reaching the Earth. Solar energy is utilized in various applications, including solar heating, distillation, drying, and cooking. The use of solar energy for cooking presents a viable alternative to traditional energy sources such as wood, kerosene, and other fuels commonly used in developing countries for food preparation.

The Parabolic square dish cooker has been introduced by M.M. El-Kassaby in 1991 [1]. H. Nemati et al optimized the dimension of parabolic solar cooker using 400 different materials [2]. Temperature profiling of parabolic concentrator on different climatic conditions is graphically explained by A. Claude et al [3]. Two parabolic reflectors were used in the solar cooker designed by Yogesh R Suple et al [4]. An asymmetrical compound parabolic concentrator is used in the proposed cooker as booster reflector [5]. The overall heat loss factor (FUL) of a paraboloidal solar cooker is discussed by S.R. Kalbande et al [6]. The low cost parabolic type solar cooker has been designed by Hasan Huseyin Ozturk [7]. The performance of a paraboloidal solar cooker under no load, water heating and rice cooing is discussed by S.R. Kalbande et al [8]. Shukla A [9] has been studied that the importance of energy in economic development is very critical as there is a strong relationship between energy and economic activity. Mondal [10] has been studied and investigated the advantage of latent heat that can be stored or released from a material over a narrow temperature range. Lahkar et al.[11] proposed a universal parameter for evaluating the optical and thermal performance of different cooker types called the opto-thermal ratio. Mussard et al. [12] compared a direct and an indirect concentrating solar cooker with similar characteristics, including a sun tracker system. Ammer [13] carried out research on the title, theoretical and experimental evaluation of double publicity photo voltaic cooker, respectively. D.Y Dasin [14] carried out an overall performance contrast of parabolic concentrator photo voltaic electricity cooker in tropical surroundings in Abubakar Tafawa et al [15] carried out water pasteurization using a solar box cooker. V.P. Sethi et.al [16] focused on optimally inclined box type solar cooker with parallelepiped cooking vessel design S.B. Joshi et.al [17] studied on hybrid solar cooker. H. Zamani et.al [18] fabricated of parabolic solar cooker with three adjustable mirrors, which can be placed on the parabolic path according to the sun's position. S. Mahanvar et.al [19] developed box solar cooker with electric power back up. Yunsheng Zhao et.al [20] concentrated on novel portable solar cooker using a curved fresnel loss concentrator.

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A. Saxena et.al [21] studied hybrid solar cooker with air duct. John J. TODD et al [22] fabricated solar cooker from cardboard and evaluated its testing and performance. Muluken Biadgelegn Wollele [23] designed and fabricated solar cooker and studied the effect of thermal storage system. Schwarzer K, et al. [24] conducted a performance analysis of flat plate type solar cooker with vegetable oil as the TES material. Mussard M. [25] carried out a low cost small-scale solar concentric collector coupled with a thermal energy storage unit for higher temperature cooking. Senthil R. et al. [26] proposed that the sensible heat transfer materials were found effective in the storage of heat as well as aiding conduction heat transfer during the cooking process. Sharma SD. et al. [27] had investigated a solar cooker based on an evacuated tube solar collector coupled with phase change material (PCM) commercial grade erythritol. Saxena A. et al. [28] studied several types of PCMs to check their suitability as heat storage for cooking purposes using a box type solar cooker. Rajendra C. Patil et al [29] reviewed different types of solar cooker on the basis of their thermal performance. A theoretical investigation on the performance of PCMs has also been conducted by Chen et al. [30]. The studies from [31] [32] Anand Patel et al. for solar cooker; [33-45] Patel Anand et al. Solar air & water heater, hybrid combination such as solar heater & heat exchanger, hybrid car with solar/renewable systems; [46, 47, 48, 49] Anand Patel et al. [50] Thakre, Shekhar et al for heat exchanger includes thermal performance enhancement studies by varying the design of solar absorber plate, material, integration review in an hybrid system which will help to performance comparative analysis between trapezium and hexagonal solar cooker.

II. EXPERIMENTAL SETUP

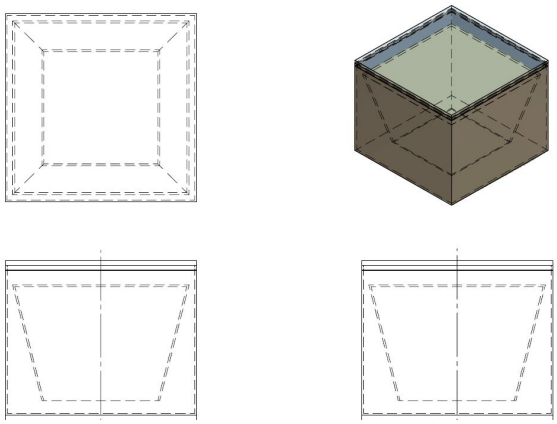


Fig. 1: CAD Model of Trapezium Solar Cooker

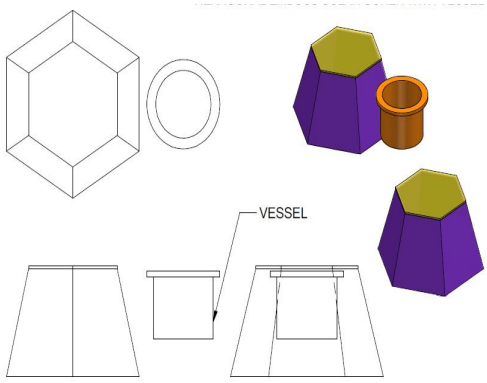


Fig. 2: CAD Model of Hexagonal Solar Cooker



Fig. 3: Trapezium Solar Cooker



Fig, 4: Hexagonal Solar Cooker



Fig. 5: Aluminium Vessels

In this work totally two experimental set up are fabricated one of trapezium solar cooker and other one is of hexagonal solar cooker; and for this work 12 mm sheet wooden is used and the box of size 1'X 1' X 1' is fabricated and inside two boxes using mirror of 2 mm thick is stick with silicon glue inside the two solar cooker of trapezium and hexagonal shapes are fabricated. The top of the both boxes are covered with 2 mm transparent glass sheet is hinged in wooden frame of 1'X 1'. With similar box dimensions the mirrors of 2 mm thick and six numbers in pieces are placed so that the top portion makes 12" diameter and at bottom of box 4"; Similarly in case of trapezium solar cooker using four tapper mirror of 1" height with top and bottom dimensions are such so after fabricating solar cooker at bottom 4" and 12" space is available at top. The base circle will formed on size of aluminium vessel. Aluminium vessel is painted with black colour which is placed inside the cooker and K type thermocouple is placed in both set up two measure temperature inside the vessel.

III.RESULT AND DISCUSSION

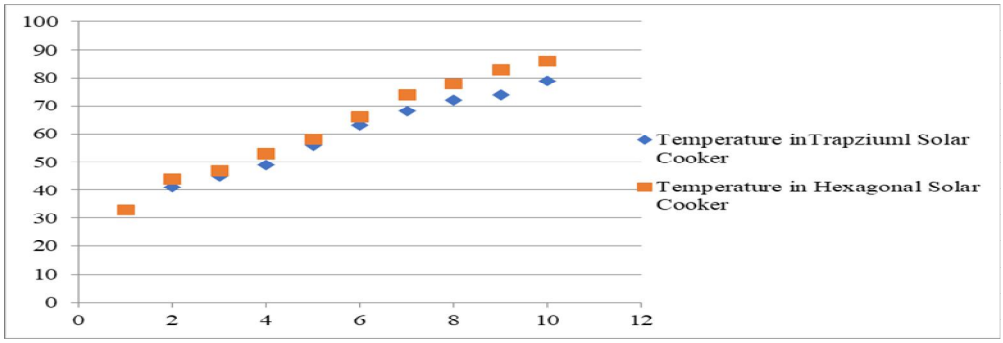


Fig. 6: Temperature Variation without Vessel

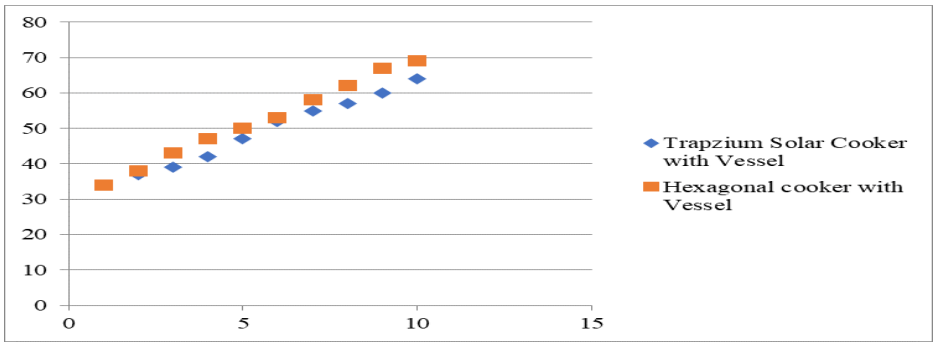


Fig. 7: Temperature Variation with Vessel

Fig. 6 and Fig. 7 show temperature variation in case of hexagonal and trapezium solar cooker without and with vessel respectively. From both figures it is obvious that compare to trapezium solar cooker in case of hexagonal the temperature values are higher as compared to trapezium solar cooker may be because of in case hexagonal solar cooker due to its shape better black body effect can be obtained and due to shape from all directions solar radiation can be penetrated inside the solar cooker.

IV. CONCLUSIONS

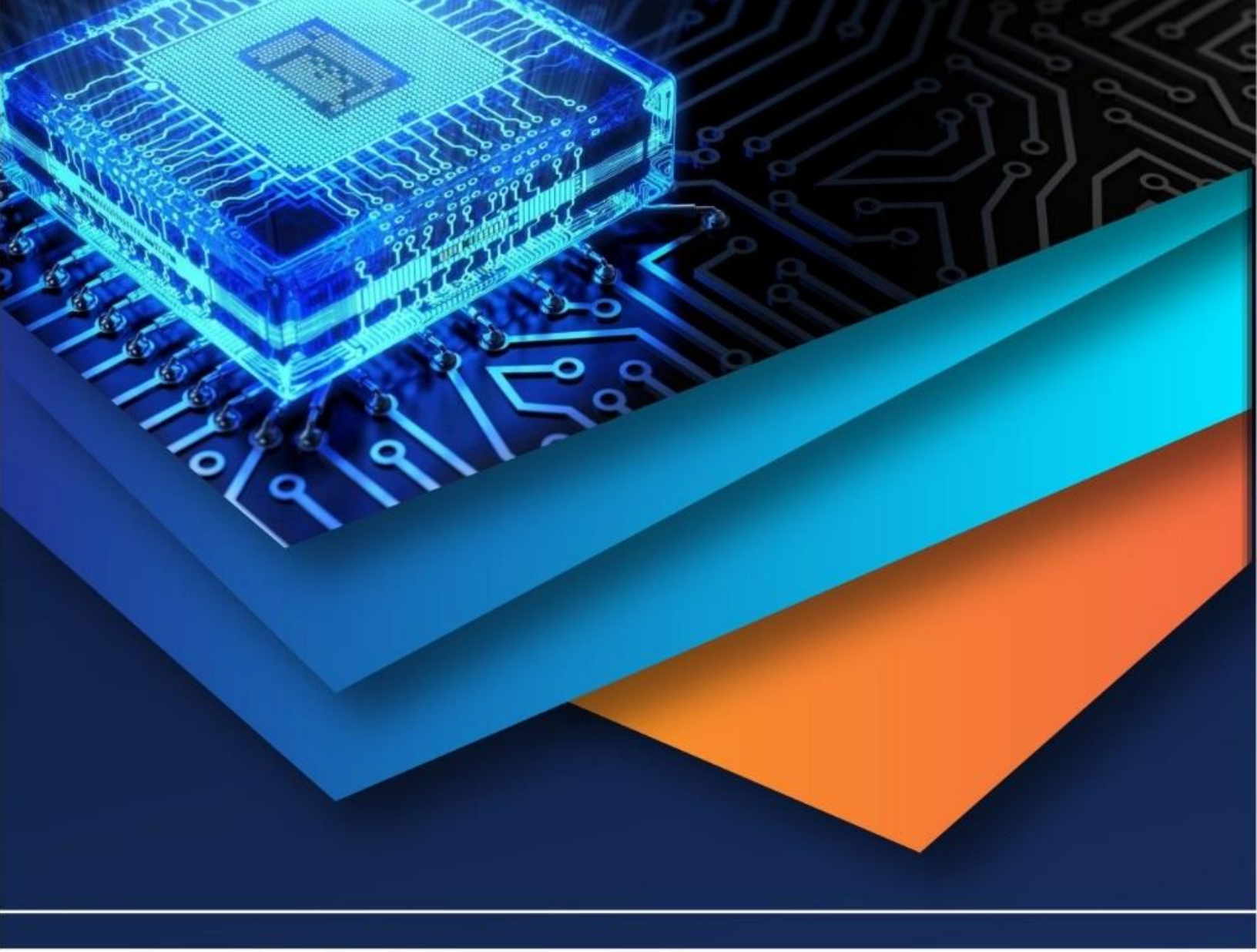
The major outcome of this work is that shape and orientation of solar cooker play an important role in performance of solar cooker.

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