Journal Homepage: www.ijrpr.com e-ISSN: 3049-0103

International Journal of Advance Research Publication and Reviews

Vol 1, Issue 1, pp 57-61, September,2024

A Review of Solar cooker with Heat Storage System

Dr. Ashish Agarwal

Independent Researcher, Bhopal, MP, India
Email:er_ashishagarwal@yahoo.com

ABSTRACT

Both urban and rural communities in many developing nations rely on non-commercial fuels to meet their energy needs for cooking. One of the possible substitutes for cooking is solar energy, however its dependability is still somewhat hampered by the sun's glaring erratic behaviour. Over the course of a day and a month, the amount of solar energy changes. By including a heat storage mechanism in a solar cooking arrangement, solar energy reliability can be somewhat boosted. The purpose of this study is to provide an overview of the research investigations that have been conducted on heat storage methods used in solar cooking systems.

KEYWORDS : Phase change materials (PCMs), solar cooking, heat storage, Heat transfer Section heading

1. INTRODUCTION

India has a huge potential for gathering solar energy.The typical average radiation from the sun is between 5 and 7 kWh/m², and most parts of the country have about 275 bright days year [1]. In India, the two most prevalent kinds of solar cookers are the box-type and parabolic models. Cooking with solar energy is a very appealing solution for homes because it is more cost-effective and environmentally beneficial. However, there are still a number of disadvantages to sun cooking, namely its dependence on the availability and intensity of solar light. By adding heat storage devices to the cookers, some of these limitations can be eliminated and solar-powered cooking becomes a more enticing method. Numerous solar cooker concepts have been proposed by researchers in the literature. An overview of studies on solar-powered cooking systems that employ heat storage materials is what this paper aims to deliver. 2. Heat storage material classification

2. CLASSIFICATION OF HEAT STORAGE MATERIALS

Sensible heat storage substances and latent heat storage materials are the two main categories of thermal energy storage materials. Liquid and solid heat storage are two further divisions of sensible heat storage. The classifications of different energy storage materials are explained in Figure 1.

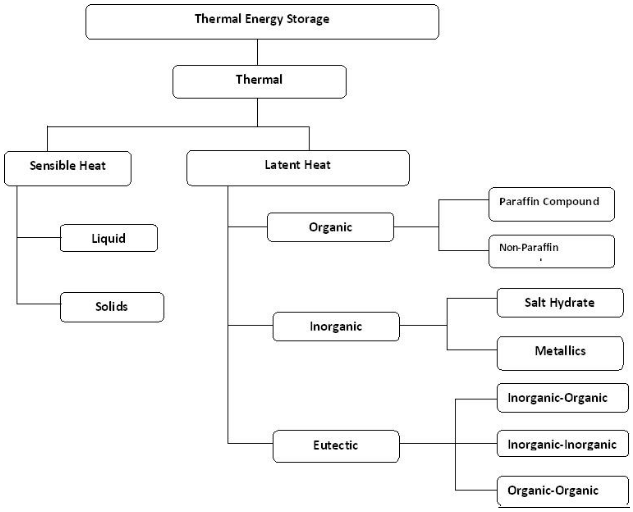

Fig 1 Classifications of Thermal Storage Material

Water is the most affordable heat storage material in the mid-temperature range due to its high specific heat capacity. Liquid metallic substances, oily substances, and molten salts are the main sources of thermal energy storage at temperatures higher than 100°C. Air heating is one use for rock bed storage materials. Latent heat storage, or LHS, is the energy storage system's ability to store energy by absorbing or releasing latent heat at steady temperatures when a material goes through a phase transition, such as changing from a solid state to a liquid or vice versa, or from a liquid to a gas or vice versa. The materials used in storage for latent heat are known as phase change materials.

3. SOLAR COOKER WITH HEAT STORAGE SYSTEM

Figure 2: An overview of a box-style cooker created by Nahar [3] that uses hot oil as a thermal storage medium

Figure 2 illustrates the design of a hot box cooker utilizing used engine oil as a thermal storage medium, as developed by Nahar [3]. The area between the plates contains 5.0 kg of completely sealed used engine oil. The space that separates the outer plate and the glass wool-insulated outer box is also divided by a wood frame. The maximum stagnation temperatures that may be reached within cooking chambers of the store material in a hot box sun cooker is 23.8°C greater for the storage solar cooker that operates between 17:00 and 24:00 than it is for a non-storage kind of hot box solar cooker during the day.

Figure 3: The flat-plate solar cooker by Schwarzer and Silva [4], which stores food in vegetable oil.Five kilogrammes of fully sealed old engine oil are located in the space between the trays. Additionally, a wood frame separates the area that lies between the outside tray and the glass-wool-insulated outer box. Between 17:00 and 24:00, the storage solar cooker's maximum stagnation temperature inside the cooking chambers of the stored material is 23.8°C greater than that of a non-storage kind of hot box solar cooker throughout the day. Figure 3: Schwarzer and Silva's [4] flat-plate solar oven, which uses vegetable oil to preserve food.

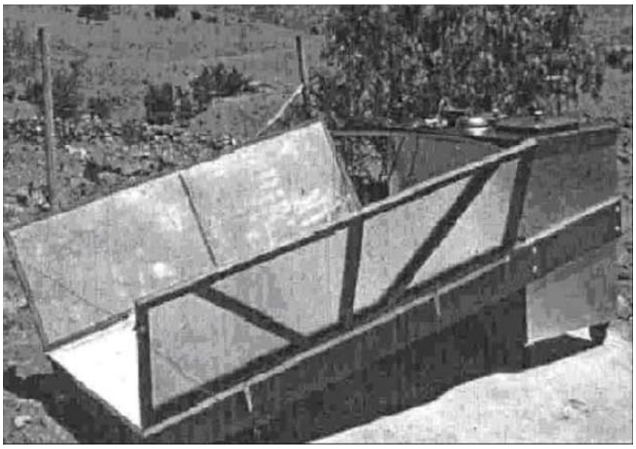

Fig 3.flat-plate solar cooker designed by Schwarzer and Silva [4]

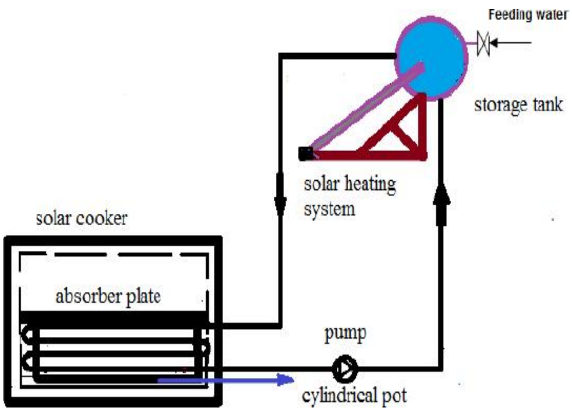

Fig 4. Schematic diagram of solar cooker designed by Kassem [5]

Kassem [5] designed, developed, and tested a paraffin-wax-based box-type solar cooker. Utilising a solar collector made of evacuated tubes and a heated water storage tank, the combined unit is a relatively simple solar water heater. The bottom of the cooker container, which acts as the absorber plate, has a cylinder pot filled with paraffin and a heat exchanger with spiral tubes of copper attached. The structure of this storage technique will provide sufficient cooking conditions such that cooking can begin at 12:00 PM. The interior temperature reduction of the cooker is concurrently counteracted by the heat sources generated by the solar heating system.

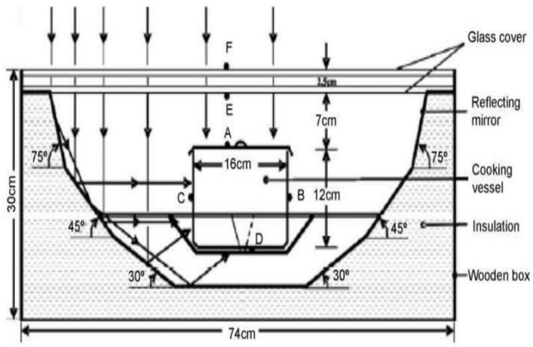

Fig. 5 Box type solar cooker developed by Domanski et al. [6]

Domanski et al. [6] also built the alternate container form of solar cooker, as shown in Fig. 5. In this study, the feasibility of cooking with no direct sunlight was examined using PCMs that are as a means of thermal energy storage. This is accomplished using two cylindrical containers made of aluminium that are concentric and 0.0015 m thick. Each vessel's top is fastened into a double-walled vessel with a space across the outer and inner walls using four screws. This interstitial gap is filled either with 1.1 kg of stearic acid (which melts at 69.8°C) or 2 kg of magnesium nitrate hexahydrate (which melts at 89.8°C), giving the PCMs enough room to expand when they melt. The performance of the cooker was assessed using the PCMs' charging and discharge times in various scenarios. The overall discharging phase efficiency of the PCM was found to be three to four times higher compared to that of a steam and heat-pipe solar cooker. for indoor applications.

Sharma et al. [7] designed a cylinder-shaped PCM storage unit, as shown in Fig. 6, to be used in a box-style solar-powered cooker for late-night cooking. This cup speeds up cooking by enclosing the cooking pot, which accelerates the rate at which heat is delivered to food through the PCM. The authors admitted that a latent heat storage material, such Acetamide, which melts at 82°C and weights 2 kg, can help with some cooking to prepare the next batch of food if charged before 3:30 PM during winter time cycles.

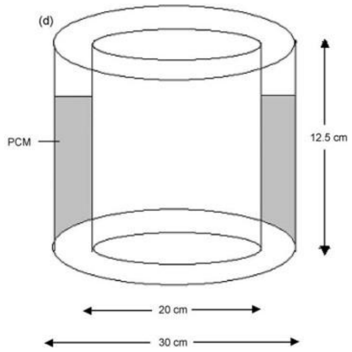

Fig. 6: box-style solar cooker's tubular PCM storage compartment designed by Buddhi and Sharma [7]

Ramadan et al. developed a simple flat-plate solar cooker with focal plane mirrors and energy storage [8]. All of the stuff used at Tanta University are easily accessible locally. Temperature variations in the absorbent plate, glass coverings, cooking pot, cooking fluid, storing medium, and ambient air were measured during the entire testing procedure. We measured the daily variations in incident global solar insolation. A lot of research has been done on sensible heat storage materials like sand. The addition of a half-centimeter thick sand coat around the cooking pot greatly improved the cooker's performance. The temperature differences among the source of heat and sink throughout testing were analysed and discussed. A fresh record of 6 hours of cooking time per day was set, with as many as three hours of indoor direct sun cooking achieved. It achieved an overall conversion rate for energy of up to 28.4%, making it one of the most efficient solar cookers reported in the literature. The possibility of employing a phase change material as a storage medium to prolong the cooking time has also been explored, as has the suggestion of a thin jacket made of the salt hydrate $Ba(OH)_2 \cdot 8H_2O$ around the cooking pot.

4. CONCLUSION

Several solar cooking system concepts that make use of heat storage techniques are covered in this study. Both box-type and flat plate collector solar cookers have been considered in the inquiry. The invention of the heat storage system has increased the efficiency of solar cookers and prolonged their running time, enabling late-night cooking. The well-liked box-type solar cooker in India requires more research, with a focus on improving heat transfer efficiency and simplifying the designs of heat storage systems.

I. REFERENCE

[1] Arjunan, T. V., H. S. Aybar, and N. Nedunchezhian. 2009. "Status of Solar Desalination in India." Renewable and Sustainable Energy Reviews 13 (9): 2408–2418.

[2] Agrawal, A., Sarviya, R. M. 2016. A review of research and development work on solar dryers with heat storage. International Journal of Sustainable Energy, 35(6), 583-605.

[3] Nahar NM. Performance and testing of a hot box storage solar cooker. Energy Conversion and Management 2003;44:1323–31.

[4] Schwartzer K, Silva MEV. Solar cooking system with or without heat storage for families and institutions. Solar Energy 2003;75:35–41.

[5] Talal K. Kassem, Investigation Of Solar Cooker With Pcm Heat Storage For High Altitude places (Taif City), International Journal of Mechanical Engineering and Technology ,2012;3(3):555-564.

[6] Domanski R, El-Sebaii AA, Jaworski M. Cooking during off-sunshine hours using PCMs as storage media. Energy 1995;20(7):607–16.

[7] Sharma SD, Buddhi D, Sawhney RL, Sharma A. Design, development and performance evaluation of a latent heat storage unit for evening cooking in a solar cooker. Energy Conversion and Management 2000;41:1497–508.

[8] Ramadan MRI, Aboul-Enein S, El-Sebaii AA. A model of an improved low cost indoor solar cooker in Tanta. Solar and Wind Technology 1998;5:387–93.