

# SOLAR COOKER WITH HEAT STORAGE SYSTEM: A REVIEW

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## ABSTRACT:

In most of the developing countries, the urban and rural population depends on non-commercial fuels to meet the energy demand for cooking. The utilization of solar energy is one of the possible solutions for the cooking the food, but its reliability is less due to intermittent nature of solar energy. The intensity of solar energy varies throughout the day and also varies with the months. The reliability of solar energy may be improved to some limit by designing the heat storage system for solar based cooking system. Therefore, in this paper, an effort has been taken to outline the investigation on solar cooker with heat storage system.

**KEYWORDS:** Phase change materials (PCMs), solar cooking, heat storage, Heat transfer.

## 1. INTRODUCTION

India has good potential of solar energy. The solar radiation intensity in the major region of India is available in the range of 5–7 kWh/m<sup>2</sup> [1]. There are two main type of solar cooker used in the country: Box type solar cooker, parabolic type solar cooker. The cooking through solar energy is one of the cost effective solution for cooking of food as well as it also protect the environment. Therefore, solar cooking could be best alternative for conventional cooking in domestic. There is some shortcoming associated with solar cooking first it depends on intensity and availability of solar energy. These shortcomings can be overcome to some extent by integrating heat storage system with solar cookers. Different types of solar cooker have been proposed by different researchers in the literature. In this review article, we try to summarize the research work on solar cooker with heat storage system.

## 2. CLASSIFICATION OF HEAT STORAGE MATERIALS

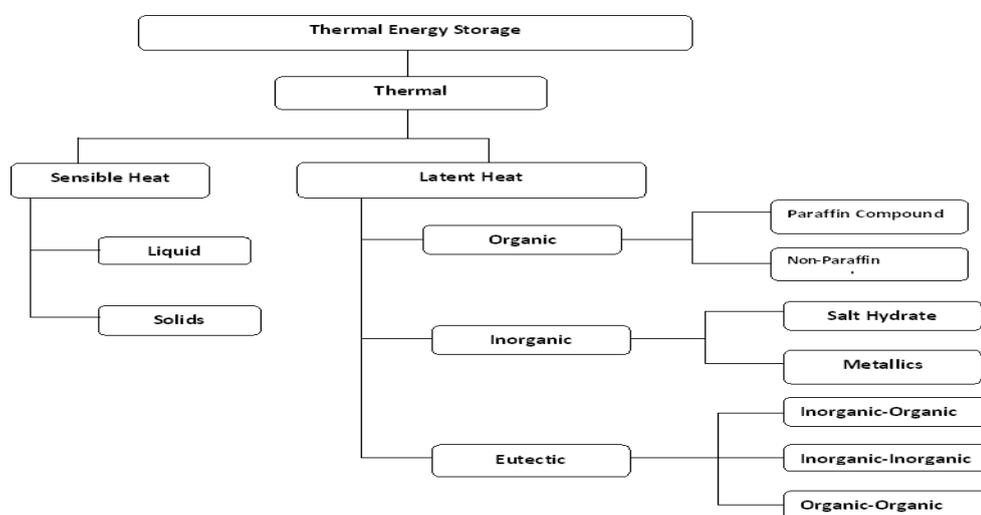


Fig 1. Classifications of Energy storage materials

Thermal energy storage materials can be classified as sensible and latent heat storage materials. Sensible heat storage further classified as liquid and solid sensible material. Classification of energy storage materials is shown in Fig 1.

Concrete, rock, water and engine oil are the example of sensible heat storage materials which commonly used in the literature [2]. Due to its high specific heat, water appears to be the most promising sensible heat storage material and it also inexpensive for mid temperature range. However molten salts, liquid metals and oils are used for storage of thermal energy above 100°C. Rock bed type storage materials are used for air heating application [2]. In latent heat storage (LHS) the heat is absorbed or released at constant temperature, in the form of latent heat when the material changes its phase from solid to liquid or liquid to gas or vice versa. Materials used in latent heat storage are the phase change materials (PCMs).

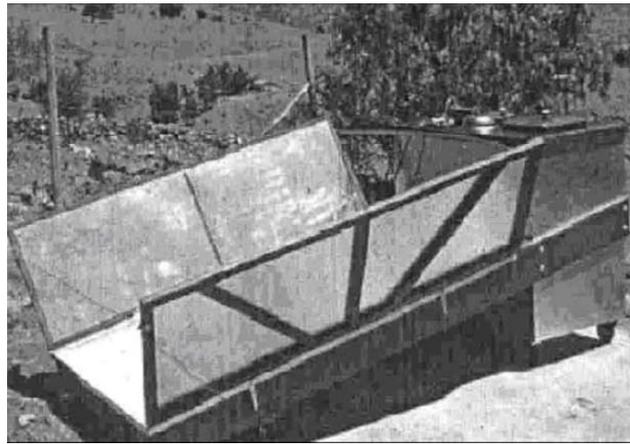
### 3. SOLAR COOKER WITH HEAT STORAGE SYSTEM



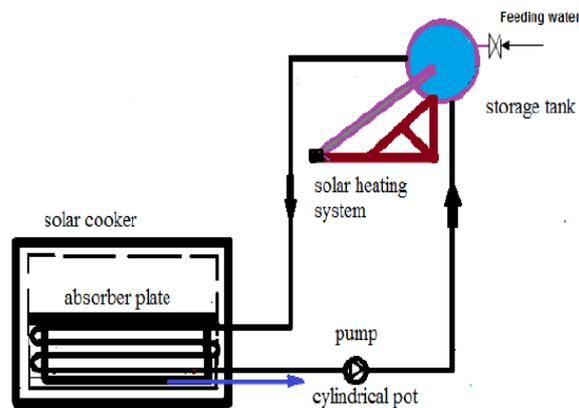
**Fig 2.** Box type solar cooker with engine oil as heat storage material [3]

Fig. 2 shows the diagram of a hot box solar cooker designed by Nahar [3]. The engine oil was used as a storage material and filled in the space between the inner trays. The glass wool was used as a insulation material and filled in the gap between the outer tray and outer box, which is separated by wooden frame. There is no change in the maximum stagnation temperature achieved inside the cooking chambers with the use of storage material but it is 23.8°C more in the storage solar cooker from 5 pm to 12 pm.

Schwarzer and Silva [4] design and developed the flat-plate solar cooker with vegetable oil as heat storage material (Fig 3). The system consists of coated absorber plate, flat plate collector, cooking pots, double glazed covering and a storage material for storing the thermal energy. The oil in the collectors is heated up by absorbing the energy and it is moved to cooking unit by natural flow due to density difference. In the cooking pot, part of the sensible energy of the vegetable oil is transferred to cooking pots. Due to heat storage the food remain warm for longer period of time and cooking is possible during nighttime.

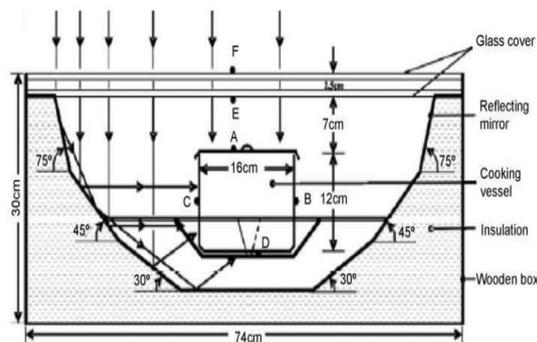


**Fig 3.** Solar cooker with flat-plate collector [4]



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

Kassem [5] designed and developed the solar cooker with paraffin as heat storage medium. The solar cooker is connected with solar water heating system which consists of evacuated tubes and a storage tank of hot water. Spiral copper tubes heat exchanger is welded at the base of the absorber plate to receive the direct heat energy during day time and the cylindrical pot inside it filled with paraffin as a PCM. The heat storage accelerates the cooking process.

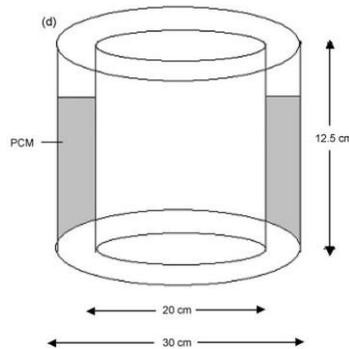


**Fig 5.** Schematic diagram of box type solar cooker [6]

Domanski et al. [6] designed and developed the box type solar cooker (Fig. 5). The solar cooker consists of double-walled cylindrical vessels. The gap between the outer and inner wall is filled with heat storage materials (stearic acid and magnesium nitrate hexahydrate). The performance of the solar cooker is measured in terms of time required for charging and discharging. During discharging mode, the total

efficiency of the solar cooker was found to be 3 to 4 times higher than that for heat-pipe and steam cookers.

A box type solar cooker (Fig. 6) with cylindrical PCM storage unit has been designed and developed by Sharma et al. [7] to cook the food in the late evening. The Acetamide having melting temperature of 82°C was used as heat storage material. It was reported that due to heat storage, a second batch of food could be cooked if it was loaded before 3:30PM.



**Fig. 6** Cylindrical PCM storage unit for a box type solar cooker [7].

Ramadan et al. [8] designed and construct the solar cooker with heat storage capabilities. The sand was used as a heat storage material. The major components of solar cooker were flat absorbing plate, the cooking vessels, the glass covers and the storage medium. A layer of sand (1/2 cm thick) in the form of jacket is form around the cooking pot to store and transfer the heat to cooking pot during non-sunshine hours. Due to heat storage the indoor cooking of approximately 3 h/day was achieved. The maximum overall efficiency reported was 28.4%.

#### 4. CONCLUSION

Different designs of solar cooking system with heat storage system have been discussed in this paper. Box type solar cooker with flat plate collector has been discussed in this paper. The integration of heat storage system, improved the effectiveness and working duration of solar cooker. The late evening cooking is possible with the integration of heat storage system. Box type solar cooker is commonly used in India, so more research is required to enhance the heat transfer in box type solar cooker with heat storage and to compact the design of heat storage system.

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