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A Survey: Experimental Investigation of Box-Type Solar Cooker with Latent Heat Energy Storage

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ABSTRACT

To use box type solar cooker during off-shine cooking .It can be used with Latent heat Energy storage media called phase change materials (PCMs). Which change their phases by observing energy and regaining its initial state by releasing energy. It can be performance as high thermal energy storage. The PCMs likes magnesium nitrate hexahydrate, stearic acid, acetamide, acetanilide and erythritol. Every kinds of PCM have different thermo-physical properties so selected according to application. PCMs are not good thermal conductor so various thermal performance enhancement techniques applied. Design and thermal performance analysis of box type solar cooker with LHES is present in current work.

Indexterms: Solar cooker, PCMs, Heat storage.

I. INTRODUCTION

A solar cooker is a device which uses the energy of direct sunlight to heat, cook or warm food. Utilization of solar energy for thermal applications, like cooking, heating and drying, is well recognized in tropical and semitropical regions. There are types of solar cooker likes Box type, Concentrator type and indirect type. These cookers are more popular due to their simplicity of handling and operation. If storage of solar energy can be provided in a solar cooker, then there is a possibility of cooking food during clouds or in the evening, and the storage will increase the utility and reliability of the solar cookers In this investigated are carried out to the solar energy is available at the day or sun shining only, so this study carried in box type solar cooker is using.

Phase change materials (PCMs) can be used to several different solar energy systems for the extended heat energy storage which is useful as the solar energy is intermittent in nature and is unavailable during the off shine period. Application of PCMs in solar energy systems allows the solar energy to be used at any time even in the absence of the natural solar radiation [1].

II. LITERATURE REVIEW

1. In paper [2] authors checked the possibility of off-shin cooking of solar cooker. The main problem in simple box type solar cooker is there is cooking is not possible during off shine. The possibility of cooking during off-sunshine hours using phase change materials (PCMs) as storage media has been investigated experimentally. Were design and evaluated a simple box type solar cooker with a box collector. They was used to PCMs is steric acid, hexahydrate for storage of energy. And this PCMs is melting temperature is 69.3°C. Here authors achieved the temperature between 78°C-84°C.
2. In this paper [3] authors designed and developed a cylindrical PCM storage unit for a box type solar cooker to cook the food in the late evening. They reported that by using 2.0 kg of acetamide (melting point 82°C) as latent heat storage material, the second batch of food can be cooked if it is loaded up to 15:30 h during the winter season. From the experimental results, it was found that the storage of solar energy did not affect the performance of the solar cooker for noon cooking, and they also recommended that for evening cooking, the melting temperature of a PCM should be between 105 and 110°C.
3. In paper [4] the authors were tested acetanilide as a PCM with a melting point of 118 °C for night cooking in a box type cooker with three reflectors. Acetanilide was filled in the cylindrical storage unit and it was reported that by using 4.0 kg of acetanilide.
4. The authors [5] conclude that during the charging process of PCM materials, the average heat transfer coefficient is very small at the start of melting process, which indicates that the heat is mainly transferred by conduction. The increased rate of heat transfer with time is due to the natural convection currents grow in the melted layer.
5. In paper [6] the authors were calculate numerical heat transfer of PCMs used in box type solar cooker with latent heat storage materials are used. Then melt fraction of the PCMs is very important of solar energy storing. Theoretical results it can be concluded that stearic acid and acetamide should be used as storage media in a box-type solar cooker to cook and/or to keep food warm in the late evening with different heat exchanger container materials. Here authors selected as PCMs are magnesium nitrate hexahydrate, stearic acid, acetamide, acetanilide and erythritol.
6. The authors [7] developed the indirect solar cooker with storage materials. It consists of three main components: an outdoor flat-plate solar collector, an indoor PCM cooking unit and a closed loop wickless heat pipes network.They used magnesium nitrate hexahydrate and this materials melting point is 89°C, and latent heat fusion 134°C.outdoor flat-plate solar collector, an indoor PCM cooking unit shown in figure:

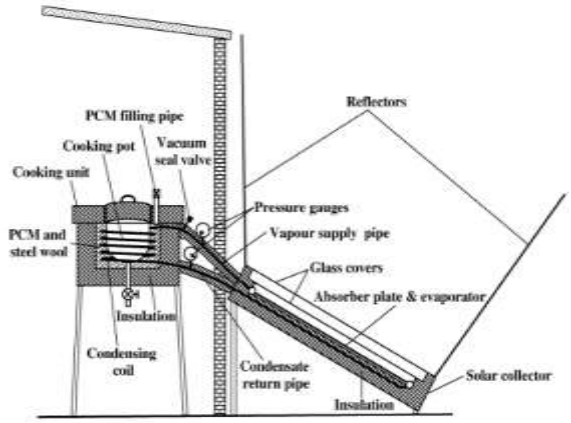

Fig. Cross sectional side view of the present solar cooker shows its main components.

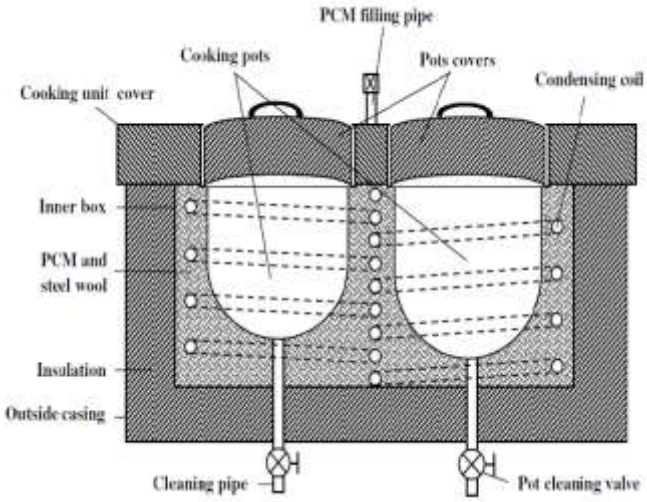

Fig. Cross sectional front view of the indoor PCM cooking unit shows its main components

7. In paper [8] the authors developed a solar cooker with PCM A-164 as energy storage and indoor cooking unit. In this setup a parabolic trough is used for concentrating solar energy. The heat transfer fluid to exchange the heat between the collector and the cooking unit. PCM A-164 filled in 1 m long, 22 mm diameter tubes will be made as a heat exchanger to store the energy during sunshine hours and to retrieve the energy during off-sunshine hours. In this system, finned flat plate was used for cooking which obtained temperature of 140-150°C.

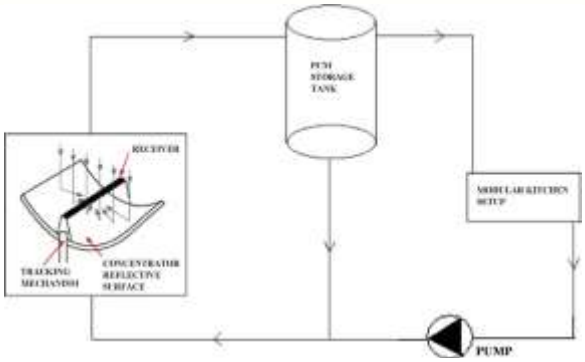

Fig. Latent heat storage type concentrating solar cooker using PCM A-164

8. The authors [9] worked on experimental investigation of portable parabolic type solar cooker. They was used PCMs materials is paraffin and erythritol. They design a solar energy storage unit consisting of two concentric cylinder having gap between this was filled with PCM. The heat storage by PCM was able to cook food at evening. The high melting point and thermal conductivity of erythritol and very efficient and fast indoor cooking.

   They was conclude it is possible to cook the three meals for a family using the utensil prototype here proposed during sunny days in summer as well as in winter. They was used PCMs materials is paraffin and erythritol. Which obtained temperature of 100-110°C.

9. The authors [10] conclude the experimentation of the solar box type cooker with finned cooking vessel showed consistent reduction in cooking time which is due to increase of the heat transfer surface area by fins attached to the external surface of the cooking vessel.

   Also the experimentation to increase the thermal energy storage capacity of the box type solar cooker using PCM (paraffin) as medium showed very beneficial for energy conservation. The food cooked in solar cooker can be kept hot for 3–4 h with the help of PCM medium. They was used PCMs materials is paraffin wax and obtained temperature of around 100°C.

10. The authors [11] studied different box type solar cooker with thermal energy storage materials use to the different cooker category. Cylindrical and rectangular containers are the most common shapes used in thermal energy storage units of the solar cookers. Oils and organic phase change materials are the most common classes of sensible heat and latent heat storage materials, respectively.
11. In this paper the authors [12] conclude the characterize the prototype completely and at high temperature, additional tests were carried out with peanut oil. These tests showed that the cooker can transfer heat to peanut oil with good efficiency: the prototype potentially requires around 41 min to take one vessel filled with 1 kg of peanut oil from 40 to 220°C, while it needs only 28 min to heat the same quantity subdivided into two vessels. Peanut oil tests also allowed to derive the prototype cooking power and thermal efficiency.

III CONCLUSION

StructureFrom this literature on solar cooking technique, it can be conclude that solar cooker are saving of fuels like wood, kerosene, and gases. Various studies were carried out and they used several technique and get experimental and numerical results of the Solar cooker to use them for cooking a food or warm in late evening. And enhancement of cooking time and achieve high temperature at noon. Using box type solar cooker with phase change material (PCMs) provides higher thermal energy storage media. The performance of the Solar cooker with phase change materials is heat storage media better than without of phase change materials ones in all weather conditions. Thermal energy storage is necessarily, needed to raise the utility and reliability of the Solar cooker. The study carried away on using PCMs for solar cooker is not yet comprehensive. It is observed that thermal conductivity of phase change materials and latent heat storage of materials may be promising option for solar energy storage. Thermo physical Properties can play massive role in Improve Solar cooker efficiency .i.e. melting point of PCM, Latent heat of fusion, Heat transfer coefficient of PCM.

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