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A Review Paper on Solar Energy Stored Cooker and its Use

Deepak Singh
SOEIT, Sanskriti University, Mathura, Uttar Pradesh, India
Email Id- laxmigoswami.ee@sanskriti.edu.in

Lakshmi Goswami
SOEIT, Sanskriti University, Mathura, Uttar Pradesh, India

ABSTRACT
Solar cooking is popular in India and many other developing nations where LPG, coal, and other fossil fuels are scarce. A solar cooking system with or without temporary heat storage has been designed and deployed in a number of nations across the globe. Cooking necessitates the use of thermal energy, which is presently supplied by liquefied petroleum gas, kerosene, and coal, all of which are costly fuels. As a source of heat, solar energy may also be utilized to prepare food. Solar energy is accessible nearly everywhere. To effectively prepare meals, a solar energy-stored cooker is utilized. The solar energy storage cooker is intended for both cooking and storing thermal energy. When heat energy is stored, the oven's efficiency and utility are improved when sunshine is not available. This kind of cooking oven is long-lasting, low-cost, and effective, making it suitable for every household. This article provides an in-depth examination of the solar energy storage cooker and how it may be used in today's society. Despite the fact that many studies in this area have been performed in the past, additional study in this field is urgently needed in the future.

Keywords
Energy, Heat Storage, Solar Cooker, Solar radiations, Sun.

1. INTRODUCTION
Man needs energy to do any action, even sleeping. Every day, the amount of energy used rises. The globe has seen significant industrial development and population expansion, resulting in increasing energy consumption. Energy has become very essential for economic growth and wealth creation. The world's primary energy need is met by the burning of fossil fuels, which pollutes the environment. Scientists have been driven to study and create new technologies to discover new energy solutions as a result of these issues, such as global warming and pollution. The use of energy by a country's population is used to determine its living standard. In the globe, energy is essential for every kind of action, such as [1]:

- Domestic activities
- Agricultural activities
- Lighting, water supply
- Industries etc.

In every culture throughout the globe, cooking is one of the most essential and required home tasks. The majority of rural regions in nations like India and other developing countries rely on costly and polluting wood, charcoal, and other fossil fuels as a source of energy. Market occurrences are transformed into usable types of energy through renewable energy technology. As a result, the sun is one of the free renewable energy sources that may be utilized to power any device. Solar energy, which is the heat and light emitted by the sun, is the most common kind of renewable energy. Which may be tapped into via a variety of methods.

Solar energy is one of the most effective ways to decrease nonrenewable energy use. Solar thermal energy is a kind of solar energy that is widely utilized throughout the globe. Cooking operations may also benefit from solar thermal energy. Many nations have designed and deployed solar cooking systems [2]. A solar cooker is a gadget that heats and cooks using direct sun rays (heat from the sun). Solar cooking is the easiest, safest, cleanest, most environmentally friendly, and most convenient method to prepare meals without using fuels or heating up the kitchen. However, without the ability to store heat, they can only be used during the day and when the sky is clear. As a result, we are cooking with solar energy by utilizing a solar storage cooker, which utilizes solar energy to produce heat that is then utilized to cook meals. Even in the evening, heat energy storage offers continuous heat [3].

Solar cooking devices come in a variety of shapes and sizes. One of them is box oven systems, which have gained widespread acceptance in India and other nations where LPG (Liquified Petroleum Gas), coal, natural gas, and biomass resources are in limited supply [4]. Solar cookers with the cooking pot at the focal point of a focusing mirror have not been extensively adopted since they require regular concentrator adjustments based on the sun's location. Box ovens and concentrated solar cookers are both inexpensive and effective, but they can only be used during the day and under clear skies, and they need the chef to work outside [5]. To date, several basic kinds of solar cookers have been created. The three main types of solar cookers are.

1.1. Direct or Focusing Type
In these types of solar cooker, some kind of concentrator is used which when placed towards the sun, concentrates the solar radiation on a point or area where the frying pan or cooking pot is kept. These cookers utilize direct solar radiation therefore adjustment of concentrator towards the sun is required frequently and the amount of heat loss from cooking vessel is large[6]. And it is difficult to capture sun rays as the direction of the keeps on changing[2].

1.2. Indirect or Box Type
This type of cookers uses an insulated box painted black from inside. To boost the solar radiation, panel sheet reflectors are used. Here not so frequent adjustment is required towards the sun as it was required for direct or focused type. This is a slow cooker and many dishes cannot be prepared in it[7][8].

2. LITERATURE REVIEW
Michael et al. discussed the advanced version of the box-type solar cooker. The box-type solar cooker with a fixed cooking vessel in contact with the absorber plate. Due to this, there is good thermal conductivity and easier access to the cooking vessels, and less frequent maintenance. This type of cooker can achieve moderate temperature and takes time in cooking food.

The main drawback of this type of cooker is that it takes more time in cooking and it can only be used outside as it requires direct sun rays and no storage of energy option is available [9]. Pankaj et al. discussed the panel solar cooker which is quite similar in construction to a box-type solar cooker. A reflective panel is used for collecting the sunlight and reflect it directly to the cooking vessel. This type of cooker is cheaper in cost and simple in construction. The main drawback of this type of cooker is that it achieves low temperature and takes time in cooking food and can be used only in outward areas where it is possible to get direct sunlight and require frequent adjustment according to the sun.

S.M. Masum Ahmed et al. discussed the parabolic solar cooker which concentrates the solar radiations. A smooth, shiny, smart (Sun tracking, temperature sensing) reflector is used. This type of solar cooker doesn't require frequent adjustment but it can be used only in outward areas where it is possible to get direct sunlight. Sharma SD. Et al. had investigated a solar cooker based on an evacuated tube solar collector coupled with phase change material (PCM) commercial-grade erythritol. [10].

3. DISCUSSION

In this section, the discussion is mainly on the type of solar cooker present in the market and being used worldwide. The types of solar cookers:

- Box-type solar cookers.
- Reflector type solar cooker

3.1. Box Cookers

This is the most commonly used low-cost type solar cooker for personal/domestic use. This is the first technology invented in the field of solar cookers. The first box-type solar cooker was invented by a French swiss naturalist named Horace de Saussure in 1967. Fig. 1. Shows the scientific diagram of box type along with labeling of the component. These Box cookers are simple in construction and are made up of cheaper material. This type of cooker has a transparent glass or plastic top. The outer portion of the box is made up of wood and the inner portion of the box is made up of insulating material. All side of the box is insulated except the double-glazed window side. Black painted vessels or black painted cooking pots are placed inside the box. Sunlight falls on the reflective surface and bounces towards the cooking vessel and dark bottom which is in contact with the vessel. Solar Box Cooker cooks at moderate temperature and like other solar cookers, it needs direct sunshine to operate. It takes 1.5 to 2 hours to cook rice, vegetables. It has a temperature range of up to 150° C. However, it has a low temperature and cannot store the heat for later use.

3.2. Reflector Type Solar Cooker

These types of cookers consist of a reflector that reflects/concentrates the sunlight directly to the cooking vessel. This type of cooker is not very desirable as it provides limited cooking. Teo types of cooker come under reflector type cooker:

3.2.1. Panel Cookers

This type of cookers has a flat panel attached to it which reflects and focuses sunlight for cooking and heating. This type of cooker has a box and curved concentrator according to the international solar cooker. They are simple in construction and cheaper to buy or produce. The "Box Kit" solar cookers are being widely used all over the world so far. The Panel-type solar cooker is similar in operation to that of the box-type solar cooker. The same principle of insulation is used as it is in box-type solar cookers. This type of cooker uses a reflecting panel for collecting sunlight on the cooking vessel.

Figure 2: Illustrates the design of panel-type solar cooker with reflecting surface with cooking vessel

Fig. 2, shows a panel type solar cooker concentrating the sun rays directly to cooking vessel. It can cook food in 2-3 hours and has a temperature range up to 200° to 250°. This type of cooker is unstable in winds and does not retain much heat when the sun is hidden in the clouds.

3.2.2. Parabolic Cookers

Parabolic cookers can reach more high temperatures in comparison with box cookers and panel cookers and can cook food quickly. This type of cooker works on the principle of concentrating sunlight or optics. It uses a reflector that reflects the sunlight on the bottom of the cooking vessel. This cooker can achieve high temperatures similar to the temperature achieved by LPG, Charcoal. But they need frequent adjustments and guides to operate it safely. It needs a more accurate to focus the sunlight on the pan and if not focused the food will not cook properly. The design of the parabolic cooker is complex and difficult to use. Fig. 3 show the scientific diagram of parabolic solar cooker and illustrates the working of parabolic solar cooker.

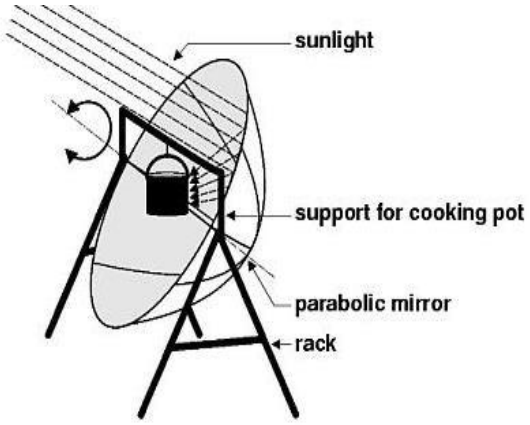

Figure 3: Show the scientific diagram of the parabolic solar cooker and illustrates the working of the parabolic solar cooker[11]

One of the designs of parabolic is a sun basket cooker. The sun basket is a parabolic mirror, made from papier mache, reinforced by a layer of jute fabric, and held in place by a bamboo frame. The reflector lining is an aluminium foil that is glued to the inner side of the basket. This is also known as a passive cooker. For fabricating the sun basket, a mound of cement concrete of parabolic shape is made on the ground. This is done with the help of a previously fabricated plywood frame of parabolic shape, which is revolved on the masonry work

while still soft. A bamboo basket is woven in such a way that it fits exactly over the shape of a parboiled mound. In this experiment reflecting type solar cooker is used to reflect the direct sun rays with the attachment of a mirror which increases the efficiency of reflection with the help of a parabolic dish along with a heat storage tank. With the use of a heat storage tank the utility of the cooker increases even after sunset. The Heat storage tank is filled with wax for storing heat.

4. DESIGN

There are numerous kinds of the main components of the solar cookers.

- Reflector
- Absorber
- Absorbing surface coating material
- Reflecting surface coating material
- Reflecting surfaces
- Insulation

4.1. Reflector

A parabolic reflector is used to which the reflecting mirror is attached as shown in Fig.4, concentrates solar radiations to a single point. When the pot is kept at the point, the pot gets heated quickly to a high temperature which is sometimes similar to the temperature achieved by gas or charcoal stoves. Galvanized magnesium nickel alloy is used to make the reflector because it is easy to shape the magnesium nickel alloy. The use of the mirror increases the efficiency of the reflector and more rays are reflected due to the mirror.

4.2. Absorber

A copper tube/copper absorber pipe is used for absorbing the heat obtained at the reflector as shown in Fig. 4. Copper tube is used because of its physical property such as high melting point and high tensile strength also it is cheaper.

4.3. Absorber Cover

The material chosen for the absorber cover should have optical properties such as transmittance for visible light and opacity to infrared radiation. Alloys and Transparent covers are used to make absorber cover material. The advantage of using alloy cover compared to other covers is that alloys are self-supporting, an alloy is generally opaque to thermal radiations from the absorber.

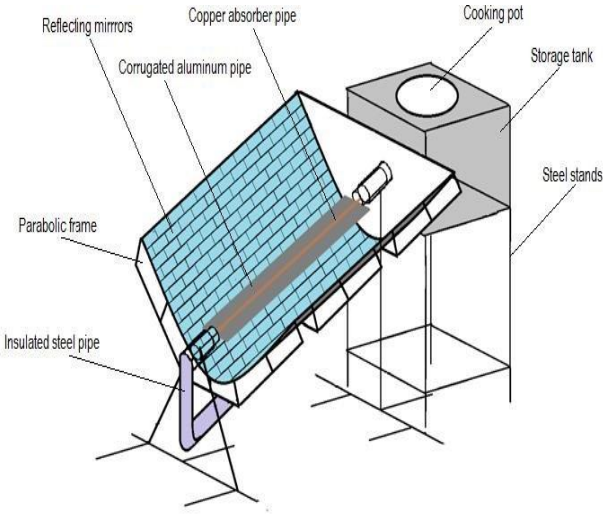

Figure 4: Sketch of the working model and the assembly of the component used for solar energy stored cooker [12]

5. CONCLUSION

In this, we have used freely available solar energy for cooking purposes. Using solar energy reduces the use of non-renewable which is limited, costly, cause's pollution. The main restraint of solar energy is that it is available only during the daytime. Which is overcome by the process of storing heat energy of the sun. Also, concentrating solar rays helps in achieving the high temperature similar to the Liquid Petroleum Gas, charcoal, etc. which makes the project the best alternative solution for such sources. The "Stored energy solar cooker" helps to cook all types of food effectively in a very short time. This is also an alternative solution for the use of conventional energy sources like LPG or kerosene. Due to this, we can save fuel for future generations. During the rainy season, the efficiency of the product may decrease. Solar energy stored has more advantages in the modern era and can be implemented in rural areas where there is a shortage of L.PG. This can be modified and developed by using more techniques according to its uses.

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