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Hybrid solar cooker

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Abstract- This paper addresses that how we can maximize the utilization of solar power for our cooking process. It is done by installing the cooker at some height and its lower or base surface will consist of transparent glass through which sun rays enters into the cooker after getting reflected by the reflecting mirror placed on the ground. This solar cooker also consists of heating element through which cooker gets heated in cloudy weather as well as in night by electricity. Thermostat arrangement is also provided to control the temperature of cooker while running through the electricity.

Index terms- introduction, solar radiations, physics and thermodynamics of solar cooker, new idea of solar cooker, calculations, references.

1- INTRODUCTION

Earth receives a continuous flux of solar energy. The planet absorbs this energy, gains heat, and radiates an equal amount of energy back into space in a constant maintenance of radiative equilibrium. Greenhouse gases in the earth's atmosphere impair the release of some of this re-radiated infrared energy. These gases, $C0_2$, water vapor, methane, ozone, nitrous oxide and CFCs, reflect infrared radiation emitted from earth's surface in multiple directions including back into the planet's system. Our research on the feasibility, efficiency, and energetic impact of solar cookers explores the interconnections between scientific principals, grassroots action, and socio environmental change. Fueled by tapping in to Earth's system of energy collection and dispersal, the cooker itself becomes a microcosm of energy transfer translatable to an understanding of broader climatic function. Exploring the concepts of reflection, transmission, absorption, convection, conduction, radiation, and insulation we will outline the mechanisms of solar cooking and their relationship to climate.

2-SOLAR RADIATIONS

The sun is a huge sphere 1391684 km in diameter and 150 million km from earth. It generates energy from the conversion of hydrogen to helium (fusion). Electromagnetic radiation from these reactions leaves the sun radially in all directions but the distance from the earth to the sun is so large that sun rays reaching earth are essentially parallel. The "solar constant" (S), is the amount of radiation per unit area (w/m^2), reaching the earth outside of the atmosphere. This is calculated by letting Q equal all of the energy given out by the luminous source (Sun) every second and making R the distance between the Sun and the surface of the receiving sphere (earth). The average flux of solar energy hitting the planet's surface is about $240w/m^2$

Due to the interference of the atmosphere, solar energy hits a horizontal plane on earth's surface in both direct and diffuse form. The direct form is the parallel rays from the direction of the sun while the diffuse form is radiation scattered in many directions by matter and gasses in the atmosphere. Direct Solar radiation can be manipulated and concentrated by the cooker's reflective surface according to laws of reflection which describe the angle of reflection as equal to the angle of incidence of the incoming ray.

3-PHYSICS AND THERMODYNAMICS OF SOLAR COOKER

In practice people design a cooker according to the resources available and intended use. In this project we built cooker that fall within a range of input expenses, efficiency based on insulation (heat retention) and efficacy of solar concentration (wattage input). The models include variations of the box cooker oven and the parabolic reflector. Cooking can occur at 70°C.
Transfer to the ambient and the radiative Exergy is the irreversible useful work resulting from increased entropy of the system and surroundings. Heat transfer into and out of the system produces increased entropy as put forth by the second law of thermodynamics. Unlike entropy, exergy is not a primary thermodynamic property but a co-property of systems. Irreversibility results from changes in the configurations of the microstates of particles within the system. The transformation energy expended cannot be recovered. As our system exchanges entropy with the surrounding air via heat flow from warmer to cooler air, equilibrium is destabilized which continues to drive heat transfer. This heat transfer is the usable work of the system, or the exergy. This heat/entropy exchange with the surroundings induces spontaneous self-organization that manifests in convective heat patterns. Energy and exergy losses result from unabsorbed insulation, convective and radiative heat irreversibility of surfaces. When losses equal input, thermal equilibrium is achieved within the cooker. Heat is transferred from the solar cookers via conduction, radiation and convection.

4-NEW IDEA OF SOLAR COOKER

In our hybrid solar cooker, we use another surface for heat entering into the cooker system. i.e. lower part of the cooker. Solar rays are reflected from the ground to the lower surface of cooker with the help of the reflecting mirror i.e. tracker. As we use double heat entering surface in our cooker, the cooking power will be almost doubled the power then the conventional solar cookers.
We also used a heating device which can run on the electricity to allow the use of our cooker during the cloudy weather as well as in night. Thermostat device is also installed in this cooker to control the temperature of the inner atmosphere of the cooking system while running through the electricity.

Our objectives behind this are-

- Avoid large amount of unconventional energy resources
- To reduced smoke in inhalation
- To reduce the danger of home fire
- Avoid difficulties of tracking
- To protect the local environment and make eco friendly
- Utilization of more solar power

4.1 FEATURES OF OUR COOKER

- High reflector are used to reflect more energy
- It is tracking free device
- Eye Safety (only 1.6 times sun concentration)
- Robustness (long-lasting material)
- It can be used in cloudy weather as well as in night
- Highly insulated, to avoid the heat leakage
- Thermostat to control the electric heating power
- More cooking capacity than conventional solar cookers

4.2 COMPONENTS OF SOLAR COOKER

The main components are as

4.2.1 Mirror

It is used as to reflect the rays of sun light and it is highly sparkle. It is responsible for the concentration of the solar radiations inside the cooker (box).

4.2.2 Box

It has rectangular shape structure around this rectangular box frame with insulated absorber are used to absorb more and more energy. It is black coated inside the surface of the wall because of black have good absorber of light use mirror on the bottom and glass cage

4.2.3 Double glass top with air

All double glass top with air some sunlight, still the overall cooking efficiency increases. In most solar cooking operation glass is used in single layer but we use it in double layer form and air gap between them to avoid the leakage of the heat through it.

4.2.4 Aluminium sheet

Because of the properties of wearing high temperature it uses Instead of polyester product. It will absorb the heat contained by the solar radiation to utilize it for the cooking process.

4.2.5 Heating filament

Heating element is used inside the box to heat up it in cloudy weather with the help of the electric power for the cooking purpose. A heating element converts electricity into heat through the process of resistive or Joule heating. Electric current passing through the element encounters resistance, resulting in heating of the element.

4.2.6 SHEATHED HEATING ELEMENT

Tubular (sheathed) elements normally comprise a fine coil of resistance heating alloy wire, usually nichrome (NiCr) that is connected at each end to a terminal pin and is electrically insulated from a metallic tube, of stainless steel alloys, such as Incoloy, or copper, by in a ceramic insulating material, fused magnesium oxide powder. The tube ends are frequently equipped with beads of insulating material such as ceramic or silicone rubber, or a combination of both to prevent the penetration of moisture in to the element. These can be a straight rod (as in toaster ovens) or bent to a shape to span an area to be heated (such as in electric stoves, ovens, and coffee makers).

4.2.7 THERMOSTAT

A thermostat is a component of a control system which senses the temperature of a system so that the system's temperature is maintained near a desired set point. The thermostat does this by switching heating or cooling devices on or off, or regulating the flow of a heat transfer fluid as needed, to maintain the correct temperature.

4.3 WORKING PRINCIPLE

A solar box cooks because a interior of the box is heated by a energy of the sun. Sunlight both direct and reflected, enter the solar box throw the double glass tap it turns to heat energy when it is absorbed by the dark absorbed plate. This heat input causes the temperature inside of the solar box cooker to rise until the heat loss of the cooker is equal to the solar heat gain. Temperature sufficient for cooking food and pasteurizing water are easily achieved

For the additional gain of heat single or multiple reflectors(mirror wheel)bounce additional sunlight throw the glass and into the solar box additional input of solar energy result in higher cooker temperature

Due to this inside the cooler box green house effect is generated and heating of in close space the light energy that is absorbed by dark pots and the dark absorbed plate short wavelength converted into longer wavelength heat energy and radiated from the interior material. most of the radiant energy ,because it is of a longer wavelength , cannot pass back out through the glass and is therefore trapped within the enclose space the reflected light is either absorbed by other materials with in the space or because it does not change wavelength passes back out through the glass.

Critical to solar cooker performance, the heat that is collected by the dark metal is conducted

through those materials to heat and cook the food Heat loss during cooking process.

The second law of thermodynamics states that heat always travels from hot to cold. Heat within a solar box cooker is lost in three fundamental ways: conduction, radiation, and convection.

5. CALCULATIONS

$$Cooking\ Power = Absorption\ of\ the\ sun\ on\ the\ cooking\ plate.$$

COOKING POWER DEPENDS ON:

- Absorption of the cooking plate
- Reflectivity of the mirrors
- Intensity of the sun
- Loss through angles
- Reflection of the glass

CALCULATIONS OF COOKING POWER

- $Cooking\ Power = Power\ from\ above + power\ from\ mirror\ 1 + power\ from\ mirror\ 2$
- Power from above = sun intensity × cooker size × glass reflectivity × absorption efficiency
- $\boldsymbol{Power\ from\ above = 800\ W \times 0.1\ sqm \times 0.9 \times 0.9 = 65\ W}$
- $Power\ from\ mirrors = sun\ intensity \times cooker\ size \times mirror\ reflectivity \times cos(sun\ angle) + 2 \times (mirror\ angle) \times glass\ reflectivity \times absorption\ efficiency$
- Power from mirror = 60w×cos (angle)
- Cosines (angle) between 0.5 and 0.9
- $\boldsymbol{Power\ from\ both\ mirrors\ approximately\ 65 - 100\ W}$

Sun intensity per square meter= 800W

Area of cookers upper portion= $0.1m^2$

Glass reflectivity= 0.9

Absorption efficiency= 0.9

Maximum cooking power = Power from above + power from mirror 1 + power from mirror 2

Maximum cooking power= 100W+65W

$$\boldsymbol{Maximum\ cooking\ power = 165W}$$

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