Design, Analysis of Solar Operated Hybrid (Water Heater Plus Cooking) System

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Abstract— The energy obtains from the solar radiation by the Concentrating system. Here design and analysis is carried out for combined hybrid system of solar cooker and water heater. Hybrid system develops and fabricate for three research objectives ENERGY, ECOLOGY & ECONOMY. Study the effects of the solar cooker on its performance with wrapping water circulating copper tube for heat recovery system. More than 85% of the incoming solar energy is either reflected or absorbed as heat energy.The hybrid concentrating collector technology using water as the heat recover has been seen as a solution for improving the energy performance. The study was carried out to evaluate the combined effect of solar cooker with water heating system. Our observation is that very few studies and design appropriate recommendations are made which will aid solar cooker with water heating systems to improve their overall and thermal efficiency and reducing their cost and utilize energy for making combination of solar cooker with water heating system. With this type of hybrid system saving increased and return on investment is faster so payback period of investment is reduced. System is utilized for more hours/day for cooking as well as water heating. that the model is verified for wide range of load.

Key words: Solar energy; Solar water heater, Solar cooker, Hybrid system

I. INTRODUCTION

Solar cooking offers an effective method of utilizing solar energy for meeting a considerable demand for cooking energy and hence, protecting environment. solar energy can make a major contribution to the energy needs for cooking food. cooking with solar cookers is an energy-efficient, pollution-free way to help fight global warming and take advantage of nature's free, inexhaustible energy supply. The solar radiation directly falls on the collector surface and the solar energy is converted into thermal energy. Water is circulated in tube and gets heated by solar energy. Heated water is then stored in the storage tank for use in the process. The majority of renewable energy technologies are directly or indirectly powered by sun, and account for over 99.9% of the renewable energy on the earth. Solar energy - a perfect solution of 3 E s: energy, ecology and economy.

II. HISTORICAL PERSPECTIVE - EARLY STEPS

Ibrahim ladan mohammed et al (2012) [1] has been investigated the design and development of a parabolic dish solar water heater for domestic hot water application (up to 100°C) is described. The heater is to provide 40 litres of hot water a day for a family of four hot water per
day. Experimental test runs carried out showed that the overall performance of the solar water heater was satisfactory. Thermal efficiencies of 52% - 56% were obtained, and this range of efficiencies is higher than the designed value of 50%.Fareed.M.Mohamed et al (2012) [2] In this research the design and fabrication of solar dish concentration with diameters (1.6) meters for water heating application and solar steam was achieved.The dish was fabricated using metal of galvanized steel, and its interior surface is covered by a reflecting layer with reflectivity up to (76 %), and equipped with a receiver (boiler) located in the focal position. The dish equipped with tracking system and measurement of the temperature and solar power .Water temperature increased up to 80°C, and the system efficiency increased by30% at midnoon time.Ibrahim Ladan Mohammed et al (2013) [3] have been design and fabricated the parabolic dish solar thermalcooker having aperture diameter 1.8 m, depth 29.0 cm and focal length 69.8 cm.The cooker was designed to cook food equivalent of 12 kg of dry rice per day, for a relatively medium size family.The main research points of this paper are food-water volume and mass ratios, cooker component design and development, material and labour economy, and energy cost savings. Khaled mahdi et al (2013) [4] have been investigated An analysis of the system's optical characteristics was performed to aid in the design of the spherical reflector and cylindrical receiver. The thermal performance of the system was analyzed. The effects of mirror reflection, concentration ratio, heat transfer to the fluid (water), incidence angle, size and form of the cylindrical receiver, environmental conditions (wind,ambient temperature), have been studied by means of thermal model. The performance of the spherical reflector was tested by the temperature of the water. Total efficiencies (solar to thermal) of ηth = 60%-70% were obtained for a wide range of temperatures up to 350°C.Mobin Arab et al (2013) [5] have been study The effects of using water, ammonia, acetone, methanol, and pentane as working fluids of the built-in heat pipe are discussed comparatively during a typical day of operation. Water is identified as the best working fluid amongst the others. Three hypothetical working fluids are then proposed for further analysis which led to a working fluid design superior to water in performance. It is shown that the performance of the solar water heater can be significantly enhanced up to 28% and 50% from economical and technical points of view, respectively. R. Riazi, et al (2008) [6] have been investigated the performance and rate of heat transfer in copper tubes in solar water heaters with thermosyphonic flow.We also show a comparison between performances of three kinds of tubes: copper, polypropylene and steel under similar conditions. A comparison of experimental data showed that performance of copper tubes is slightly better than polypropylene tubes while both of these tubes are significantly better than steel tubes.Maxime Mussard et al (2013) [7] has been investigated comparative experimental study of two solar cookers. The first is the widespread SK14 cooker; the second is a prototype of a

solar concentrator (parabolic trough) using a storage unit. The SK14 is a direct solar cooker where the cooking pot is placed on the focal point of a parabolic dish; in the trough system heat is transported from an absorber to a storage unit by means of a self-circulation loop filled with thermal oil. Following these experiments, simulations are conducted to optimize and improve the system. Cooking on a heat storage with optimized surface contact is proved to be less effective as competitive with standard solar cookers or other cooking devices.Ali A. Badran et al (2013) [8] have been designed, built and tested to A portable solar water heater and solar cooker. A higher collector efficiency and cooking power was achieved in glass cover pot comparison with and bare pot. after to using alternate system cooking and water heating that increase the performance of system.

III. PERFECT SOLUTION OF 3 E'S: ENERGY, ECOLOGY AND ECONOMY FOR SOLAR SYSTEM

A .Energy:
Its plentiful and its virtually inexhaustible. In fact, the energy requirements of the entire human race can be fulfilled by the power of the sun alone.

B.Ecology:
Solar energy is a clean, silent energy technology that generates no waste, and allows compliance with targets under the Kyoto protocol. Also, with reduced carbon footprint, user's quality for earnings through carbon credits.

C. Economy:
With an attractive payback, it provides a compelling case for return on investment. It is a fixed cost that is hedged against increasing energy costs.

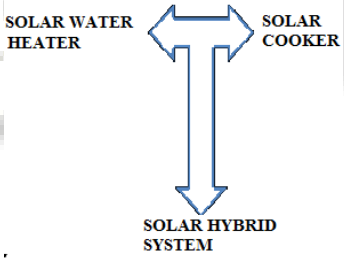

Fig.1: A perfect solution of 3 E's: Energy, Ecology and Economy

IV. DESIGN INPUT DATA OF SOLAR HYBRID SYSTEM

ybrid solar system is design in solid works for the following input data:

- Collector type-concentrating point focusing.
- Collector dish diameter-1.8 m
- Depth of dish-29 cm
- Focal length-69.8 cm
- Material for absorber-aluminum.
- Parabolic dish reflector material-polished aluminum
- Body of dish-mild steel
- Material for the absorber surface coating-black paint.
- Heat transfer fluid-water

V. DESIGN OF ASSEMBLY AND COMPONENTS

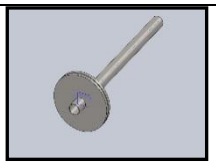

Fig.2 Balance rod

It helps us to reduce efforts required to move the collector according to sun movement. It is balance the left-right movement of collector.

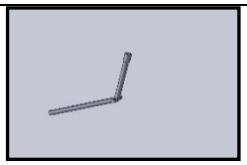

Fig.3 Lever and balance

It is used for give effort to the collector according to sun movement. It is made from mild steel.

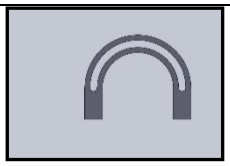

Fig.4 Lock guide

It is help to lock the movement of collector as per required. It is mounted on square pipe.

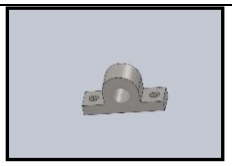

Fig.5 Pedestal

It is made from mild steel or cast iron. It supports the Bearing and bearing housing.

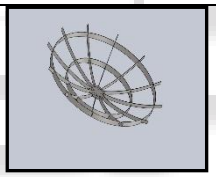

Fig.6 Concentrator segments assembly

It is made with the use of different segment and two different diameter segment support ring used. It is made from mild steel.

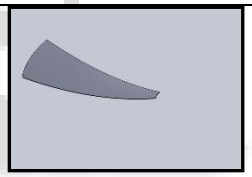

Fig.7 Concentrator segment

It is heart part of assembly which is known as reflector. It is made from polished Aluminum.

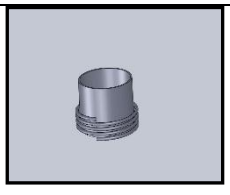

Fig.8 cooker

It is receiver that used to for cooking purpose. The water circulated copper tube wrapping around receiver which absorbed heat loss around the receiver.

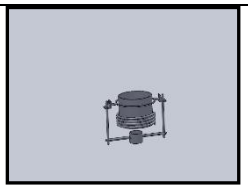

Fig.9 Basket assembly

Receiver mounting on basket assembly. It is supported by concentrator rod.

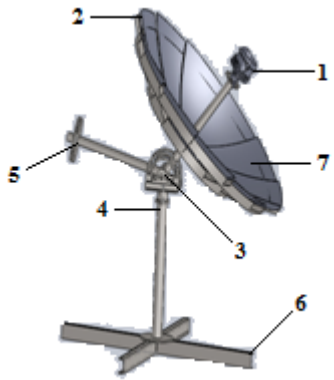

Fig. 10: Assembled drawing of the parabolic thermal cooker.

S/No.	Item	Material
1	Absorber	Aluminium
2	Parabolic dish	Mild Steel
3	Aperture tilting mechanism	Mild steel
4	Vertical part	Mild steel
5	Lever and Balance	Mild steel
6	Base Support	Mild steel
7	Reflector	Polished Aluminum

VI. PRIMARY RESULTS

After the solar hybrid system was constructed as shown in fig.10, some hybrid system tests were carried out. The results of the tests achieved up to 280 °C temp of oil. The overall performance of the cooker is satisfactory. Still lots of scope for design and performance improvement.

VII. CONCLUDING REMARKS

Concerns regarding the Global Warming Potential and the more recently defined Thermal Equivalent Warming Impact (TEWI) are an opportunity to further explore the applications of use of solar energy. Finally, the adoption of solar energy to power hybrid system, even with marginal economic benefits, should not be underestimated for next generation point of view.

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