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Design and Fabrication of Portable Solar fryer and its comparative analysis with SK-14.

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Abstract-- Renewable energy source-These are those energy sources which are sustainable and have less environmental impacts. Now-a-days Renewable energy like solar energy is gaining importance they are preferred over conventional sources because of its various advantages. One of such application is solar cooking. There are many designs of solar cookers available in market, but only few of them became commercial. So, our aim is to design a simple, compact and portable solar fryer. Based on the design a prototype will be fabricated and experimented and its performance will be tabulated along with the performance of SK-14. Based on the results i.e. efficiency will be determined and it will be concluded that solar portable fryer is applicable for commercial purposes.

Keyword: Efficiency, Portable, SK-14, Solar Fryer.

I. INTRODUCTION

Solar cooking is simplest fastest most convenient way to cook food without consuming fuel or heating up kitchen. Paraboloidal Dish type solar cooker. A specially designed parabolodial reflector surface concentrates the beam radiation and concentrates it at a point, where a cylindrical brass vessel containing food material is placed. A commercial solar cooker SK14 developed by EG Solar, an NGO of Germany, is being manufacture in India recently. The vessel directly receives the concentrated solar radiation. The reflector is periodically adjusted to track the sun. A fairly high temperature of about 450□C can be obtained and a variety of food requiring boiling, baking and frying can be cooked for 10-15 person. It can save on fuel for up to 10 LPG cylinders annually on full use. The cooking time is approximately 20-30 minutes. The approximate cost of cooker is Rs 8,500.In our project instead the food material we kept one liter water in the container and we got temperature up to 50 degree Celsius.

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Portable solar fryer [2]: The Portable solar fryer adopted for cooking food almost at any time, latitude, altitude or season. It can be used to boil water or heat soup. The fryer can be mounted or dismounted in minutes, its portable in size and packs up easily making it easy to transport in any bag, It is also very light weight. The portable solar fryer can reach up to 200□C.Fryer also eliminate the tracking time to time during day.

Solar Fryer collector-which is little curved in shape also called as parobolodial dish collector. When a parabola is rotated about its optical axis a parabolodial shape is produced. Diffused radiation is focused at a point in the paraboloid .This require two axis tracking. It can have concentration ratio ranging from 10 to few thousand and can yield a temperature up to 3000□C.Parabolodial dish collector of 6-7 m in diameter commercially manufactured. Our concentrator having concentration ratio about 11.34 and temperature gained up to 50□C and diameter of 64 cm.

Different Type of cooking [3]

1- Baking- The word baking usually refers to the cooking of foods made from a batter or dough.
2- Roasting-The Word usually refers to the cooking of meat.
3- Broiling and Grilling-In grilling food lies directly over the heat source and in broiling food lies directly under a heat source.
4- Frying-Frying is the cooking of food in fat.
5- Boiling-Boiling is cooking food in boiling water.
6- Steaming-cooking food in steam.

II. LITERATURE REVIEW

Steam Solar cooking Method which employed in India. Tirupati Balajee to feed over 70, 000 people daily. Solar Cooking system saves 1, 20, 000 liters of diesel. The steam is also used for the bathing purpose of thousands of devotees daily [4]. In Shirdi Sai Mandir Gadhia Solar has manufactured and installed world's largest solar steam powered for cooking facility [5]. A Parabolic Dish Supplies air conditioning to a hospital in Gujarat State in western India and replace 1 ton of

wood consumption in a day [6]. Installation of solar cooking device at Vigyan Aashram.Project proposal for the installation of solar cooking devices(16sqm Schaffer concentrator, PRINCE 40 solar parabolic cooker, tunnel drier, 12 sqm solar batch drier, Bakery/oven , biogas generator) at the Vigyan ashram was submitted to INDUSA[7]. Sabarmati Central Jail in Gujarat planned to use solar thermal power generation for cooking purpose for which jail authority investing 40 lakh 'solar steam is generating system' probably It is the first for any jail in the country[8]. Solar Energy system of 2.2 MW is being used for making food for student of Styabhama University. The system comprises parabolic-shaped reflectors, which focus the sun's rays on a particular point on an aluminum pipe through which water is made to pass through. The water heats and generates steam that passes through another pipe to be used for cooking purpose [9]. Professor Ajay Chandok Researcher in Non-Conventional energy resources completed commissioning and installed over 300 large solar parabolic cookers of Dia 2.3 meter and at tribal school in Maharashtra [10]. Approx 30 women in a half-dozen western districts of Madhya Pradesh state here have so far received household-sized SK14 cookers through a program run by the Barli Development Institute for Rural Women (BDIRW), which is based in Indore [11].

III. MATERIAL AND METHOD

Material: Primary material used is aluminum sheet and all the strip of collector is tied up, for that purpose used binding wire.

Scope: The scope is prepared a solar cooker with an appreciable efficiency compared to SK-14 and can be employed for outdoor cooking.

Components [12]

- Parabolic Dish- A parabolic dish was constructed which was supported firmly over a rigid frame. Its size and shape are such that when exposed to sun in the normal direction, a point focus is formed.
- Diameter of Dish-As per convenience dia 64 cm for a single dish opted.
- Material of Dish and its thickness- Material used for construction of dish is aluminum and its thickness is 2 mm.
- Focal length of Dishes-A common focal length was obtained after placing the entire three reflectors and there we kept a vessel.
- Cooking pot- A stainless steel box of capacity one liter was used as a cooking pot. Which was black coated.
- Supporting frame-supporting frame was made of wood to support the dish.
- Tracking Mechanism-Tracking done manually.

Sample preparation: Before preparing sample we draw a diagram in which for convenience we took an angle 10 degree and by mathematical calculation we got diameter of collector 63.8 cm and length of curvature is 62.9 cm, and after that preparation of sample was started and material was purchased material from Vellore market and pieces of aluminum were cut in desired circular shape and then for achieving required curve shape we cut aluminum sheet in equally strip up to a particular distance and by the help of binding wire and ring we got the shape according to our requirement.

Sample testing: We started experimental analysis first we took the temperature of stainless steel black coated box without water which considered as initial temperature of vessel and later took reading with water which considered as initial temperature of water and after every 15 minute readings of both container and water was noted with help of thermo couple and along this process we also took reading of pyranometer and pyheleriometer.

Enumeration: To enumerate all the term we calculated the efficiency of our designed project and SK14 we got average efficiency respectively 15.833% and 31.25 %.

IV-RESULT AND DISCUSSION

Table-4.1: Efficiency calculation for solar fryer.

Time In PM	Tin °C	Tfinv°C	Tinw°C	Tfinw°C	Pyr(mV)	Pheler(mV)	Efficiency In %
1:25	33	35	32	34	7.39	2.84	12.1
1:40	35	38	34	40	7.10	2.57	13.54
1:55	38	41	40	43	6.54	2.62	18
2:10	41	44	43	46	6.65	2.75	19.63
2:25	44	46	46	44	4.70	1.87	16.16

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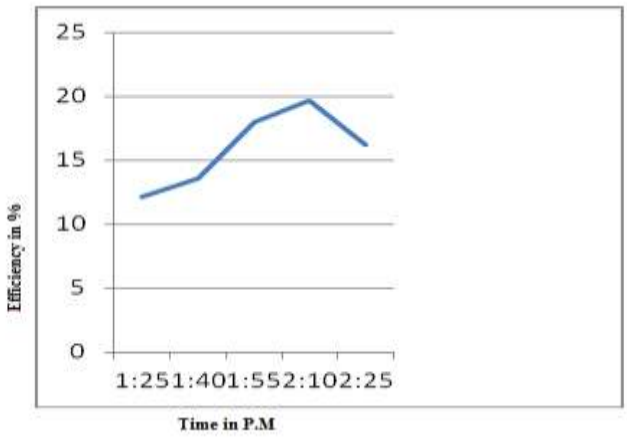
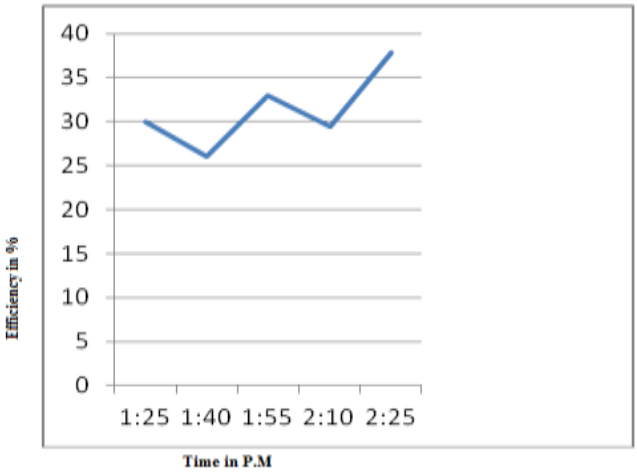
Table-4.2: Efficiency Calculation for SK-14

Time in PM	Tinv in °C	Tfinv°C	Tinw°C	Tfinw°C	Pyr (mV)	Phel (mV)	Efficiency in %
1:25	33	40	32	40	7.39	2.84	30
1:40	40	46	40	47	7.10	2.57	26
1:55	46	51	47	53	6.54	2.62	33
2:10	51	54	53	56	6.65	2.75	29.48
2:25	54	55	56	59	4.70	1.87	37.8

4.3-Figure of Portable solar fryer and SK -14.



4.4- Time Vs Efficiency for Solar fryer



4.5- Time Vs Efficiency for SK-14

There is an Indian standard method available to check the time taken in boiling of water that is called water boiling test. Strength of this test is its simplicity and replicability.It provide a preliminary understanding of stove performance .However, the WBT has some weakness. It is applicable to many different type of stove, the WBT only a rough calculation of actual cooking. Therefore it cannot provide much information about how to stove perform when cooking real food. The WBT test cannot be used to accurately to predict actual change in fuel consumption [13].

In this project aim was to compare the efficiencies of SK-14 and of proposed design collector .So for which we adopted laboratory method which is described below.

Readings in Graph and table-1 and table-2 clearly indicate solar portable fryer has lower efficiency than SK-14 and here used solar flux as the difference of pyranomemter reading and pyherelioameter reading. When I thought about this project our objective was to define cooking arrangement parallel to SK-14.During the experimental process we adjusted pyhereliometer at an interval of two minute. During experimental analysis first measured the Vessel temperature to the thermometer and later again measured the vessels temperature after keeping water and kept vessel where the focal point of all the reflector well occurring and in case of SK-14 we just putted vessel according to the sunlight and took interval after 15 minute and final calculated quantity of water evaporated. Since day was cloudy we got very little evaporation for solar fryer got 5ml and for SK-14 20 ml.On the basis of that by applying formula we got efficiency.

V-CONCLUSION

Based on the outdoor experiments conducted it was found that efficiency of proposed solar fryer was lower than that SK-14 as our material was general cheap aluminum not an expensive proper reflective material as used in SK-14,but one advantage of our design over SK-14 was that it is portable, another important advantage is that we keep reflector in all four direction and then according to the direction of sunlight every individual reflector will work and here we reduced time to time manual monitoring and If we make this reflector on large scale with better material then definitely we can make parallel cooking arrangement against sk-14 .Total investment during the fabrication was 1000 Rs.

VI- NOMENCLATURE

Qvessl= Mv × Cv × Δɵ .

Qwater= Mw × Cw × Δɵ .

Qvaporised= (1-water left after evaporation) × hfg.

$$\text{I For Pyranometer} = \frac{\text{Pyranometer reading (mV)} \times 1000}{12.56}$$

$$\text{I For Pyrheliometer} = \frac{\text{Pyrheliometer reading (mV)} \times 3.1552 \times 221.4}{4.95}$$

$$\text{Efficiency for SK} - 14 = \frac{\text{Qvap} + \text{Qvessel} + \text{Qwater}}{\text{I for Pyheroliometer} \times \text{A} \times \text{t}}$$

Efficiency for Solar Portable Fryer.

$$= \frac{\text{Qvap} + \text{Qvessel} + \text{Qwater}}{\text{D} \times \text{A} \times \text{t}}$$

Where A=Area of Dish

T_{inv}=Inlet Temperature of Vessel.

T_{finv}=Final Temperature of Vessel

T_{inw}=Inlet Temperature of Water.

T_{finw}=Final Temperature of Water.

I=Solar Flux (w/m^2)

D= I for Pyranometer – I for pyrheliometer.

t=Time.

C_V=Specific heat capacity at constant Volume.

C_W=Specific heat capacity of water.

Δɵ =Temp. Diff=T_{in}-T_{fin}

M_V=Mass of Vessel in Kg.

$M_{W=}$Mass of Water in Kg.

h_{fg}=Latent heat of Vaporization of Water.

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