

Experimental study of Solar Dish Type of Solar Concentrator

The aim of this research is to develop a solar dish type cooker for domestic cooking purpose in rural area where there is no access of electricity and to ensure the sustainable development through clean energy. Many researchers had developed the solar dish type of cooker where the material like Aluminium was taken as glazing or polishing surface as reflector. But in this research there were number of Chromium vinyl material strips were attached on the dish which acts as reflector in order to increase the reflectivity and to enhance the efficiency. The cooking power and Energy generated for the steam was calculated as 835 W and 0.977 KW. The maximum temperatures was measured in a sunny day as 136⁰C which is sufficient enough to cook food and for generating steam.

1. Introduction

Due to the maximum energy consumption in India the world energy demand is expected to rise more than 25% in next 20 years. It has been observed that industrial sector accounts more than 50% of the world energy consumption followed by transportation and building sector. Energy consumption is different for rural and urban area. Maximum energy is consumed in rural area as domestic purpose like cooking and lightning purpose. Generally the resources like cow dung, fire wood, agricultural residue are used as fuel for cooking purpose which results environment pollution and health issue. So solar operated cooking device is the alternative source for solving the problems.

2. Experimental set up

The main components of the solar dish type of collectors are dish type of reflector and receiver. There are number of segment of chrome vinyl material are attached in the surface of dish and act as reflector. The receiver was placed at a focal length and placed perpendicular to the centre of the dish. The dish was placed on the structure in such a way that it will be manually operated as per the direction of the sun's position. The receiver was painted as black in order to absorb maximum solar radiation. This dish having 2 m aperture diameter, 0.5 m depth and 0.3 m focal length was designed, constructed and fabricated. The receiver was made up of aluminium container and entire surface of the dish is stainless material. As the sun radiation incident on the reflecting surface of the dish, it will concentrate all the radiation into the receiver which was placed at focal distance. It will absorb the heat and gets food cooked.

2.1 Mathematical modelling

The focal distance was calculated as $f=d^2/16h$ equation 1

$$\tan \varphi = \frac{1}{\frac{d}{8h} - 2h/d} \quad \text{equation 2}$$

Where, f=focal length, d=diameter of aperture, h=depth of parabola ϕ = rim angle.



Figure 1 represents the experimental set up of solar dish type concentrator with manual operated tracking system

3. Result and discussion

The solar cooker was put in an open atmosphere and where there was no shadow effect. With a regular interval of time the temperature reading was taken with the help of Temperature sensor and Solar irradiation was measured with the help of Lux meter. The maximum temperature reached up to 136⁰C which is sufficient enough to cook the foods and also boil the water in the table 1. The amount water taken as 2 litres for testing purpose. Throughout the day a manual operated tracking device was used to rotate the dish as per the direction sun's position.

Si no	Timing (AM/PM)	Temperature in 0 _c	solar irradiation in LUX
1	10 AM	90	71400
2	11 AM	95	71900
3	12 AM	120	72500
4	12:30PM	130	80900
5	1:00 PM	136	73600
6	2 PM	100	53600
7	2:30 PM	70	12300
8	3:00 PM	67	12000
9	3:30 PM	61	12000

Table 1 represents the Temperature verses time of solar dish type of cooker

The cooking power was calculated as 835W by taking maximum interval temperature as 136⁰ C and 130⁰C. $C_{\text{water}} = 4.2\text{J/g}^{\circ}\text{C}$ or 4179.6J/KgK .

Si no	Timing required for boiling water in minutes	Kg of water boiled
1	30	0.1
2	60	0.25
3	90	0.45
4	120	0.5
5	150	0.65
6	180	0.7

Table 2 show the amount of water evaporated in regular interval of time

It has been observed that the maximum amount of water evaporated in 30 minutes is 0.65 Kg. The mass flow rate computed as $3.611 \times 10^{-4} \text{Kg/s}$. By taking latent heat of vaporisation= $h_v=2706 \text{ kJ/Kg}$, the total energy of the steam per unit mass= $3.611 \times 10^{-4} \times 2706=0.977 \text{ KW}$

4. Conclusion

The present research describes about the performance testing of dish type of solar cooker. The cooking power and total energy of the steam was calculated. The amount of heat produced by the cooker was sufficient enough to cook foods. There was some heat lost to the atmosphere and again when the intensity of solar radiation decreases, there was no possibility of cook the food. Further scope of research is to reduce the heat loss and increase the cooking power.