International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 06 | June 2022 www.irjet.net p-ISSN: 2395-0072

Parabolic Solar Cooker: Design, Construction and Testing

[1]Sonam Kumar, [2]Raja Kumar Singh, [3]Sandeep Jhamb

[1]Dept. of Mechanical Engg., Arya Institute of Engineering & Technology, Jaipur, India
[2]Dept. of Mechanical Engg., Arya Institute of Engineering & Technology, Jaipur, India
[3]Head of Dept. of Mechanical Engg., Arya Institute of Engineering & Technology, Jaipur, India

---

Abstract: *Sun rays are used in solar cooker which makes it natural and clean source of energy. Uses of solar cookers can save fuel and helps in eco-friendly cooking of food. The main disadvantage of the use of solar energy is it only available in daytime. The research is on the Design, Construction and Testing of Parabolic Solar Cooker with concentrated parabolic reflector. Heat which is coming from the sun is concentrated on the base of cooking pot which is kept inside the transparent glass box, the transparent glass box is fixed at the focal point of the parabolic reflector, the black coated makes cooking pot as a heat absorber. The heat absorbed by the black coated cooking pot is utilized for baking or cooking or boiling the liquid inside it. The sun rays tracking system is manual, the parabolic reflector can be rotate in the direction of sun easily with the help of screw jack mechanism.*

Key Words: Parabolic, Solar Cooker, Heat absorber, Reflector, Focal Point.

1. INTRODUCTION

Use of solar energy is one of the best ways to reduce the use of non-renewable resources of energy. The sun rays are also used to generate electricity, to heat water or other fluids and also used to heat the rooms in winter season through window glass and also for cooking. Solar Cookers are used as an alternative source of heat for cooking instead of conventional sources like firewood and other burning fuel oil and gasoline. One of the more efficient and famous solar cookers is the parabolic solar cooker. The working of solar cooker is so simple in which the incoming sun rays are concentrated at a point to generate heat or increase the inside temperature of cooking pot which is used for cooking or any other purposes.

In the parabolic solar cooker, there is a parabolic shape reflector on which the incoming sun rays are incident and after reflection all the rays are concentrate at a point. There is also another type of solar cooker called box type solar cooker in which the cooking pot is kept inside a box which is made up of transparent glass and wood and there is a plane reflector. And it is also possible to cook food approximate in the same time interval that food is cooked by conventional methods.

The parabolic solar cookers have been identified to cook faster and can achieve higher temperatures compared to other types of solar cooker. There are two types of parabolic cookers, one is the direct solar cookers in which cooking pots are placed at the focus point of the parabolic dishes and another type are the indirect solar cookers in which the heat is stored and channelled for indoor or night. Concentrating solar cookers can achieve concentrating temperatures up to 350 ^{0}C.

2. DESIGN AND CONSTRUCTION

The design is first and most important steps and everything or we can say whole thing is dependent on design, if our design is not good or not full fill our requirement the project is fail and we will not get desired results.

In parabolic solar cooker the challenging design is the design of parabolic reflector, in this we designed the parabolic solar reflector in such a way that the rays which is coming from sun after the reflection from the parabolic reflector converged at a point that point is called the focal point of the parabola. Aluminium foil of thickness 0.4mm is used over the mild steel structure for the reflector construction, due to its light weight, low cost, energy effectiveness and high quality and good specular reflectance with reflectivity of 87%. To make parabolic reflector the reflecting aluminium sheet is cut into the required number of pieces in the trapezium shape. To support all the trapezium shaped aluminium sheet circular aluminium channelled structure is designed in which the one side of all sheet is fixed by the help of screw and nut, and copper wire.

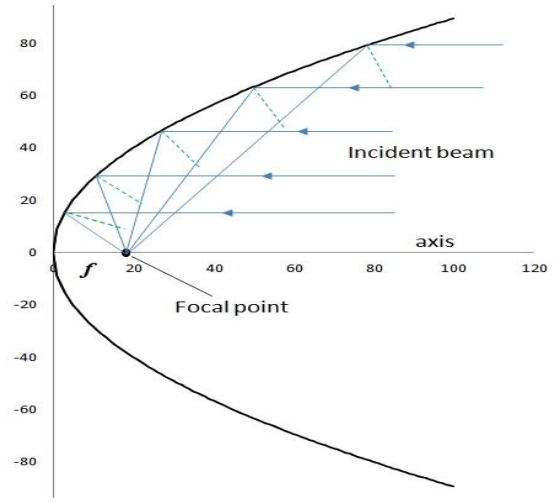

Fig - 1: Geometry of Parabolic Reflector

Calculation of focal point of parabolic reflector

$$equation\ of\ parabola, y^2 = 4a$$

$$focal\ length\ (f)\ =\ y^2/4a$$

Parabolic reflector surface area

$$A = \frac{8\pi}{3} f^2 \left[\left(1 + \left(\frac{D}{4f}\right)^2\right)^{\frac{3}{2}} - 1 \right]$$

Relation between focal length and rim angle

$$\emptyset_{rim} = \tan^{-1} \left[\frac{\frac{8f}{D}}{(\frac{f}{D})^2 - 1} \right]$$

Where, y is longest radius, D is diameter of the parabola and a is the depth or height, A is surface area, f is focal length of the parabolic reflector.

The rays which come after reflection converges at focal point at that point a glass box is designed with metal base which is supported through an external stand and the cooking pot is keep inside the glass box. The whole system is supported through a base structure which is designed under the consideration of load and the high temperature and also the base material is designed in such a way that the parabolic reflector can be adjusted according to the direction of sun rays. Mild steel rectangular tube is used to make the base structure frame and plastic boll wheels are used to rotate the whole structure, the rectangular mild steel tube is measured and cut using the hack saw and grinding wheels, according to the requirements and specification of each of the component of structure member, mild steel strip is also cut and bend the shape according to the design. After the cutting and the bending and drilling to make holes for nuts and bolts, the members of the structure are joined by electric arc welding process. After the construction process all the components and members are assembled and make the complete structure of parabolic solar cooker. First the parabolic reflector is assembled with base structure frame by nuts and bolts and then the cooking pot stand is assembled with rotation mechanism, after the completion of all the process the final process is to fix the aluminum foil reflector with the structure by copper wire and screw and nuts, it is highly reflective and shiny if we assembled it first then due to shiny it can damage our eyes while assembling all the component that's why it is assembled at last time.

3. Materials

3.1 Mild Steel:

It is ductile and malleable, the carbon content in it is 0.08% – 0.32% and the melting point is 140 ^{0}C. It absorbs shocks and has strength and it can be readily welded and forged. Mild steel sheet is used for the base structure of parabolic reflector and also used for base structure and stand structure. Mild steel rectangular pipe is used for entire frame and structure of the base.

3.2 White Glass:

It is transparent and colorless in nature. The solar absorption of glass is depended on the thickness and the chemical composition of the glass. White Glass is used to construct the glass box with the help of aluminum clip in which the cooking pot keep.

3.3 Aluminium:

It is ductile and malleable, it has high resistance to corrosion, melting and boiling points are 658 and 2057 ^{0}C respectively. It is used for the absorber plate and the material of cooking pot and also used to make circular channel in which the reflecting sheet is fixed.

3.4 Bright Anodized Aluminium Sheet:

Foil is a solid metal having thickness of 0.4mm. It transmits no light and it is a total barrier to light including ultraviolet spectrum. It reflects approximately 87% of radiant heat and light. It is used as a reflecting surface of parabolic reflector the foil is fixed on the base metal of parabolic reflector, it is in trapezium shape through which we can make parabolic shape easily.

4. WORKING

In parabolic solar cooker the sun rays are used to generate heat at a point which is further used for cooking or other purpose.

The incoming rays from sun incident on the parabolic reflector having larger diameter of 1.5m which is made up of mild steel sheet at base and aluminum foil on it, after the reflection from reflector the reflected rays are converges at a point called focal point which is calculated by the above equation for focal length, at that point a white glass box is fixed and the inside of the glass box the aluminum material cooking pot having black coated is keep. The purpose of use of white glass box is to create greenhouse gas effect and the purpose of coating black on outer surface of cooking pot is to absorb more heat because black body absorbs heat by which the heat generation is more and the efficiency of solar cooker will increase. The converged ray incident on glass box and the rays transmits into the glass box and generate heat at that point where the cooking pot placed and absorb heat and increase the temperature of the cooking pot and the material inside in it.

Fig - 2: Parabolic Solar Cooker

All the components are assembled and supported by the frame which is made up of mild steel and the base structure is adjustable according to the height and the reflector is also adjustable to the direction of the incident rays or in the direction of the sun.

5. USAGES

Parabolic solar cooker is used for houses and small commercial applications.

Ideal for Homes, Farmhouses, Camp sites, Military cantonments, Hostels, Canteens, etc.

It can be used from an hour after sunrise to an hour before sunset.

CONCLUSION

The main limitation of solar energy is that it is only available in day time. On the basis of results obtained during the testing of the project, due to many losses the cooking pot temperature (highest) reading is 110 ^{0}C against 35 ^{0}C ambient temperature. If this testing is done in sunny or hot area or in summer season where the ambient temperature is more than it is expected to be more effective and also may require less time to achieve the desired temperature.

REFERENCES

1. Kalogirou SA (2004) Solar thermal collectors and applications. Prog energy combust 30: 231–295.

2. Bensenouci A, Medjelled A (2016) Thermodynamic and efficiency analysis of solar steam power plant cycle. Int J Renew Energy Res 6: 1556–1564.

3. Kalogirou SA, Karellas S, Badescu V, et al. (2016) Exergy analysis on solar thermal systems: a better understanding of their sustainability. Renew Energy 85: 1328–1333.

4. Singh B, Mishra AK (2015) Utilization of solar energy for driving a water pumping system. Int Res J Engg. Technology 2: 1284 1288.

5. Thakkar V (2013) Status of parabolic dish solar concentrators. Int J Enhance Research Science Technology Engg. 2: 42–50.

6. Sandeep, H.M. and Arunachal, U.C. (2017) Solar Parabolic Through Collector: A Review on Heat Transfer Augmentation Techniques, Renewable and Sustainable Energy Reviews, 69, 1218-1231.

7. Sukhatme, S.P. and Nayak, J.K. (2011), Solar Energy, TMH Publications, 240-253.