Analysis of Parabolic Solar Dish collector with Different Reflecting Material

[#1]PratapSoanwane, [#2]JayantBhangale

[#1]PG Student,Heat Power Engg.,MCOERC ,Nashik, SPPU,India
[#2]Asst. Professor, Head of Mechanical Department, MCOERC, Nashik, SPPU, India

Abstract— Application of solar energy for domestic and industrial heating purpose has become very popular .The solar water heater is one of the major application which uses solar energy. The flat plate collector is most widely used collector in solar water system but these types of collectors typically have high heat losses and low efficiency. For these types of drawbacks of flat plate collector we have to concentrate on concentrating solar system. The aim of this project is to investigate the effect of changes in reflector with different reflecting material .Also tracking of sun where we are getting maximum intensity of solar energy. From these experimental set up calculate the heat gain and maximum efficiency for the reflecting material apart from other materials.

***Keywords*:**PDSWH- Parabolic dish solar water heater, PSDC-Parabolic solar dish collector

NOMENCLATURE

Z -Axial distance (m)
R - Distance (m)
f- Focal distance (m)
h- Parabola depth (m)
d- Parabola opening diameter (m)
S- Parabola area (m^2)
Φs -Solar flux density received by concentrator
T -Temperature (°C)
I_t-Solar radiation
η- Efficiency of parabolic solar dish collector
Q_u- Useful heat gain
C_P-Specific of water
m- Mass of flow rate

I. INTRODUCTION

The development of the world is going on at the expenseof energy consumption. Presently conventional sources are fulfilling the energy needs of the world. But the conventional energy sources like fossil fuels have two main limitations: firstly they are limited in quantity and secondly they produce environmental pollution. It makes the world think for alternative energy sources. Renewable energy sources eliminate the limitations of conventional sources. But because of less knowledge about these sources and high initial cost of the conversion systems limits the use of these resources. Out of the all renewable energy resources, solar energy is the most promising, a very large, clean, inexhaustible and universally available source of energy.The solar water heater is one of the major application which uses solar energy. The flat plate collector is most widely used collector in solar water system. But these types of collectors typically have high heat losses and low efficiency. For these types of drawbacks of flat plate collector we have to concentrate on concentrating solar system. The aim of this project is to investigate the effect of changes in reflector with different reflecting material.Also tracking of sun where we are getting maximum intensity of solar energy. From these experimental set up calculate the heat gain and maximum efficiency for the reflecting material apart from other materialsbe represented graphically. In short this proposed work will compare the performance analysis of parabolic dish collector for different reflecting materials.

II. LITERATURE REVIEW

Many researchers worked on Parabolic Solar Dish collector, the introduction of their experimentation and results given below:
Author prepared design and manufacture solar dish concentration with diameters (167) centimeters for water heating application. The dish prepared with tracking system and measurement of the temperature and solar intensity. Water temperature improved up

to 70^0C, and this set up increases heat gain and operationalefficiency that is increased by 30% at after noon time form 11am to 3 pm (Mohamed, et al, 2012).

Set was prepared design and fabrication of a parabolic dish solar water heater for increases the temperature for domestic as well as industry application this set up gives higher amount of temperature difference reached up to phase change of water is done in this paper. The heater is to provide mass flow rate of 0.002 kg/sec from pipe which is beneficial to people of four in family and efficiency for this system in more than 50%

(Laden, 2012). Experiment performed and examined with the working fluid as water. Absorber takes place as copper coils, heat is concentrated with the help of copper tube concentrated heat is absorbed by a copper tube which is stationary on solar trace pathway in which, it is eliminates tracking the sun to obtain maximum solar energy. The test results were measured 190^0C, for this system solar thermal efficiency is done up 50-60 % calculated (Arukumaran, et al, 2013).Design, fabrication and testing of a parabolic dish collector, this set up is point concentratedhaving heat from the sun is concentrated on a blackabsorber. The whole set up is placed on a hinged frame supported with a slotted lever for slanting the parabolic dish reflector to different angles so that the sun is always directed to the collector at different hours of the day. On the normal bright and unclouded bright free days, the set up readings gave high temperature above 200^0C.(Folaranmi, 2009).Hourly efficiency and hourly gain are considering with considering values of useful energy, heatgain are calculated after considering the optical and thermal losses of the collector. Apart from the months April and August offer the largest irradiation and useful solar energy rates compared to remaining months. The prediction hours starts from 5 a.mto 8 p.m. to interpretation for difference in dawn and sunset times of twelve months. In this paper absorbed radiations having less temperature losses up to 3.5% (Ali, 2009).A parabolic dish of optimized flexible petals. The dishes are made by no. of petals and having highly reflective surface, regarding petals thickness and lengthmathematical analysis is done. These petals attached to the back apparent of the mirror petals,several thin films whose figures are optimized to have reflective petals form into a parabola when their ends are pulled toward each other by cables or rods (Zhang, 2009).New design for parabolic dish collector with copper as receiver and theoretical analysis with selecting copper helical coil tube receiver of 220 cm diameter and length. (Sakhare, et al, 2014).A variety of different solar concentrators,explaining there terminology related to solar, about concentration, reflectivity of surfaces, area of reflectors. The link between concentration, acceptance angle and inlet and outlet temperature of a solar collector is examined in simple terms for designing collectors with maximum concentration. There are also proposed new concentrators as second stage concentrators for conventional parabolic or Fresnel mirrors. Such a combination approaches the performance of an ideal concentrator without demanding a large reflector (Rabl, 1976).The experimental study on tracking and non-tracking solarsystem to examine the result of with a nonstop process two-axes following on the solar energy collected. The collected energy was calculated and equated with that on a immovable surface slanted at towards the South. The results specify that the calculated solar energy on the stirring surface was considerably higher (up to 46.46%) equated with the immovable surface. The projected two-axis Sun trailing system was categorized by a fairly simple and low-cost electromechanical fabrication of set-up with less maintenance requirements and easily installation and working. It is concluded that when the solar intensity is low and the tracking system operates only on sensor mode, the solar reflector cannot follow the Sun orbit, and the efficiency is decrease significantly, reaching the efficiency of the fixed inclination surface (Bakos, et al 2006).To solve the economic, ecological and energy efficiency problems in dealing with the oil industry through a solar thermal application. They mentioned that a solar energy application has a great advantage for the oil industry to be economical with fossil fuels partly, to improve safety measures and ecology, and to also reduce additional financial expenses. New technical and technological opportunities of a solar energy application in crude oil treatment in oil fields have been established. by decreasing the additional expenses and reduction of the production cost of commercial oil.(F Mammadov, et al, 2008).A low cost steam generating system which is incorporated with solar parabolic dish collectors system. The result indicated that the steam conversion efficiency lie between the 70-80% at 450^0C and cost of collector lie between 8000-9000also it has very low weight and reflectivity are close to glass mirror (Reddy, et al, 2009).A paper on solar thermal collectors and applications and kalogiru presented different types of point concentrates and line concentrators such as flat plate collector, parabolictrough,parabolicdish, frsenelscollector. With description and done with an optical, thermal and thermodynamic study of the collectors and study of different methods to calculate their performance. Typical applications of the various types of collectors were presented in order to show the extent of their applicability. The application described in this paper show that solar energy collectors can be used in a wide variety of systems, could provide significant environmental and financial benefits, and should be used whenever possible (Kalogiru, 2004)A solar concentrator of220 cm diameter is designed and developed. Set up consist of measurement of solar flux and temperature difference by help of equipment placed on reflector dish and absorber disc.There are two results are obtained temperature at absorber is 400°C and efficiency increased with considering various parameters. Indirectly we can collect thermal energy from solar system this energy that is used directly for a number of applications such as water heating, power generation using Stirlingengine,vapour production (Ouederni et al, 2009)

III. METHODOLOGY

The proposed work concentrates on the Experimental investigation of Performance, reflecting characteristics and evaluation of heat gain for solar dish collector. The work can be divided in the following ways Information Gathering from the books and Literatures for concentrating and non-concentrating solar collectors, In second stage material selection for the set up and reflector for parabolic dish and method selection for angle tracking which are automatic or manual system. From these data we have to prepare experimental set up of parabolic solar dish collector. By using this set up for various reflectors calculate the inlet and outlet temp. for system for various angle. Final stage for this work is to calculate heat gain, efficiency and comparing with reflectors.

IV. EXPERIMENTAL SETUP

a) The experimental setup includes solar parabolic dish system, absorber and reflector.
b) Water asheat transfer fluid is circulated through the system from water tank.
c)To circulate water from absorber tank trough circular pipemade up of copper which is coiled to reflector tank.
d)In this set up point concentration takes place on coil.
Fordish made from reflective petalswith reflectiveness is more with various reflective materials. Dish is made from no. of petals they are joint at center.

4.1 Reflector

The reflector of our experimental set up consists of a parabolic concentrator of 1.67 m upper diameter. Its inner area is covered with a reflecting film. These panels reflecting sun light and collecting at point location at receiver. The Follow of the sun is done by the directional support for dual axes system.
The equation for the parabola from geometry of parabolic dish.
$Z= r^2/4f$
The surface of opening of a parabolic is:
$S=\pi d^2/4$
The focal distance (f) is calculated by the following formula.
$f=d^2/16$
h is the depth of the dish.

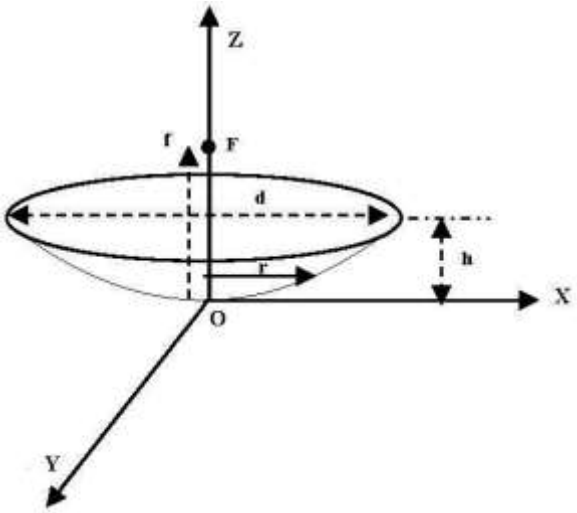


Fig .1 Geometry of parabolic dish

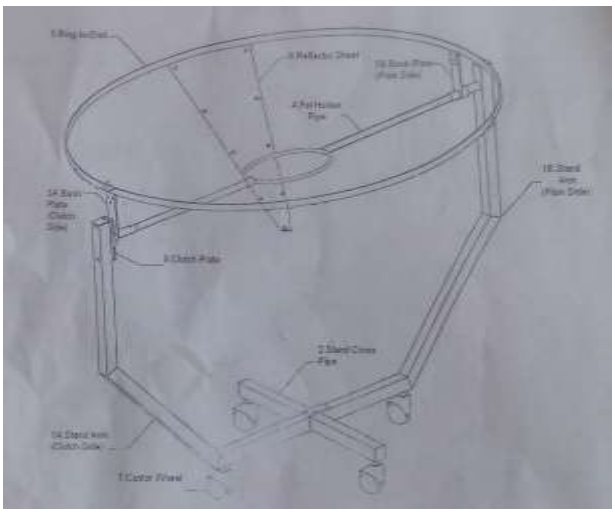


Fig .2 FBD Of parabolic dish

Fig .3 Set up Of parabolic dish

Table 1 Characteristics of the solar concentrator

Diameter of opening of the parabola	1.67m
Surface collecting of the parabola	2.19 m^2
Depth of the parabola	0.30m
Focal distance f	0.579m

4.2 Follow-up of the sun

Table 2 Solar radiation for declination of parabolic dish

T (hour)	Solar radiation (W/m2)	δ(in Degree)
8	494.0438	70
9	533.1737	55
10	691.5731	45
11	728.904	35
12	857.4852	10
13	858.0719	10
14	771.6237	15
15	627.704	40
16	534.0798	55
17	527.0719	70

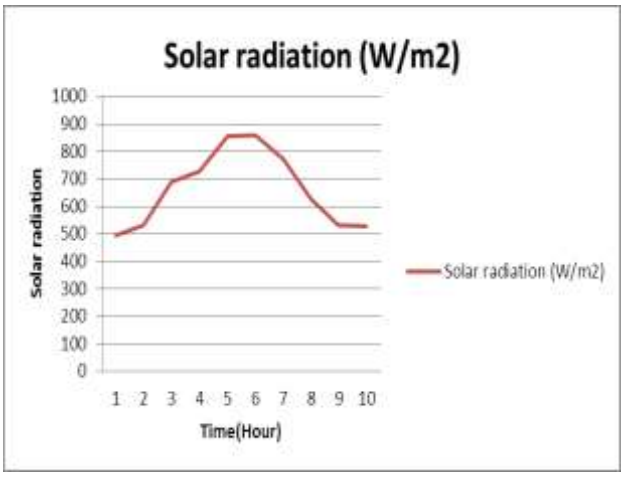


Fig. 3 Time (Hour) Vs Solar Radiation

4.3 Sample Calculations

The efficiency of parabolic solar dish collector can be evaluated by an energy that, determine the amount of the incoming radiation delivered as useful energy to the working fluids

$\eta = Q_u/(I_T * A_c)$……(1)

For the parabolic solar dish collector heat gain can be calculated by using the formula below.

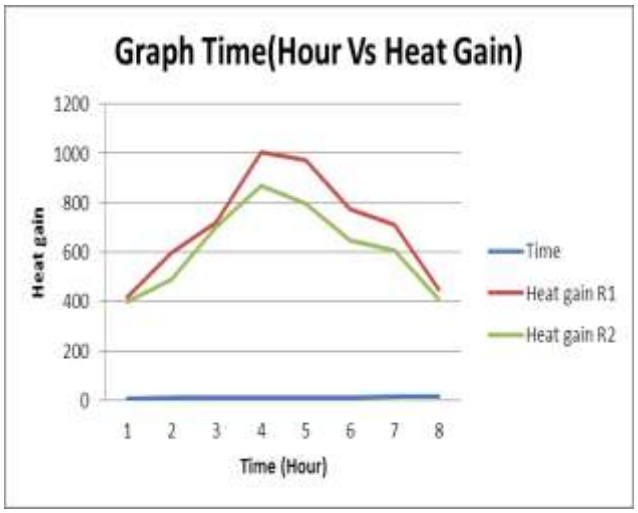
$Qu = m * C_p * (T_{out} - T_{in})$……..(2)

Table 3 Inlet Temp, Out Let Temp and Time for date14, 15 Feb 2016

Sr No.	Time	Inlet Temp	Out let Temp.	
			R1	R2
1	9	20	40	39
2	10	21	49.5	44.5
3	11	23	57.5	54.5
4	12	24	72	65.5
5	13	24	70.5	62
6	14	23	60	54
7	15	21	55	50
8	16	21	42.5	40.5

Table 4 Time and Heat Gain for R_1,R_2

Sr No.	Time	Heat gain	
		R1	R2
1	9	418.71	397.765
2	10	596.64	491.97
3	11	722.25	701.3225
4	12	1004.88	868.8
5	13	973.477	795.775
6	14	774.59	648.98
7	15	711.79	607.11
8	16	450.1	408.23



Fig, 4 Time (Hour) Vs Heat Gain

Table 5 Time and efficiency for R_1, R2

Sr No.	Time	Efficiency	
		R1	R2
1	9	35.87	32.76
2	10	39.39	37.13
3	11	45	42.33
4	12	53.31	51.42
5	13	51	48.98
6	14	45	42
7	15	39	36.12
8	16	38	34

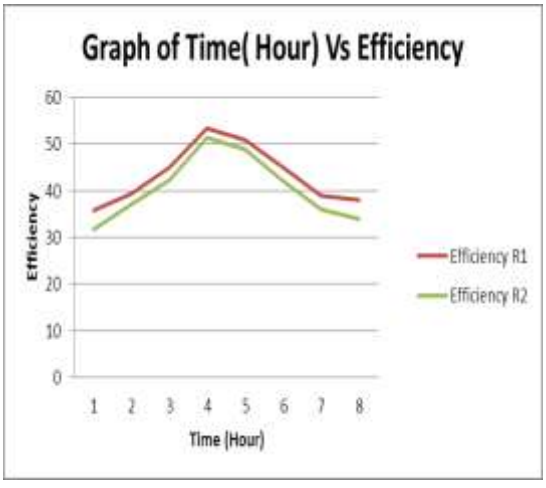


Fig. 5 Graph of Time(Hour) Vs Efficiency

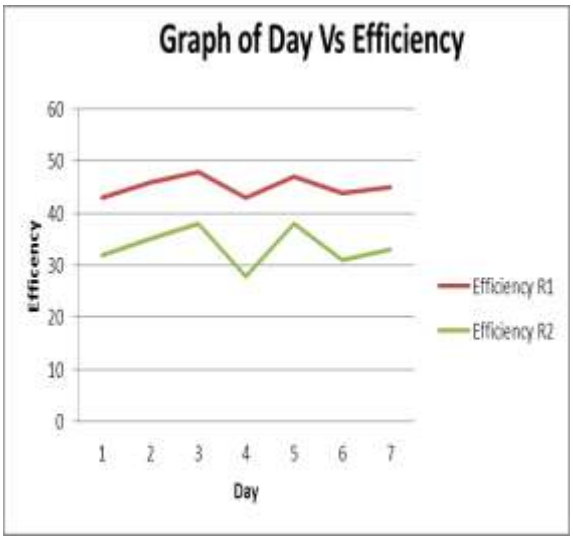


Fig. 6 No. of Days Vs Efficiency

V. CONCLUSION

1) It is possible to utilize parabolic solar dish collector for the water heating and cooking application as well as in industrial purpose.
2) From this work when using tracking of sun by some angle we are getting higher solar radiation due to that heat gain and efficiency is higher than non-tracking of solar dish.
3) From the readings we observe that maximum heat gain and efficiency of parabolic solar dish collector between 11 to 13hours and it is maximum at 12 hours for both the reflectors.
4) This work is depended on changing of reflectors between these two reflectors silver foil dish giving higher efficiency than the steel for the same mass flow rate and same area. Reflectors silver foil dish giving higher efficiency than the steel for the same mass flow rate and same area.

REFERENCES

F.M.Mohamed, A.S.Jassim, Y.H. Mahmood, Mohamad, A.K.Ahmed, (2012), Design and Study of Portable Solar Dish Concentrator, International Journal of Recent Research and Review, 3,pp. 95-105.

I.M.Laden(2012), Design and Development of Parabolic Solar Dish Water Heater, International Journal ofEngineering Research and Applications (IJERA) Vol. 2, Issue 1, pp. 822-830.

M. Arukumaran and W. Christraj(2013), Experimental analysis of Non tracking parabolic dishconcentrating system for steam generation, International Journal of Engineering Research and Applications (IJERA)Vol. 3, Issue 1, pp. 930-931.

J.Folaranmi(2009),Design, Construction and Testing of a Parabolic Solar Steam Generator,Leonardo Electronic Journal ofPractices and Technologies, issue 14, pp. 115- 133.

Aliman, I. Daut,(2007), Simplification of sun tracking mode to gain high concentration solar energy, A Journal of Applied Science 4(3), pp. 171-175.

Z.Liangdong,Jili, R. Liang, (2010), Thermal performance test of u-type evacuated glass tubular solar collector filled with graphite, International Energy Conference, vol. 4, pp.1-4.

V. Sakhare and V.N.Kapatkar,(2014)Experimental Analysis of Parabolic Solar Dish with Copper Helical coil Receiver, International Journal of Innovative Research in Advanced Engineering IJIRAE, Volume 1, Issue 8, pp. 199-205 .

A. Rabl,(1976),Comparison of Solar Concentrators Solar Energy, pregamon press vol.18., pp.93-111.

P. Masjuki, G. C. Bakos,(2006)Design and construction of a two-axis Sun tracking system for parabolic trough collector (PTC) efficiency improvement, Renewable Energy 31,pp. 2411–2421.

F Mammadov, U Samadova, O Salamov,(2008) ,Experimental results of using a parabolic trough solar collector for thermal treatment of crude oil , Journal of Energy in Southern Africa Vol 19 ,pp 102-110.

K.R. Kumar, K.S. Reddy, (2009), Thermal analysis of solar parabolic dish with porous disc receiver, Applied Energy 86,pp. 1804–1812.

S.A.Kalogirou, (2004) Solarthermal collectors and applications", Progress in Energy and Combustion ScienceVol. 30 pp-231 - 295.

K. Ouederni, M.B. Salah,(2009), Experimental study of a parabolic solar concentrator, Advances in Mechanical Engineering and its Applications (AMEA) , United States Vol. 12, pp 395 – 404.

