INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)

www.ijprems.com
editor@ijprems.com

Vol. 04, Issue 06, June 2024, pp: 532-542

e-ISSN : 2583-1062

Impact Factor: 5.725

PERFORMANCE OPTIMIZATION OF CONCENTRATED SOLAR THERMAL COLLECTOR

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DOI: https://www.doi.org/10.58257/IJPREMS34772

ABSTRACT

The following study will provide an in-depth analysis of the disk Stirling engine, a unique parabolic dish system. Parabolic solar disk collector system is a device that converts solar energy into electricity obtained by changing sunlight. These systems often use glass, lenses, or other devices to focus sunlight collected from the collection area into a small area. The conversion process begins with the conversion of primary sunlight into thermal energy (heat) that drives a thermal engine (Stirling engine, steam turbine, etc.). Likewise, the generator produces electricity (return), which is transferred to the generator to produce electricity. In this study, a method is proposed for the optimization of parabolic concentrator solar disk collectors In this study, a fixed generator was used to use thermal energy obtained from solar energy. Calculations of all parameters were made using MS Excel and detailed graphs were drawn showing the interpretation of the results.

Key words: Stiriling Engine, Parabolic Disc, Solar Energy, Absorber Cavity, Emissivity, Daily Normal Irradiation.

1. INTRODUCTION

CSP technologies all work beneath a standard principle that is aggregation sunrays over an oversized space and concentrate them at a smaller space that corresponds to a circular surface for purpose focus CSP or over the outer surface of a cylinder for line focus CSP. the world accustomed welcome sunrays is named the solar furnace and corresponds to a reflective surface. The concentration point/line is named the concentrate or focal line and it's wherever the receiver is found. The receiver options associate absorbent material that is that the medium accustomed carry the warmth. For parabolic dish systems, the receiver comprehends, in addition to the absorbent material, an influence conversion unit. regarding the subsequent work, it'll analyze deeply a particular parabolic dish system that is that the Dish Stirling system.

2. FORMULATION OF PROBLEM

GEOMETRY OF THE DISH COLLECTOR

The parabolic solar collector we are interested in, has a first important parameter which is the focal length. The focal length f defines the distance at which the focal point will be located wrt the vertex V of the parabola. This vertex shows the deepest point of the parabolic. In spatial geometry, the paraboloid of revolution is parameterized as : $\boldsymbol{x^2 + y^2 = 4fz}$

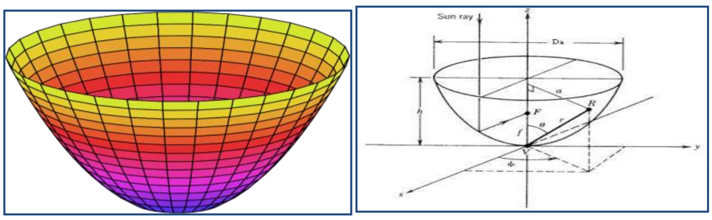


Figure -1 illustration and a Graph of a Parabolic of Revolution

The depth h refers to the distance from the center of its aperture to the vertex V. On the other hand, the diameter D is the diameter of the paraboloid's aperture which is the circular surface of its upper base. These parameters are critical to defining the shape of the solar collector and thus to determining the position of its focal point F. If we take the two-dimensional plane yz, the equation of the parabola will simply be $\boldsymbol{y^2 = 4fz}$

As D is directed along the y axis and the plane of interest is the yz plane, the y parameter is simply the radius of the aperture R. Therefore, as h is directed along the z axis, the equation becomes as follows, $R^2 = 4fh$ which is equivalent to $D^2 = 4fh$. Then, f can be expressed as a function of parameters h and D as shown in equation **[f =**

D²/16h]

When designing a parabolic solar collector, the rim angle ψ is the most important parameters as it gathers all the dimensions of the collector and thus defines its focal length. The rim anglerefers to the angle made by the line, drawn from the edge of the rim to the focal point F, and the z axis. ψ is defined by equation

$$\tan\psi = \frac{1}{\left(\frac{D}{8h}\right) - \left(\frac{2h}{D}\right)}$$

$$A_a = 4\pi f^2 \frac{\sin^2\psi}{(1+\cos\psi)^2}$$

The rim angle is the metric that defines how curved or flat is the parabolic dish collector. Consequently, a collector with a relatively great rim angle is relatively curved and one with a relatively small one is relatively flat. Since, the upper base of the paraboloid is a circular surface, the area or the aperture's defined by the area of a circle.

SIZING OF THE COLLECTOR/RECEIVER

The most common utilized types of receivers are cavity receivers and they are placed at the focal point; thus the concentration of sunrays will occur at its basis. The optical performance ofthe system strongly related to the size of the receiver.. For Dish Stirling systems, the concentration ratio can reach high values since the application of such systems require a large collector's area. The geometric concentration ratio $C_g$is given by the equation. $\mathbf{C_g=A_{dish}/A_{rec}}$

It is important to introduce the optical concentration ratio which is the exact measurement of the concentration ratio and it corresponds to the ratio of the radiant flux density at the receiver I_r (intensity at the receiver) to the direct normal irradiance DNI. The optical concentration ratio is given by the following formula. The dimensions are given in Watts per meter square ($W.m^{-2}$) while C is dimensionless. **C=Ir/DNI**

3. REFLECTOR MATERIAL SELECTION

The selection of the material to be used to reflect the incoming solar .It produce a major effect on the amount of solar radiation transmitted to the receiver. The surface of the collector must be highly reflective in order to minimize the energy absorbed by the reflector material and reflect most of the incident solar radiation to the focal plane. The usually used mirror materials have a great reflectivity. The range of reflectivity of reflective materials range from 0.85 to 0.98. Besides mirror materials, the surface may be in the form of a

polished metal such as aluminum or stainless steel. The most used materialis silver coated glass. Some of the reflector materials.

Table of Potential Reflector Materials [2]

Materials	Reflective (%)	Emissive (%)
Polymeric film, non metal	98	2
Aluminum, acrylic	98	2
Silver, aluminum acrylic	97	3
Silver, acrylic	95	5
Aluminum	86	14
Aluminum, polyethylene	97	3
Plexiglas with mirror	90	10
Thermoplastic, silver, gold, brass, etc.	80	20
Aluminum mylar	97	3
Polymer, copper, silvered, alumina	97	3
Polished stainless	50	50
Ceramic metallic coating layer	95	5
Glass/silver 4 mm	93.8	6.2
Glass/silver 2 mm	94	6
Glass/silver 1 mm	94.6	5.4
Miro 2–95	88.6	11.4
Miro 3–95	91.1	8.9
Anod aluminum	86.8	13.2
1000.90	89.8	10.2
ECP305+/aluminum	95.6	4.4
ECP305+/glass	96.1	3.9
Sunflex (polymer/aluminum)	86.9	10.1
SA 85/glass	88.1	11.9
SA 85/steel	88.2	11.8
Sol-gel coated silver	95.5	4.5
Sol-gel coated aluminum	91	9

For this application, the preferred reflector material is the glass silver coated material Glass/Silver 2mm with a reflectivity of 0.94 (94%) as shown in the table. The anti-soiling coating for the reflector is titanium dioxide for its attracting properties.

RECEIVER MODEL The selection of the receiver comprehends different criteria which are most importantly good absorption rates of energy but also high heat transfer properties. In the design of solar dish systems, two main types of receivers' geometry are considered and they are external receivers and cavity receivers.The advantage of cavities is that it reduces thermal losses and thus maximize the heat transferred to the working fluid. Also, convective heat losses are minimum in case of cavity receiver compared to an external receiver which would be exposed to the outer environment. the aperture of the receiver is located on the focal plane of the parabolic collector while the absorber is located behind it. as seen in the figure below.

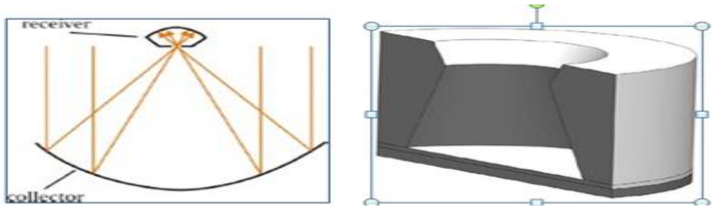


Illustration of a Cavity Receiver (left) and a Modeled Geometry ofthe Cavity (right)

Efficiency of the Collector/Receiver system

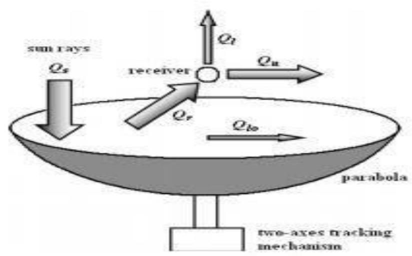
Optical Efficiency of the Concentrator The optical efficiency of the concentrator is denoted as η*o*, it evaluates how much radiation thecollector is able to reflect towards the receiver.The system is subject to shading loss which occurs due to the receiver and the Stirling Engine which block the sun from radiating on a little area over the concentrator. It is computed as the percentage of the receiver's aperture over the dish's aperture. The efficiency due to shading loss **Ɣ**=The efficiency due to shading loss is therefore calculated as **Ɣ = (1-Aa/Ar)**

Reflectivity loss is another loss experienced by the concentrator, it refers to the radiation lost due to the emissivity of the concentrator. It depends on the reflectivity of the reflector material. The efficiency in this case is simply the reflectivity of our material which is $\rho = 0.94$.

The loss is evaluated to be between 2-4% . In this study, we are not considering a transparent interface at the receiver's opening so the receiver can be considered as a black bodywith null transmittance. The efficiency of the system with regard to the transmission/absorption loss is Ɛ = 1 – (2 – 4%), we will take the average loss value 3% and set Ɛ = 0.97 (97%).

The spillage loss shall be considered as well and it corresponds to the reflected radiation that miss the receiver's entrance. It is estimated to be 1-3% [4], therefore we take the efficiency considering this loss to be 2% and we set Ә = 0.98 (98%). Finally, the optical efficiency η*o* is the product of all the previously stated efficiencies and it isgiven by **η*o* = Ɣ*ρ*ӘƐ**

Thermal Modeling of the Receiver



Thermal losses

A major part of the total system thermal losses occurs in the receiver. So therefore, calculation

These losses are an important aspect. These losses include

- Conduction through the receiver walls.
- Radiation through the opening of the aperture to the environment.
- Convection from the cavity.

$$T_{cav} = \sqrt[4]{\frac{Q_R}{A_t.\varepsilon_r.\sigma}}$$

The Conduction Losses: The conduction losses from the receiver-cavity is calculated by

$$\mathbf{Q_{cond} = (T_{cav} - T_{amb})/\ln[(d_{cav}/2+\delta_{in})/(2\,\pi K_{ins} L_{cav})}$$

Tcav =temperature of cavity

Stefan boltz mann constant = $\sigma = 5.67*10^{-8} w/m^2k^4$

The Convection Losses The natural convective heat transfer coefficient, which refers to transfer through the receiver cavity, depends on the aperture and receiver diameters, and the cavity location on a specific day. To estimate this coefficient, the Nusselt number can be calculated as below

NU =0.88Gr1/3 (Tcav/Ta)0.18 .cos(ɵ)2.4.(dap/dcav)$^{-0.982(dap/dcav)+1.12}$

Gr = {g. βair.(Tcav- Tamb). Lcav^3 . ρair} / μ^2}   Bair=1/Tcav

The forced convective heat transfer coefficient of the receiver cavity can be expressed as a function of the wind speed, as follows

$h_{forced} = 0.1967 \cdot v^{1.849}$, $h_{natural} = Nu.\,\lambda/d$

The total convective heat transfer coefficient and total convection losses through the receiver cavity are calculated using the following equations.

$H_{total} = h_{natural} + h_{forced}$

$Q_{convection} = H_{total} \cdot A_{cav}(T_{cav} - T_{amb})$

The Radiation Losses A major portion of the heat loss experienced by the receiver is due to radiation losses. Radiation heat transfers can be distinguished as two mechanisms, emission and reflection. The radiation loss is computed according to the relation below

$Q_{radiation} = \mathcal{E}_{eff} \cdot A_{cav} \cdot \sigma \cdot (T_{cav}^4 - T_a^4)$ $\mathcal{E}_{eff}$ is the effective absorptance of the cavity receiver and can be calculated by the following

$$\mathcal{E}_{eff} = \frac{1}{\left[1+\left(\frac{1}{\mathcal{E}_c}-1\right)\cdot\frac{A_{ap}}{A_{cav}}\right]}$$

Total heat loss of system $Q_L = Q_{cond} + Q_{conv} + Q_{rad}$

efficiency of the system The efficiency of the reciver dicribed its ability to transfer heat from the cavity to absorber of strilling engine is

$\eta_{thermal} = \frac{Qr - QL}{Qr}$

$\eta_o = \gamma \rho \partial \mathcal{E}$

γ=The efficiency due to shading loss is therefore calculated as $\gamma = (1\text{-}Aa/Ar)$

$\eta_{gen} = 50\%$

$\eta_{engine} = 70\%$

The total efficiency of the system is the multiple of all the efficiencies.

$\eta_{Total} = \eta_o * \eta_{thermal} * \eta_{gen} * \eta_{engine}$

POWER OUTPUT OF THE SYSTEM The overall efficiency of the system is the multiple of all the efficiencies multiplied by the efficiency of the power generator. So that the total efficiency will give us the amount of Power generated in function of the direct normal solar radiation. It would simply be the product of the total efficiency, the total area of the collector Aa and the DNI. $P = \eta_{Total} * Aa * DNI$

By using all equations an aproch is made to calculate the efficicncy and power output of taken system and by making parametric variations optimization of the system is performed in order to find the best possible design of the system to gain maximum power output of the system.

4. METHODOLOGY

(SAMPLE-CALCULATION) Solar energy data is taken from NASA **website (https://power.larc.nasa.gov/data-access- iewer/)** Sample data for jan-2023 similarly all month data has been taken

DY	T2M_MAX	T2M_MIN		WS10M	Ir	DNI
1	19.42	10.93	292.42	2.63	8.44	8440
2	20.48	11.98	293.48	3.28	8.86	8860
3	21.35	11.35	294.35	2.78	8.61	8610
4	20.86	10.52	293.86	2.37	7.8	7800
5	20.65	6.98	293.65	2.89	7.31	7310
6	22.17	6.4	295.17	2.45	7.14	7140
7	24.01	7.24	297.01	2.44	7.76	7760
8	20.88	11.73	293.88	3.76	8.64	8640
9	19.7	6.55	292.7	3.52	7.1	7100
10	17.81	3.5	290.81	2.54	6.15	6150

Vol. 04, Issue 06, June 2024, pp: 532-542
e-ISSN : 2583-1062
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ESTIMATION OF OPTICAL EFFICIENCY

η_o = Ɣ𝜌ƏƐ=0.891

Ɣ=1-Ar/Aa=0.997, =0.94, Ə=0.97, Ɛ=0.98

ESTIMATION OF HEAT ENERGY RECEIVE IN RECEIVER

Qr= η_o*DNI*Aa Qr =0.891*1089.171*19.63= 19049.95159 watt

ESTIMATION OF THERMAL LOSSES

Dimensional parameters

Concentrator Parameters	
Diameter (m)	5
Depth (m)	0.2
Reflectivity (-)	0.94
Focal Length (m)	7.81
Rim Angle (rad)	0.32
Aperture's Area (m^2)	19.63

Table dimensional parameters of csp system (4)

Conduction heat loss

$Q_{cond} = (T_{cav} - T_{amb})/\log_e[(d_{cav}/2+\delta_{in})/(2\,\pi K_{ins} L_{cav})$ [2]

Tcav= 1670.29 K

Tamb= 295.8674

Ɛr=0.86 ,0.88,0.91,0.93,0.18,0.12

At=0.05 m^2 $\sigma = 5.67*10^{-8} w/m^2k^4$

Temperature of cavity is depend on the emmisivity of reciever as well so with the variation the different temperature of reciever cavity is calculated with the help of ms -excel

Ɛ	0.86	0.88	0.91	0.93	0.12	0.18
Qcond	189.62	188.4	186.64	185.51	324.7	291.21

Q_{cond} =

The conduction losses from body to environment reduced with reduction in emmicivity of receiver

The Convection Loss

$Q_{convection} = H_{total}.\ A_{cav}(T_{cav} - T_{amb})$ [2]

$H_{total} = h_{natural} + h_{forced}$

$h_{forced} = 0.1967 .\ v^{1.849}$,

$h_{natural} = Nu.\ \lambda/d_c$

Nusselt number (NU) =0.88Gr1/3 (Tcav/Ta)0.18 .cos(ɵ)2.4.(dap/dcav) $^{-0.982(dap/dcav)+1.12}$

Gr= grasoff number

ɵ=0.89 rad

Dap= dia of arpeture 0.25m

Dcav =0.15

Gr = {g. βair.(Tcav- Tamb). Lcav^3 . ρair} / μ^2}

βair = 1/Tcav   ,

Tcav= 1670.29 K

Tamb= 295.8674

βair= 0.000358

Lcav=length of cavity 0.1

ρair=1.125kg/m3

μ= viscosity of air =1.8110^(-5) kg/m-s

Gr= 41454542

Nusselt number

(NU) =0.88Gr1/3 (Tcav/Ta)0.18 .cos(ɵ)2.4.(dap/dcav) $^{-0.982(dap/dcav)+1.12}$

NU= 10.11976746

h_{forced} = 0.1967 . v $^{1.849}$, V=wind velocity = 3.67m/s, h_{forced}= 2.5638,

$h_{natural} = Nu.\,\lambda/$, λ=thermal conductivity of air=0.024

$h_{natural}$= 0.971498, H_{total}= $h_{natural}$+ h_{forced} , H_{total} = 3.535297

$Q_{convection}$.= H_{total}. A_{cav}(T_{cav} -T_{amb})

Acav=0.24

Ɛ	0.86	0.88	0.91	0.93	0.12	0.18
Qconv	191.1331	189.9075	188.1331	186.9903	327.1761	293.4475

The reduction in losses is convection occurred with reduction in emissivity.

4.3.3 The Radiation Losses

$Q_{radiation}$= $\mathcal{E}_{eff}.\,A_{cav}.\,\sigma.\,(T_{cav}{}^4\text{-}\,T_a{}^4)$ [4]

$$\mathcal{E}_{eff} = \frac{1}{\left[1+\left(\frac{1}{\mathcal{E}_c}-1\right).\frac{Aap}{Acav}\right]} \quad [4]$$

$\mathcal{E}_c$= 0.86,0.88,.91,0.93,0.18,0.12,

$\mathcal{E}_{eff=}$0.786585, A_{cav}=0.24, Aa=19.63

σ = 5.67*10^{-8}w/m^{2}k^4 , Tcav= 1670.29 K, Tamb= 295.8674

Ɛ	0.86	0.88	0.91	0.93	0.12	0.18
Qrad	6280.01	7228.79	9347.02	11616.30	1072.46	1149.76

Q_{rad}=

The reduction in losses is convection occurred with reduction in emissivity

TOTAL HEAT LOSS OF SYSTEM

Q_L=Q_{cond}+Q_{conv}+Q_{rad}

Ɛ	0.86	0.88	0.91	0.93	0.12	0.18
Total heat losses (watt)	6660.76	7607.10	9721.80	11988.80	1724.34	1734.41

Heat losses has been calculated similarly formulating in ms –excel and the reduction in losses is found with reduction in emmesivity of the absorber cavity.

4.4 Estimation of the efficiency of the system

The efficiency of the receiver described its ability to transfer heat from the cavity to absorber of starling engine is Ƞthermal=$\frac{Qr-QL}{Qr}$ = 0.55

Ƞo= Ɣρ϶Ɛ= 0.891

Ɣ=The efficiency due to shading loss is therefore calculated as Ɣ = (1-Aa/Ar)

Ƞgen=50% ....[1].generator efficiency from research paper

Ƞengine=70%.....................[1] consider the efficiency of sterling engine from the system describe in research paper 1

The total efficiency of the system is the multiple of all the efficiencies.

$Ƞ_{Total}$=$Ƞ_o$*$Ƞ_{thermal}$*$Ƞ_{gen}$*$Ƞ_{engine}$ [1]

Ɛ	0.86	0.88	0.91	0.93	0.12	0.18
$Ƞ_{thermal}$	95.87%	95.28%	93.97%	92.56%	98.93%	98.92%
$Ƞ_{Total}$	29.90%	29.71%	29.30%	28.86%	30.85%	30.85%

The overall system efficiency is matched with base papers reading at 0.86 emissivity to validate the calculations and further calculation is establish in Ms –excel to elaborate the calculations in order to find the best possible results in term of power output.

4.5 Estimation Power output of the system

The overall efficiency of the system is the multiple of all the efficiencies multiplied by the efficiency of the power generator. So that the total efficiency will give us the amount of Power generated in function of the direct normal solar radiation. It would simply be the product of the total efficiency, the total area of the collector Aa and the DNI.

P= η_{Total}* Aa* DNI*

Aa=19.63, DNI= 1089.171w/m^2

Ɛ	0.86	0.88	0.91	0.93	0.12	0.18
power output	54049.48	53718.26	52978.12	52184.67	55777.23	55773.70

the over all efficiency and power output of the system is calculated with the emissivity of 0.86 as taken from literature review and the effect of the emissivity is determined by taking various emissivity of the material in to the accounts.

5. RESULTS AND DISCUSSION

Location and Monthly Weather Data of the Site on a Specific

The simulation shall be conducted under ALL conditions to test the reliability of the model. The site used for the Excel calculations is JABALPUR (M.P)with a latitude of 23°11'9.18". The day simulated is a ALL day, JAN – DEC of 2023. The direct normal irradiance, ambient temperatures as well as wind speeds have been extracted from historical weather data. The data has been analyzed on an hourly basis to evaluate the variation of the thermal efficiency of the receiver and the total electrical output of the system at different times of the day AND MONTHS. Our model tests the Dish Stirling system performance from JAN to DEC . The collected weather data as summarized in the table below.

Monthly average Weather of year 2023

Table 5.1 Solar Data Jabalpur

MONTH	DNI (W/m²)	Ambient Temperature-Ta	Wind Speed (m/s)-V
JAN	7624.193548	295.8674194	3.887419355
FEB	7530.344828	300.5593103	4.102068966
MAR	8666.774194	305.8554839	4.076129032
APR	9341.666667	312.4516667	4.707333333
MAY	10074.51613	315.2848387	5.409354839
JUN	10905.33333	307.3463333	5.710333333
JUL	10808.3871	304.6806452	4.731612903
AUG	10825.48387	302.7006452	5.336774194
SEP	10361.33333	303.3146667	3.520333333
OCT	9188.709677	302.2793548	3.291612903
NOV	7663.333333	300.2863333	3.096000111
DEC	7469.032258	299.2341935	3.047741935

Calculation of Solar Position and Monthly Incident Angles The input angles for trigonometric built-in functions on Microsoft Excel take angles in radians; that is why, the latitude of the site and the solar incident angles must be converted to radians. The incident angles are exactly the altitude angles (t) of the monthly fixed system since we assume that the Dish Sterling is constantly oriented towards the sun. On the 21st December, the sun will rise 80° east of due south and set 80° west of due south. On the 21st March/21st September, the sun will rise 91° east of due south and set 91° west of due south. On the 21st June, the sun will rise 102° east of due south and set 102° west of due south. Figures shown in degrees from vertical

Table5.2

Jan	Feb	Mar	Apr	May	Jun
51°(0.89rad)	**59°(1.02rad)**	**67°91.16rad)**	**75°(1.30rad)**	**83°(1.44rad)**	**89°(1.55rad)**
Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
83°(1.44rad)	**75°(1.30rad)**	**67°(1.16rad)**	**59°(1.02rad)**	**51°(0.89rad)**	**44°9(0.76rad)**

Jabalpur Optimum Tilt of Solar collector by Month

Table solar inclination monthly

Sizing of the Parabolic Dish and Receiver The simulation conducted is done on a 5-m diameter parabolic dish Stirling system with a concentration ratio of 400. Therefore its receiver's diameter is approximately 25 cm.

$C = Aa/ Ar = Da2/ Dr2 = 400$, so $Dr = \sqrt{Da^2\ C}$ Since the cavity is similar to a conical shape, let us estimate the diameter of the lower base of the cavity to $dcav = 3\ 5\ Dr$. The diameter of the cavity is then equal to 15 cm.

Calculation of Geometric Metrics of the Collector Relying on the equations stated in section, we calculate the geometric metrics of the receiver and the parabolic concentrator.

Table5.3

Concentrator Parameters	
Diameter (m)	5
Depth (m)	0.2
Reflectivity (-)	0.94
Focal Length (m)	7.81
Rim Angle (rad)	0.32
Aperture's Area (m^2)	19.63

Characteristics and Sizing of the Receiver The results showing the characteristics of the receiver upon which the simulation is conducted are as in the following table. In fact, to minimize heat losses through radiation, the cavity walls are insulated with an insulator of conductivity k.

Table5.4

Receiver Parameters	
Receiver's Diameter (m)	0.25
Receiver's Radius (m)	0.13
Receiver Aperture's Area (m^2)	0.05
Thermal Conductivity of Insulation k (W/m.K)	0.04
Thickness Insulation (m)	0.05
Emissivity of Cavity	0.86
Cavity Length (m)	0.1
Cavity Diameter (m)	0.15
Cavity Radius (m)	0.075
Effective Absorptance	0.24
Cavity Area (m^2)	0.024

Table Sizing and Characteristics of the Receiver

COMPUTATION OF EFFICIENCIES

Calculations of efficiencies and output of system

Variation in thermal efficiency of the receiver and power output of system.

Monthly average of all the data calculated is considered for displaying of results . Results are summarized in the form of tables and respective graphs are produced to elaborate the results of performance of solar disc in Jabalpur (M.P.)

Vol. 04, Issue 06, June 2024, pp: 532-542
e-ISSN : 2583-1062
Impact Factor: 5.725

This work is focused on 1: calculation of thermal performance of solar parabolic disc . 2 : evaluation of effect of receiver emissivity on solar parabolic disc.

Emissivity is an important parameter for the evolution of performance of solar parabolic disc collector. Radiation losses are the major loss in the system. So higher emissivity cause the increment in radiations losses and reduce the thermal efficiency and power-output of the system. So lower emissive material is a better solution to improve the performance of the system in present work various emissivity materials are tested analytically the emissivity of material considered are.-

Table5.5

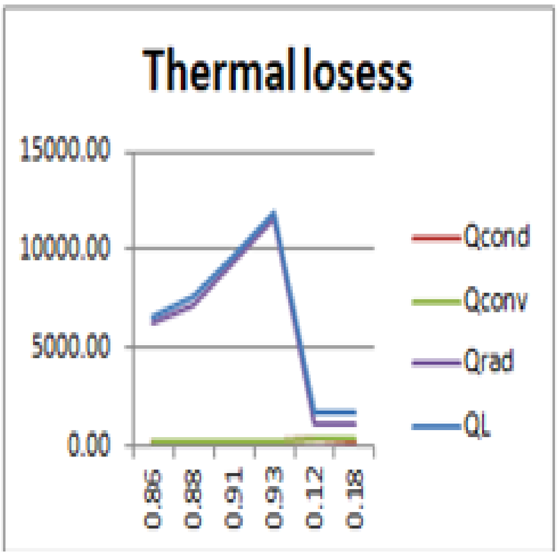
s.n.	Ɛ	MATERIAL
1	0.12	black NICKEL GLAVNIZED IRON
2	0.18	hastelloy X
3	0.86	Stainless steel
4	0.88	Asphalt
5	0.91	Concrete
6	0.93	Quartz glass

Table 5.6 Absorber Materials

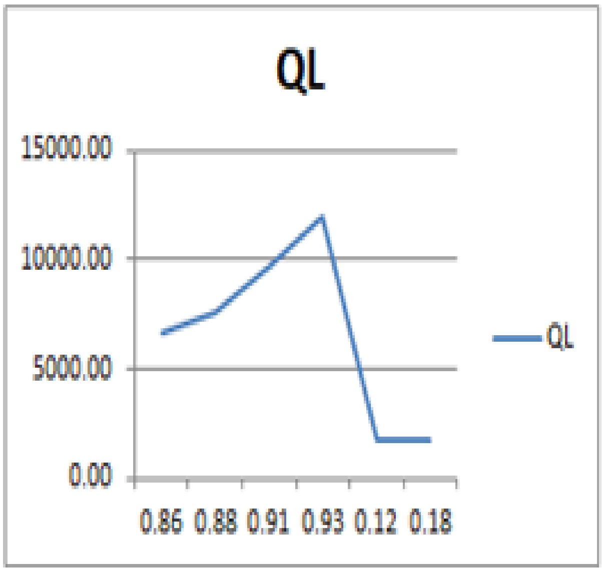
s.n.	Ɛ	Qr	Qcond	Qconv	Qrad	QL	Ƞthermal	Ƞsystem	power output
1	0.86	161087.85	189.62	191.1331	6280.01	6660.76	95.87%	29.90%	54049.48
2	0.88	161087.85	188.40	189.9075	7228.79	7607.10	95.28%	29.71%	53718.26
3	0.91	161087.85	186.64	188.1331	9347.02	9721.80	93.97%	29.30%	52978.12
4	0.93	161087.85	185.51	186.9903	11616.30	11988.80	92.56%	28.86%	52184.67
5	0.12	161087.85	324.70	327.1761	1072.46	1724.34	98.93%	30.85%	55777.23
6	0.18	161087.85	291.21	293.4475	1149.76	1734.41	98.92%	30.85%	55773.70

And further calculations were made to optimize the performance.The results are elaborated in table and graphs.

emissivity v/s performance parameter



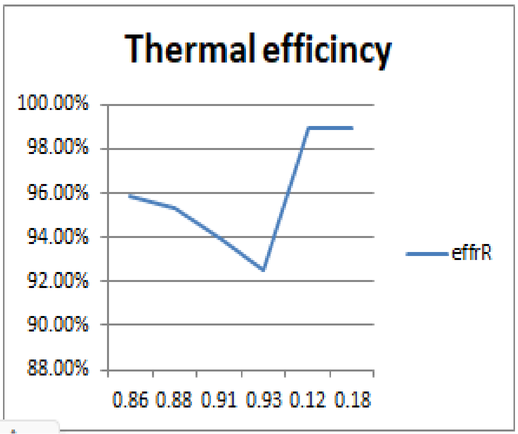
Thermal Losses

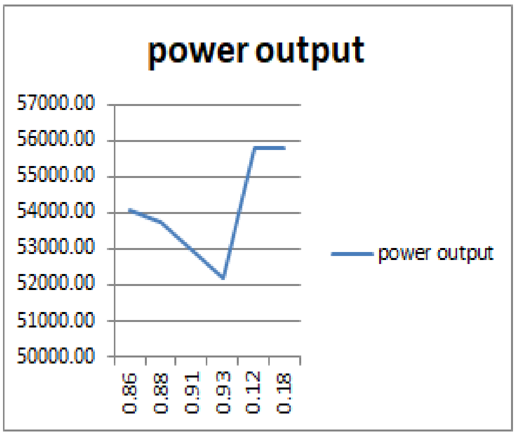


Overall Heat Loss

Conductive and convective losses reduces with increase emissivity but radiative losses increases.

Overall heat loss is a additive of the all losses : Qcond+Qconv+Qrad=QL Total heat loss from the system increase with increment in emissivity so that material with lesser emissivity should to be consider in design.





Thermal efficiency power output

Thermal efficiency and power output increases during reduction in emissive value of receiver material.

6. CONCLUSION

In his research, a method was proposed to increase the performance by calculating various parameters to increase the output power. Power loss is the main loss in the system. Therefore, a higher emission leads to more electricity and reduces the thermal efficiency and energy output of the system. Therefore, low energy products are a better solution to increase performance. Conduction and convection losses decrease with increasing emission, but electrical loss increases.

Total heat loss from the system increase with increment in emissivity so that material with lesser emissivity(black NICKEL GLAVNIZED IRON) should to be consider in design & also the material which can sustain under higher temperature occurred for the receiver cavity. So considering that material having emissivity of 0.18 (hastelloy X) is better solution because it can sustain under high temperature about 2800 K."

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