Asian Journal of Research № 1-3, 2020
IMPACT FACTOR
SJIF 6,1
IFS 2,7

ISSN 2433-202x
JOURNAL DOI 10.26739/2433-202x
www.journalofresearch.asia
info@journalofresearch.asia

DETERMINATION OF THE SIZE AND AMOUNT OF ENERGY INCIDENT ON THE REFLECTIVE SURFACE OF A PARABOLIC CYLINDER CONCENTRATOR

Jobir Kodirov
(PhD student, Bukhara State University)
Saidova Rano
Lecturer, Department of Physics, Bukhara State University
Sabina Khakimova
(Assistant of the Bukhara branch of the Tashkent Institute of Irrigation and Agricultural Mechanization Engineers)
Bakhshilloev Mironshokh
Student of the department "Physics" Bukhara branch of the Tashkent Institute of Irrigation and Agricultural Mechanization Engineers

http://dx.doi.org/10.37057/2433-202x
Issue DOI http://dx.doi.org/10.37057/2433-202x-209-2020-1-6
Article DOI http://dx.doi.org/10.37057/2433-202x-2020-1-6-29

Abstract: This article discusses the use of parabolic cylinders, as well as provides a method for calculating the focal length required to determine the size and amount of energy incident on the reflective surface of a solar installation.

Keywords: parabolic cylindrical concentrator, technology, parabola, function, focus, energy, solar radiation, amount of energy.

Over the past decades, the growth of the manufacturing industry around the world has led to a high demand for alternative sources, especially in the transport and agricultural sectors. Studies on the optimization of the geometric dimensions of the

Asian Journal of Research № 1-3, 2020
IMPACT FACTOR
SJIF 6,1
IFS 2,7
ISSN 2433-202x
JOURNAL DOI 10.26739/2433-202x
www.journalofresearch.asia
info@journalofresearch.asia

structural elements of a solar installation based on the accumulation of solar energy are not adequately covered in the scientific literature. Today, in regions where there is a lot of solar energy, especially in Central Asia, searches and studies in the field of the use of solar energy and the accumulation of solar radiation in parabolic cylinders in the national economy are of practical importance.

An analysis of the scientific literature shows that the creation of parabolic cylindrical concentrators, from an energy point of view, is hindered by a complex of problems:

- having an effective energy source;
- creation of metrological conditions;
- creation of normal conditions for operation;
- maximum collection of scattered solar energy in one place.

Everyone knows that in parabolic cylinders, both alternative and traditional energy sources can be used. It should be noted that the use of solar radiation in parabolic cylinders not only saves natural fuel, but also prevents environmental pollution, that is, does not harm the environment.

This paper presents a methodology for determining the rational geometric dimensions of the design of parabolic cylinders. And the relationship of the heat engineering parameters of parabolic cylindrical concentrators from the rational sizes and shapes of the chosen design has been developed.

Based on parabola function $y^2 = 2px$ can be deduced Y: $y = \sqrt{2px}$, with the help of which the following function is found:

$$y = \frac{x^2}{500} \qquad (1)$$

Here, $x^2 = 500y$ that is, 2p=500, if then p=250.

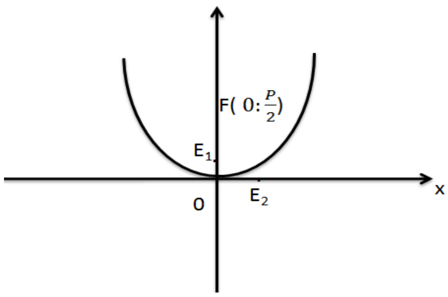

Fig. 1 General view of the parabola

Asian Journal of Research № 1-3, 2020
IMPACT FACTOR
SJIF 6,1
IFS 2,7

ISSN 2433-202x
JOURNAL DOI 10.26739/2433-202x
www.journalofresearch.asia
info@journalofresearch.asia

In the case when the focus is located on the ordinate OY at the point $F(0:\frac{p}{2})$ (Fig. 1), the focal length of this parabola, if we substitute the value of p, will be equal to $F\left(0:\frac{250}{2}\right)$ or $F(0:125)$.

Using tangents to a function $y = \frac{x^2}{500}$ we prove that the focal length lies at the point $F(0:125)$ To do this, we draw the tangent function at the point x_0=50 and use the equation of this tangent:

$$f(x) = y(x_0) + y'(x_0)\cdot(x - x_0) \qquad (2)$$

where $y(x_0) = \frac{2500}{500} = 5$

$$y'(x) = \frac{x}{250} = \frac{50}{250} = \frac{1}{5}$$

Substitute the found values in the equation of the tangent (2) and solve it:

$$f(x) = 5 + \frac{1}{5}(x - 50) = 5 + \frac{x}{5} - 10 = \frac{x}{5} - 5$$

It follows that

$$f(x) = \frac{x}{5} - 5. \qquad (3)$$

Since the value of the derivative at the point of tangency is the angular coefficient of the tangent, and it is equal to the tangent of the angle of inclination:

$$tg(90 - \beta) = \frac{5}{25} = \frac{1}{5} \qquad (4)$$

hence the angle of inclination of the tangent is

$$ctg\beta = \frac{1}{5}, \text{ то there is } tg\beta = 5 \qquad (5)$$

We define the function g (x), which passes through the point (50: 5) and makes the angle β between the tangent and the function f (x). Let's pretend that

$$g(x) = kx + b\,. \qquad (6)$$

Crossing a point (50: 5), this function takes the value 5 = 50k + b.
We use the formula for determining the angle between two straight lines:

$$\left|\frac{k - \frac{1}{5}}{1 + \frac{1}{5}}\right| = tg\beta \qquad (7)$$

Substituting the tangent of the tangent angle (5), we will have two solutions:

Decision 1. $\left|\frac{5k-1}{k+5}\right| = 5$

ISSN 2433-202x
JOURNAL DOI 10.26739/2433-202x
www.journalofresearch.asia
info@journalofresearch.asia

$$\frac{5k-1}{k+5}=5$$

$5k-1=5k+25$

$-1\neq 25$, that is, it has no solution.

Decision 2. $\frac{5k-1}{k+5}=-5$

$$5k-1=-5k-25$$

$$10k=-24$$

$$k=-2.4$$

We substitute the found value of the coefficient into the function g (x) (6)

$$5=50\cdot(-2.4)+b$$

$5=-120+b$

$$b=125$$

Therefore, the general form of the function has the form:

$$g(x)=-2.4x+125 \qquad (8)$$

Define the coordinates of the intersection point of the function with the ordinate

$$g(0)=-2.4\cdot 0+125=125.$$

That is (0; 125), then F (0; 125). This means that the focal length is F = 125. Using mathematical calculations, we determined the focal length F = 125 of the function $y=\frac{x^2}{500}$. To confirm, we use the chart drawn using the Maple program (Fig. 2). To do this, enter the above equations and their values into the program database, which will give the following graph.

ISSN 2433-202x
JOURNAL DOI 10.26739/2433-202x
www.journalofresearch.asia
info@journalofresearch.asia

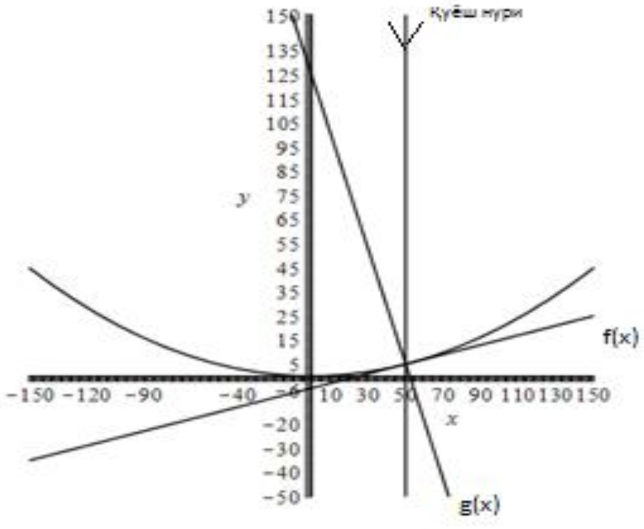

Fig. 2 Graph of function and tangent drawn on Maple

Using the features with $y(x) = \frac{x^2}{100}$ by $y10(x) = \frac{x^2}{1000}$ build their graphs on the MathCad program to determine the values of x and y:

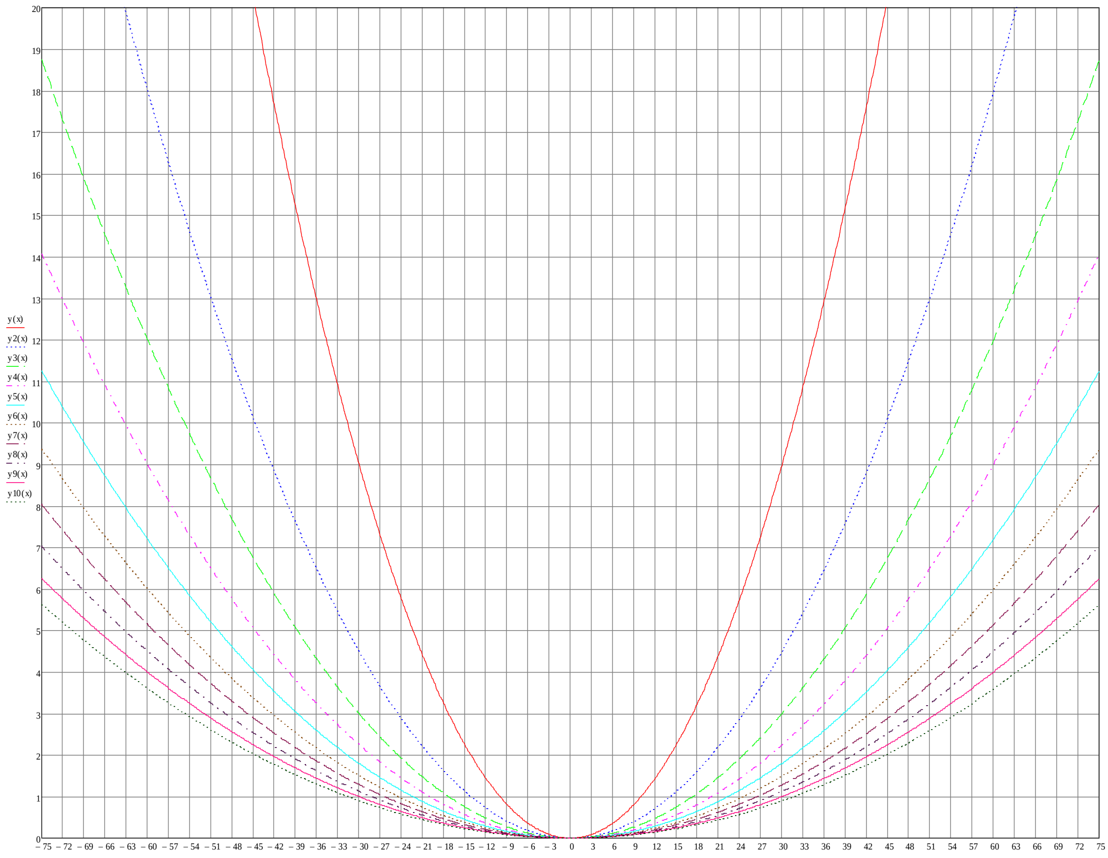

Fig. 3 Function graphs drawn on MathCad

ISSN 2433-202x
JOURNAL DOI 10.26739/2433-202x
www.journalofresearch.asia
info@journalofresearch.asia

From function (1), p = 250 and F = 125 cm were found. The area of the graphs drawn using the MathCad program (Fig. 3), namely the abscissa length, was taken as x = 75cm. We substitute this value into $x^2 = 2 \cdot 250y$, we get y = 11.25.

From the found values, we determine the amount of energy incident on the surface area of 1 m^2, using the following formulas:

$$Q_{раб} = cm\Delta t + m\lambda \qquad (9)$$

$$m[c(t_2 - t_1) + \lambda = Q_{раб}] \qquad (10)$$

$$m = \frac{Q_{раб}}{c(t_2 - t_1) + \lambda} \qquad (11)$$

The data obtained are given in table 1.

Table 1. Table of direct scattered solar radiation values arriving in July on a horizontal surface with a cloudless sky, depending on the area of the concentrator

№	P (см), function related parameter $y = \sqrt{2px}$	$F(0:\frac{P}{2})$ (см), focal length	S ($м^2$), hub area	X (см), abscissa lengths	Qₒ (МДж/(sq. m • day), solar radiation entering a horizontal surface	Qраб (МДж/(sq. m • day), the amount of energy passing through the reflective surface of the concentrator
1	50	25	0,67	67	15.63	14.54
2	100	50	0,95	95	22.16	20.60
3	150	75	1,16	116	27.06	25.17
4	200	100	1,34	134	31.26	29.07
5	250	125	1,5	150	35	32.55
6	300	150	1,64	164	38.26	35.58
7	350	175	1,77	177	41.29	38.40
8	400	200	1,90	190	44.33	41.23
9	450	225	2,01	201	46.90	43.62
10	500	250	2,12	212	49.46	46

The table shows that the amount of direct scattered solar radiation entering a horizontal surface with a cloudless sky directly depends on the size of the concentrator structure. Using the obtained results, based on mathematical calculations, we made a solar installation in order to conduct research. The experimental setup in the form of a parabolic-cylindrical concentrator was made on the basis of the parabola function $Y^2 = 4500 * X$. To do this, originally wooden

ISSN 2433-202x
JOURNAL DOI 10.26739/2433-202x
www.journalofresearch.asia
info@journalofresearch.asia

planks measuring 2.4 m in length and 2 m in width were parabolic in shape. They served as the foundation for fastening on them two reflective surfaces 2 m long and 80 cm wide. 30 cm of space were left between them, because there is a focus on top and reflective radiation should not fall from it. On the stand of the concentrator, whose height is 1 m, levers are attached, the purpose of which is to manually adjust the position of the device depending on the location of the Sun. These levers can change the height of the hub supports that support it from all sides. Total surface area 3.2 m^2

Fig. 4 Appearance of parabolic cylindrical hub

Having mounted the solar installations in certain places, the following work was carried out, namely, from 8 a.m. to 20 p.m., the external temperature and the temperature in focus at both concentrators were measured with a digital sensor every hour. Based on the data obtained, the values of solar radiation, the amount of incoming energy, as well as the mass of water that will be required for heating using the received energy were calculated by calculation. Below are the experimental results.

Table 2. The dynamics of the thermal parameters of the parabolic cylindrical concentrator in the hourly interval of the day in the summer period of time

№	Hourly interval	Outdoor air temperature, °C	The temperature at the focus of the parabolic cylinder concentrator, °C	Solar radiation, W / m2	The amount of energy, MJ * h
					Parabolocylindrical hub
1	8.00-9.00	32	117	418	4.81
2	9.00-10.00	36	137	528	6.08
3	10.00-11.00	42	151	671	7.73
4	11.00-12.00	44	171	770	8.87

5	12.00-13.00	44.5	187	814	9.38
6	13.00-14.00	45	195	825	9.5
7	14.00-15.00	46	199	803	9.25
8	15.00-16.00	48	214	770	8.87
9	16.00-17.00	46	189	605	6.97
10	17.00-18.00	42	174	462	5.32
11	18.00-19.00	40	156	330	3.8
12	19.00-20.00	38	137	154	1.77

Summarizing the above, we came to the conclusion that for the manufacture of an affordable solar concentrator, we needed several methods to theoretically perform mathematical calculations, which were later used in practice. In particular, knowing the focal length, we determined the exact dimensions of the structure and the amount of energy that depends on them, incident on the reflective surface of the parabolic cylinder concentrator. A self-made solar concentrator is suitable for heating water and can be used in domestic conditions when heating a room, supplying hot water to suburban areas. To maximize their effective use, it is planned to supplement our installation with a steam engine in order to generate free electricity, as well as continue experiments on it at other times of the year to determine its efficiency and economic efficiency.

REFERENCES

[1] Dvoretsky A.T., 2002: Geometrical Models of Solar Energy Reflected Flows. The 10th Int. Conf. on geometry and graphics. Vol.1, 124-127.

[2] Sukhatme S. P. (2007), Principles of Thermal Collection and Storage, McGraw Hill Publication.

[3] Alvarez M.R. and Zarza E., ‘Concentrating Solar Thermal Power’, Hand Book of Energy Efficiency and Renewable Energy, pp. 212 - 216,

[4]Fernandez-Garcia A, Zarza E, Valenzuela L, Perez M. Parabolic-trough solar collectors and their applications. Renewable and Sustainable Energy Reviews, 2010, 14, pp. 1695-1721.

[5] Suhatme C. P. (2007), Principles of Heat Collection and Storage, McGraw Hill Publication.

[6] Duffy and Beckman (2005), Solar Thermal Engineering, Fourth Edition

[7]Manuel Romero-Alvarez. Steam turbines for solar thermal power plants. Handbook of Energy Efficiency and Renewable Energy. 2008.

[8] Jobir Kodirov, Sabina Khakimova. Analytical Review of Characteristics of Parabolic and Parabolocylindrical Hubs, Comparative Data Analysis Obtained On them. International Journal of Advanced Research in Science, Engineering and Technology. Vol. 6, Issue 8, August 2019. pp 10535-10539.

ISSN 2433-202x
JOURNAL DOI 10.26739/2433-202x
www.journalofresearch.asia
info@journalofresearch.asia

[9] JR Kodirov, S Sh Khakimova, Sh M Mirzaev ANALYSIS OF CHARACTERISTICS OF PARABOLIC AND PARABOLOCYLINDRICAL HUBS, COMPARISON OF DATA OBTAINED ON THEM. Journal of TIRE № 2, 2019 г. 193-197 pp.

[10] Kodirov J.R., Hikmatov I.I., Mirzaev Sh.M. Creation of solar concentrators and data analysis obtained on them in the summer period under the conditions of the bukhara area. Scientific-technical journal (STJ FerPI, 2020, T.24, №1).

[11] Salim Ibragimov, Ilhom Hikmatov. Experimental verification of the operation of a solar dryer such as an advanced greenhouse for drying grapes. International Journal of Advanced Research in Science, Engineering and Technology. Vol. 6, Issue 9 , September 2019, P.1873-10880.

[12] I.I. Rakhmatov, Investigations into kinetics of sun drying of herb greens. Applied solar energy. T. 31. (1995) № 5. pp. 61-66

[13] K. A. Samiev, Sh. M.Mirzaev, M.S.Mirzaev. Experimental Study of Distance between Evaporator and Condensate of Inclined Multistage Desalination Plan. Applied Solar Energy. January 2019, Volume 55, Issue 1, pp 36-40.

[14] J.S. Akhatov, K.A. Samiev, M.S. Mirzaev, A.E. Ibraimov. Study of the Thermal Technical Characteristics of a Combined Solar Desalination and Drying Plant. Applied Solar Energy. January 2018, Volume 54, Issue 2, pp 119-125.

[15] Boidedaev S. R., Dzhuraev D. R., Sokolov B. Yu., Faiziev Sh. Sh. Effect of the Transformation of the magnetic structure of a $FeBO_3$:Mg crystal on its magnetooptical anisotropy. Optics and Spectroscopy, 2009, Vol. 107 No. 4 -P. 651-654

[16] D. R. Dzhuraev, B. Yu. Sokolov, and Sh. Sh. Faiziev. Photoinduced changes inthe space-modulated magnetic order of a $FeBO_3$:Mg single crystal. Russian Physics Journal, 2011, Vol. 54, №3, -P 382-385.

[17] Sh.Sh.Fayziev. Effect of light on the modulation of the magnetic order of the $FeBO_3$:Mg crystal. «Young Science». 2017, No.28, P.8-11

[18] Sh.Fayziev. Investigation of the magnetic structure of $FeBO_3$:Mg. III international scientific conference of young researchers. 2019. No.1, P. 105-107

[19] D.R. Dzhuraev, Sh. Fayziev, B.Yu. Sokolov. 'Magnetic ripple' in rhombohedral $FeBO_3$:Mg crystal. Proceedings of fourth international conference dedicated to the eightieth anniversary of academician M.S. Saidov 'Fundamental and applied problems of physics'. 2010. -P. 342-344