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# Automation problems of finding the optimal coordinates of a photocell in a selective radiation photothermogenerator

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**ABSTRACT**: The paper presents the results of a study on the design of highly efficient samples of a photothermogenerator. The effectiveness of combined designs of light and heat energy converters is indicated. A method for creating a combined photothermal converter with a high value of the solar cell efficiency has been found. A new design of a highly efficient combined converter operating on selective photoactive radiation with a movable gap is presented. An automation algorithm for finding the coordinates of a solar cell is given. Theoretical methods for the automatic selection of photoactive radiation and determining the location of the solar cell in the construction of a photothermal converter using controllers are indicated.

**KEY WORDS**: photothermal converter, combination, automatic spectral distribution, photocell autofocus, selective radiation

## I. INTRODUCTION

The use of information and communication technologies in scientific research and in the process of visualizing results is one of the most effective research methods. This is the result of the fact that modern information technologies make it possible to obtain and save a large amount of data, perform fast data processing, automate technical calculations, obtain results in several versions, visualize the results and predict situations.

In previous papers [1–5], based on theoretical and empirical analyzes of diffraction phenomena, radiation dispersion, and the characteristics of an absolutely black body, a photothermoelectric method [6–10] was proposed for converting light energy. A new design for a highly efficient selective light photothermogenerator, and a combination design of device with a movable slot was recommended. In the present work, a method for determining the coordinates of the optimal point of a solar cell using information technology is given.

Determining the optimal coordinates for the photocell of the protective unit is a difficult task. With optimal placement of the photocell in the spectral space, the following factors must be considered:
1. The absence of initial and final boundaries of the spectral ranges gives rise to difficulties in determining the coordinates of the gap;
2. As shown in previous works [3], the secondary monochromatization system will lead to the bulkiness of the protection blocks of the photothermogenerator. And the absence of a secondary monochromatization system will result in non-photoactive rays reaching the photocell surface or in the scattering of photoactive rays due to the not constant spectrum width in the space between the prism and the gap.

## II. RELATED WORKS

Today, leading research centers focus on research aimed at improving the efficiency of hybrid systems of photo- and thermoelements. While a group of researchers led by Italian scientist F. Ativissimo described the theoretical features of hybrid systems consisting of photovoltaic and thermoelectric elements[7], Pakistani authors S. Ahmad, M. Javed and others experimentally determined that the efficiency of polycrystalline silicon can be increased by 7 % using thermoelectric elements [6]. Indian scientists M. Singh and others have been able to increase the efficiency of solar panels to 81% using a hybrid system consisting of concentrators, autonomous solar panels and thermo generators [8]. Y.

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Biser and others in their research studies used a holistic approach to encompass all processes and their interactions in the solar cell; such as photon: photon transfer, reflection and spectral absorption, background (black body) radiation at a cell temperature; electric: electronic excitation to create a photocurrent, electron-dipole recombination, transfer of electricity to an external load; heat element: internal heat through shunt and series resistances and heat through convection [11].

## III. TECHNICAL PART OF THE SYSTEM

A photothermogenerator of selective radiation, constructed on the basis of the circuit shown in Fig. 1, converts photoactive sunlight into electrical energy. To do this, the light stream 1 emanating from the source is converted into a parallel beam of rays using a set of lenses (collimator) 2 and transmitted to prism 3 for dispersion. The rays of light are separated into the spectrum due to the composition with different wavelengths [11], [12]. The photoactive part of the spectrum for the current photocell is transmitted to a special block through a movable slit 4. Reflectors 5 direct the scattered rays into the block.

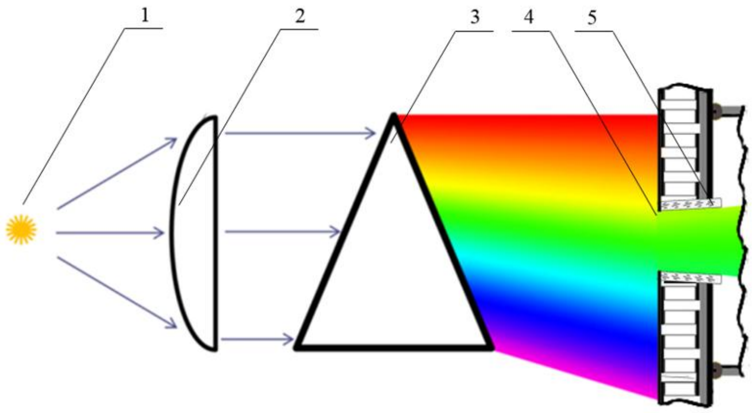


Fig. 1. Photothermogenerator: separation of light into a spectrum.
1-light source; 2-set of lenses (collimator); 3-dispersion prism; 4-slot; 5-reflector.

The design of the movable slit is shown in Fig. 2. The surface of the block, consisting of thermoelement 2, cooling system 3, cold junctions of the thermoelement and the surface of the protextion block, reflectors 4 and slots is moved using low power engines. A slit moving along the spectrum, placed on the surface of the block, allows a monochromatized light beam to penetrate into the block. A transmitted light beam can be directed to the photocell in several ways. One of them is the movement of the photocell with a slit. In addition, based on the horizontal position of the slit, it is possible to send a beam passing through it to a fixed photocell in the form of parallel light fluxes. For this, a collimator with an adjustable angle of inclination is used.

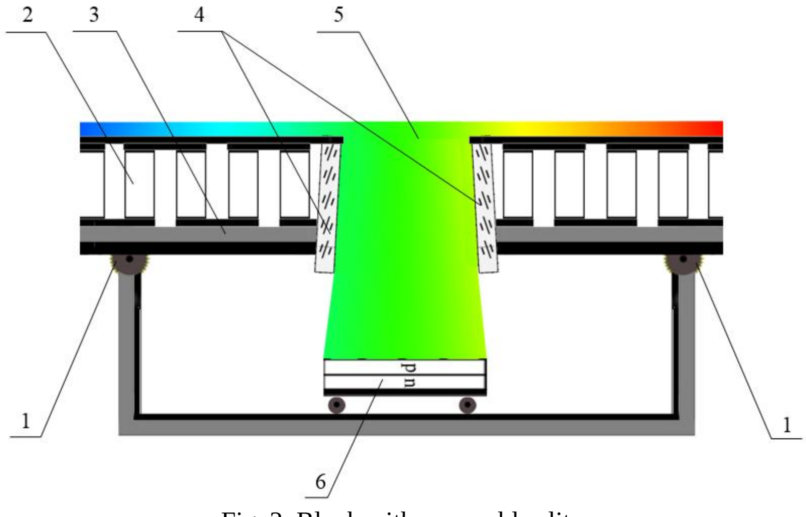


Fig. 2. Block with a movable slit.

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1-motors for moving the block surface; 2-thermoelements; 3-cooling system; 4-reflectors; 5-slit; 6-cell with moving substrate.

## IV. FORMULATION OF THE PROBLEM.

At first glance, determining the photoactive ranges of the spectrum and the direction of rays with specific wavelengths on the surface of the photocell seems to be a simple technical task. But in this process, several physical and technical factors must be taken into account (Fig. 3).

Creating parallel to the height h from the angle γ of the prism of the light flux. This problem arises due to the continuously horizontal and vertical changes in the coordinates of the sun. The solution of this problem makes it possible to obtain maximum power value for a given photocell. As a result, the efficiency The used photocell reaches its maximum value. In the form of a technical solution to this problem, you can use the sun tracking system - the solar tracker [13], [14]. Currently, work is underway to create a new system for tracking the sun (Fig. 4).

Due to the difference in the values of the refractive index n and the angle γ of the model prism, the value of the width of the spectrum L at a distance M from the prism is not constant. The reason for the difference in the width of the spectrum at different points of the same range is its trapezoidal shape. In the conditional range λϵ (λ_1; λ_2) of the light spectrum, the width of the spectrum L_λ changes for different values of M_λ of the distance M between the prism and the slit. I.e

$L_{M_1} \neq L_{M_1+M_2}$

If the length of the photovoltaic element lΦ and the length of the slit l are considered equal, then it is necessary to determine the distance M and the coordinate 〖y = h〗 _ (λ_M) corresponding to the conditional upper limit of the light spectrum for the condition l = L_M.

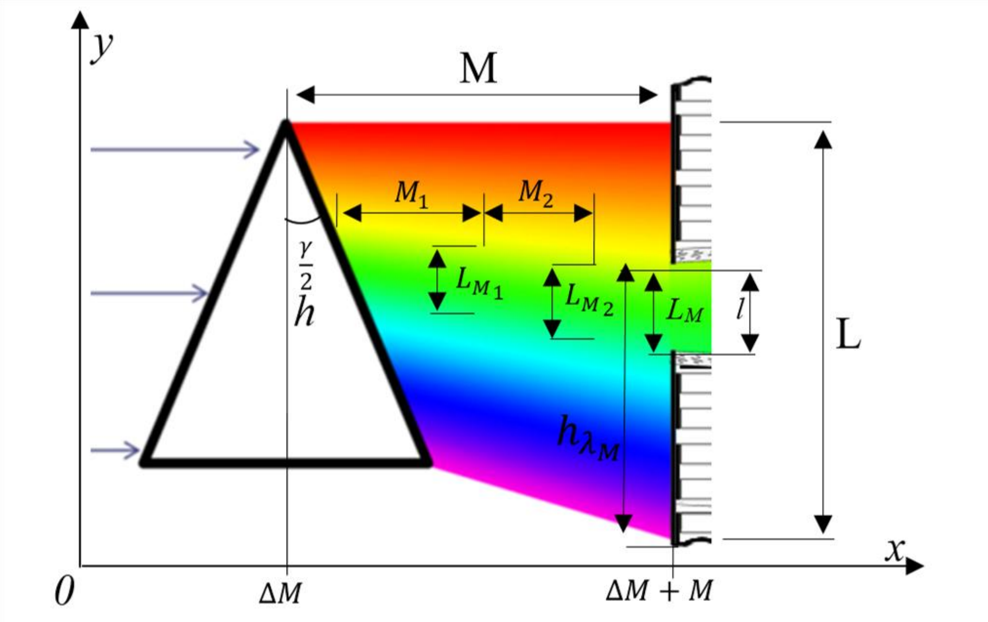


Fig. 3. Technical and physical quantities for the process of selection of spectra.

It is known that the refractive index of a medium n is a relative quantity that can have different values for materials of the same type if different technologies or technological parameters are used in them. In addition, the refractive index of the prisms of a single sample can also vary with temperature. This factor leads to a decrease in the efficiency of the stationary photothermogenerator even with an optimal arrangement.

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## V. TECHNICAL METHODOLOGY OF SOLUTION

Trying to solve the above problems physically or mathematically, we must perform complex mathematical modeling. This is difficult due to the fact that the size of the factors influencing the process is very large, and the influence of these factors is not constant. The main thing is that the results of the created mathematical or physical modeling are not completely consistent with the real results. Therefore, the best solution in this case is to create a technical device that will continuously recalculate the coordinates of the block and the slit, analyzing the results obtained in real conditions.
As noted earlier, the perpendicular direction of sunlight on the surface of the photothermal generator is carried out using solar trackers (Fig. 4).


a)


b)

Fig. 4. Uniaxial (a) and biaxial (b) solar trackers.

The second problem can be solved using the algorithm shown in Fig. 5, and a mechanism using this algorithm.

The above software algorithm is designed to determine the optimal value of the coordinates of the block and the gap only along the horizontal axis. An automated system based on this algorithm receives N times an analog signal from a voltmeter while the photocell moves in the spectrum for a certain period of time. The results are written to the array V [i]. At the second stage, the results are compared, the optimal point (coor_x) for the maximum signal value is determined, and the photoelectric element returns to this point. Of course, the described algorithm is individual and does not give the full expected result. An improvement of this algorithm can be achieved by optimizing it (for example, by increasing the number of V [i] values in the set and obtaining a larger number of values (signal) N or by increasing the time and decreasing frequencies for the motion of the photoelement by spectrum) and by organizing algorithms of this type for each process.

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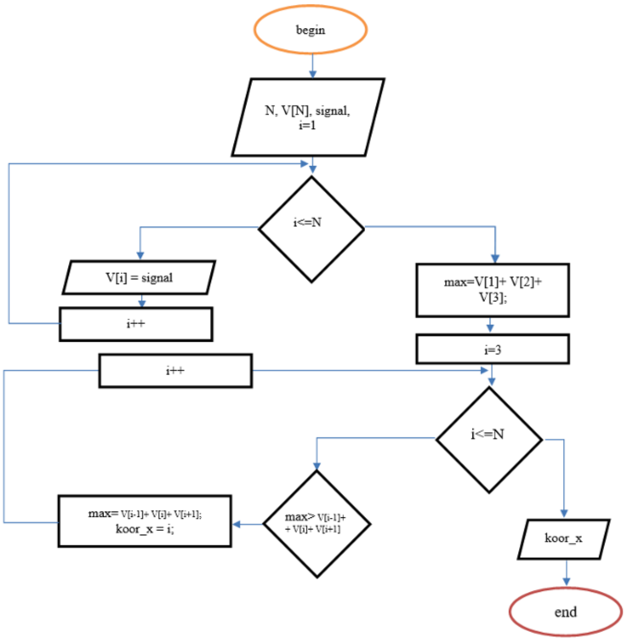


Fig. 5. Algorithm for determining the optimal value of the coordinates of the block and slit along the horizontal axis.

## VI. CONCLUSION

Creating a ray of light perpendicular to the height h from the angle γ of the prism, calculating a constant horizontal and vertical change in the solar coordinate, ensuring the perpendicularity of the light flux on the surface of the photothermogenerator, a physical and mathematical solution of the problem of preventing non-photoactive rays from entering or incomplete absorption of photoactive rays, all this, as already said a rather complicated process.

But the effective use of modern information and communication technologies increases the reliability of the results, allows you to receive, process and quickly receive large volume signals. Most importantly, creating virtual environments saves time and financial resources compared to real experiments.

## REFERENCES

[1]. Kasimakhunova, A.M. and others. (2018) Highly Efficient Conversion of Solar Energy by the Photoelectric Converter and a Thermoelectric Converter. Journal of Applied Mathematics and Physics, 6, 520-529. https://doi.org/10.4236/jamp.2018.63047
[2]. A.M.Kasimakhunova, N.R. Rakhimov, Sh.Yu. Usmonov. A method of producing photothermogenerators. The decision of the state patent examination of 06/18/2002. Application No. IDP 2000 09 10.
[3]. A. M. Kasimakhunova, S. I. Zokirov, M. A. Norbutaev. “Development and research of a new model of Photothermogenerator of selective radiation.” First international congress of the Turkic world on health and natural science. 22-23 april, 2019. Kyrgyzstan.
[4]. A. M. Kasimakhunova, S. I. Zokirov, M. A. Norbutaev. “Development and Study of a New Model of Photothermogenerator of a Selective Radiation with a Removable Slit.” IJARSET. Vol. 6, Issue 4, April 2019, India.
[5]. A. M. Kasimakhunova and others. “Photo Thermal Generator of Selective Radiation Structural and Energetic Features.” JAMP. Vol.07 No.06 (2019). DOI: 10.4236 / jamp.2019.76086
[6]. S.A. Ahmad and others. “Efficiency Improvement of Photovoltaic Module by Thermo Electric Generator.” NIJESR. DOI: 10.24081 / nijesr.2017.1.0011
[7] F.Attivissimo and others. “Feasibility of a Photovoltaic–Thermoelectric Generator: Performance Analysis and Simulation Results”. IEEE transactions on instrumentation and measurement, Vol. 64, No. 5, may 2015
[8] M.Singh and others. “Efficient Autonomous Solar Panel and Thermo-Electric Generator (TEG) Integrated Hybrid Energy Harvesting System”. Progress In Electromagnetic Research Symposium. Shanghai, China, 8–11 August, 2016
[9] J.Chen and others. “Photovoltaic Generation Solar Automatic Tracking System”. IOP Conf. Series: Earth and Environmental Science 170 (2018) 042029 doi :10.1088/1755-1315/170/4/042029
[10] Q.Li, H.Liu. “Design of Solar Energy Automatic Tracking Control System Based on Single Chip Microcomputer”. IOP Conf. Series: Earth and Environmental Science 242 (2019) 022056 doi:10.1088/1755-1315/242/2/022056

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 6, Issue 9, Sep 2019

[11] Yu.Bicer and others. "A holistic approach to thermodynamic analysis of photo-thermo-electrical processes in a photovoltaic cell". Energy Conversion and Management. 27 May 2016. http://dx.doi.org/10.1016/j.enconman.2016.05.090

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