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Determine the amount of heat accumulated at the focal point of the solar oven

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Annotation: This article discusses the methods of creating and effectively using the design of a modern device "Solar oven" based on physical and technical solutions and using scientific advances. The high efficiency of solar radiation returns of the proposed structure and the parameters for calculating the thermal energy concentrated in the focus of the concentrator are discuses. The proposed device and method of obtaining thermal energy in the production of thermal energy is based on environmental friendliness, the differences and advantages of faceted concentrators from integrated concentrators, economic savings in terms of raw materials consumed.

Keywords: Alternative energy sources, wind generators, solar ovens, solar panels, paraboloids, quartz mirrors, concentrators, solar radiation, thermal energy.

At a time when science and technology are advancing, humanity faces four major challenges. The first is food, the second is water, the third is ecology, and the fourth is energy. Today, fossil fuels, oil, coal and natural gas are declining primary energy resources. According to the IX International Energy Conference: 88% of the currently available fuel reserves are coal. The potential reserves of coal are $1.2 * 10^{17}$ kW, oil - $2.14 * 10^{16}$ kW, gas - $1.23 * 10^{6}$ kW [5]. This leads to energy shortages. This leads to energy shortages. It is known that the energy problem is one of the most pressing issues in the world today, and this problem is being supplemented by various alternative energy sources, wind generators, solar ovens and solar panels and other sources. Efficient use of alternative energy sources is being studied by experts from European countries. In particular, various models (USA, Germany, Russia, Spain, France, Switzerland, England, Italy) have been proposed to explain solar panels or solar ovens. Scientists from the Solar Research Institute of the Republic have also considered several classifications of the effect of solar flux on the efficient use of solar panels and determined their effectiveness. Solar panels and solar ovens have been shown to increase efficiency.[6]However, the design of solar ovens is poorly understood. To date, research and projects have been carried out in various constructions. In smaller solar furnaces, such as the GU-2 furnace (a paraboloid mirror with a diameter of 2 m) built in Tashkent, experiments were performed on melting and welding steel, aluminum and their alloys. Heat-resistant materials used in quartz and blast furnaces, open-hearth furnaces and electric arc furnaces were melted in a 2 m diameter projector-type solar furnace (heliostat size 2.5x3 m^2)[1] built in Yerevan. The melting point of these substances is 2000-2600 ^{0}C. This temperature can be easily formed in a solar oven.

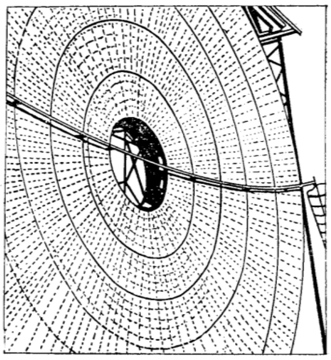

Figure 1.

Figure 2.

Figure 3.

Figure 1. Concentrator circuit. Figure 2. Integral concentrator

Figure 3. Heat energy concentrated in the concentrator focus.

The goal is to create small-scale, laboratory-powered solar furnaces and develop the photovoltaic field, research new materials by melting various materials, develop semiconductor materials science and semiconductor physics, and high-efficiency energy-efficient[7] alternative and renewable energy. aimed at creating resources. Preliminary results show that the number of sunny days in the country is 310-315, which increases the ability to process solar energy[2]. On a sunny day, when the average temperature was 15-20^0 C, the temperature in the focus of the solar oven rose to an average of 850-1000^0 C [3](D -10 cm of F). If we reduce the F of the solar oven to D, the temperature will rise by a few degrees Celsius.

Let's get acquainted with the concept of accumulation rate of return concentrators. The surface formed by the rotation of the parabola curve relative to its axis of symmetry is the paraboloidal surface. If a beam of light falls parallel to a paraboloidal mirror, it will focus on the paraboloid when it returns to its face (Figure 4). Therefore, the sun's rays fall on any point on the paraboloid reflector's surface at a maximum angle of $\varphi_0 = 32'$ from different points on the sun. [4]

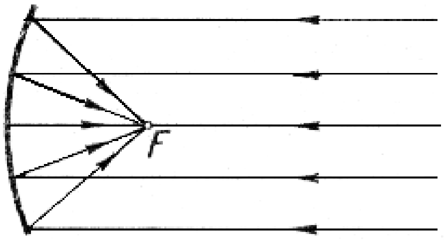

Figure 4. The return of the parallel beam beam from the paraboloid face.

If the reflection face was an ideal paraboloid, then it is a paraboloid the angles of incidence and return would be equal. In practice, however, the paraboloid surface is not an ideal paraboloid. [5]Therefore, the angle of return φ is always greater than φ_0. As a result, the beam of rays returning from the paraboloid does not intersect exactly at the focal point in the plane-focal plane passing vertically from the paraboloid focus to the axis of symmetry, but forms a light spot with diameter *d* relative to the focal point (Figure 4). Let's denote the diameter of the paraboloid mirror by the letter D. The average geometric concentration of energy is the ratio of the cutting surface $\frac{\pi D^2}{4}$ of the concentrator to the light spot $\frac{\pi d^2}{4}$. If we denote the average geometric concentration by the letter p, then we can write:

$$n = \frac{\frac{\pi D^2}{4}}{\frac{\pi d^2}{4}} \cdot R = \left(\frac{D}{d}\right)^2 \cdot R,$$

In this case, R is the reflection coefficient of the mirror material.

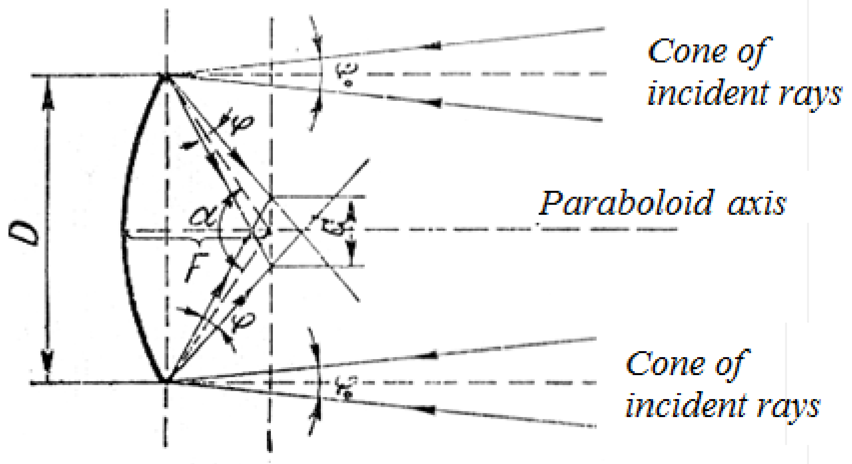

Figure 5. The return of sunlight from a paraboloid reflector.
apply the above formula to find the maximum value of p.

From Figure 5:

$$\frac{d}{2}=F\cdot\sin\frac{\varphi}{2};\frac{D}{2}=F\sin\frac{\alpha}{2},$$

where α is the angle between the lines connecting the two ends of the paraboloid with the focal point.

From the above

$$\frac{D}{d}=\frac{\sin\frac{\alpha}{2}}{\sin\frac{\varphi}{2}}\ \text{yoki}\ \frac{D}{d}=\frac{\sin\alpha}{\sin\varphi}$$

we can write.

From this formula, it can be seen that φ decreases and sin α increases
the diameter of the focal spot becomes smaller as it progresses.

It is not difficult to see that there is a maximum concentration when $\alpha=90^{0}$ is, ideally equal to $\varphi=\varphi_{0}=32'$:

$$\frac{D}{d}=\frac{\sin 90^{0}}{\sin 32'}=\frac{1}{0,01}=100$$

we can write

Hence, formula (1) can be written as follows for a glass paraboloid. Given that R = 0.8):

$$n=\left(\frac{D}{d}\right)^{2}\cdot R=(100)^{2}\cdot 0,8=8000.$$

Thus, the maximum concentration of reflectors of the ideal paraboloid type is 8000. Examations show that the energy distribution at each point of the focal spot does not have the same value. For example, the value of the thermal voltage at its center is the maximum, even in some ideal paraboloidal mirrors

$$30\cdot 10^{6}\frac{\text{ккал}}{\text{м}^{2}\cdot\text{соат}}$$

reaches,
and its value as it moves away from the center of the focal spot
decreases sharply. (Figure 5)

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Conclusion

When concentrators are used, the heated surface of the heat sink placed in its focus is much smaller than that of low-temperature devices. Therefore, if we provide good thermal insulation on all sides of the sun, we will ensure that such a "solar oven" heats up to a high temperature. Tests show that in ideal mirrors, the temperature of an object placed in a focal spot can reach 3000-3500 ^{0}C.

Solar furnaces are used effectively in the metallurgical industry. For example, solar furnaces play an important role in the melting of various metals that melt at high temperatures, in the processing of various metals, in modern materials science, in the production of new structural materials, in their processing. It is also important because it is harmless to the environmentally friendly environment. Inexpensive materials of various sizes increase the ability to develop new types of energy-efficient, high-efficiency sources and their compositions.

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