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# Analytical Review of Characteristics of Parabolic and Parabolocylindrical Hubs, Comparative Data Analysis Obtained On them

**JobirKodirov, Sabina Khakimova**

PhD student, Bukhara State University

Assistant of the Bukhara branch of the Tashkent Institute of Irrigation and Agricultural Mechanization Engineers

**ABSTRACT:** Solar energy technologies can be quickly deployed and have the potential for a global transfer of technology and innovation. In order to manufacture parabolic and parabolic cylindrical concentrators, an analytical review of these two types of solar devices was carried out and, after their creation, experiments were conducted on them in the season of maximum solar radiation. The article also presents data and their comparison for planning subsequent actions of research activities.

**KEYWORDS*:*** solar energy, concentrators, radiation, parabolic concentrator, parabola, parabolic cylindrical concentrator, temperature, energy.

## I.INTRODUCTION

Serious environmental problems and the finite reserves of fossil resources lead to the need to create new sustainable energy production options that allow the use of more economical renewable energy sources. Solar energy has many advantages, including environmental protection, profitability, and the creation of new jobs. Solar energy technologies can be quickly deployed and have the potential for a global transfer of technology and innovation. During the year, a huge amount of energy enters the Earth’s surface (3.65 × 1024 J or 1.08 × 1018 kWh). This amount of energy is more than 10,000 times the annual human consumption of all kinds of energy. Current global energy consumption shows that approximately 84.7% of global energy is consumed from fossil fuels, and only 9.9% from renewable energy sources. World energy consumption is projected to increase by 50% from 2005 to 2030 [1].

Hubs are optical devices that increase the flux density of solar radiation. For solar power plants with thermal cycles of energy conversion, concentrators allow you to create the high temperatures necessary to produce steam with certain parameters. The shape of the reflective surface of the paraboloid is formed by the rotation of the parabola around the axis of symmetry. One of the properties of a parabola is the convergence of all light rays incident parallel to the main optical axis (axis of symmetry) in focus. A paraboloid creates an image of a distant object in the focal plane. Parabola belongs to the category of high-potential concentrators, the radiation concentration of which can exceed 104 [2]. Therefore, for our research work, we decided to manufacture and experiment two types of concentrators: parabolic and parabolic. In some concentrators, the radiation of the sun is focused along the focal line, in others - at the focal point, where the receiver is located. When solar radiation is reflected from a larger surface to a smaller surface (to the surface of the receiver), a high temperature is reached, the heat carrier absorbs heat moving through the receiver.

Parabolic cylindrical concentrators have the shape of a parabola, stretched along a straight line. A parabolic cylindrical mirror concentrator focuses solar radiation in a line and can provide its concentration a hundredfold. The focus of the parabola is a tube with a coolant, which is heated to the temperature necessary for the further generation of electricity by a steam turbine generator. These systems require monitoring so that the maximum amount of sunlight enters the concentration system. Mirror systems can be oriented both horizontally and vertically. Horizontally oriented systems are usually located in an east-west direction, which reduces the need for control over the system, while

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vertically mounted "solar troughs" need to rotate after the movement of the sun during the day. The parabolic system is the most effective of all solar technologies.

The advantage of systems with concentrating solar receivers is the ability to generate heat with a relatively high temperature and even steam. The disadvantages include the high cost of construction; the need for continuous cleaning of reflective surfaces from dust; work only in the daytime, and, therefore, the need for large-capacity batteries; high energy consumption for the drive of the tracking system for the solar movement, commensurate with the generated energy. These disadvantages hinder the widespread use of active low-temperature solar heating systems with concentrating solar receivers. Recently, most often for solar low-temperature heating systems, flat solar receivers are used.

Parabolic concentrators are in the form of a satellite dish. The parabolic reflector is controlled in two coordinates when tracking the sun. The energy of the sun focuses on a small area. Mirrors reflect about 92% of the solar radiation incident on them. In the focus of the reflector on the bracket, a Stirling engine, or photoelectric elements, is fixed. The Stirling engine is positioned so that the heating region is in focus of the reflector. The main advantage of such devices is that it is a proven technology. The disadvantages include the following: high costs relative to other "green" sources; low coolant temperature; in some cases, such systems require the provision of water, which is not easy in desert conditions; the installation site should not have a slope of more than 1%.

Below are comparative tables of characteristics of solar thermal power plants using parabolic cylindrical and parabolic types of concentrators. [3], [4].

**Table 1 Characteristic of Solar Thermal Power Plants**

| Characteristic | Parabolic Cylinder Hub | Parabolic concentrator |
|---|---|---|
| Power | 30-320 MВт | 5-25 MВт |
| Operating Temperature (C / F) | 390/734 | 750/1382 |
| Availability factor | 23-50% | 25% |
| Peak efficiency | 20% | 29.4% |
| Practical annual efficiency | 11 -16% | 12-25% |

**Table 2 Comparison of major solar thermal technologies**

| | Parabolic Cylinder Hub | Parabolic concentrator |
|---|---|---|
| Where applicable | Connected to a network of power plants; industrial heat for industrial processes. | Small autonomous power plants; network support |
| Benefits | Dispatching peak load; 4,500 GWh of experience in the commercial market has been accumulated; hybrid system (solar energy / fossil fuel). | Load scheduling, high conversion ratio; modularity; hybrid system (solar energy / fossil fuel). |

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If only 1% of the Earth's deserts were used for the production of clean solar thermal energy, it would be received more than is generated today by burning fossil fuels around the world. [five]. Solar thermal power plants have a number of features that make them highly attractive technologies in the expanding global renewable energy market. Thermal solar power plants over the past few decades have come a long way. Continuation of design and development work should make these systems more competitive in comparison with the use of fossil fuels, increase their reliability and create a serious alternative in the context of an ever-increasing demand for electricity.

To obtain reliable data and compare them with each other, two options for the experimental setup were selected. A standard offset satellite dish with a diameter of 1.8 m was taken as the base of the parabolic solar concentrator of the first embodiment. The antenna surface was covered with a cotton cloth and pre-prepared 3x4 cm mirror pieces were glued onto it. The total surface area is 2.54 m2.

Fig. 1 Appearance of the fabricated parabolic concentrator

The second experimental setup in the form of a parabolic cylinder concentrator was made on the basis of the parabola function

$Y^2 = 4500 * X.$

To do this, originally wooden planks measuring 2.4 m in length and 2 m in width were parabolic in shape. They served as the foundation for mounting on them two reflective surfaces 2 m long and 80 cm wide. Between them 30 cm of space were left, 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. The total surface area is 3.2 m2.

Fig. 2 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

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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 3. The dynamics of thermal parameters in the hourly interval of the day in the summer**

| № | Hourly interval | Outdoor air temperature °C | Temperature in focus of a parabolic concentrator, °C | The temperature at the focus of the parabolic cylinder concentrator ,°C | Solar radiation, V/m$^2$ | The amount of energy, MJ * h | |
|---|---|---|---|---|---|---|---|
| | | | | | | parabolic concentrator | Parabolo cylindrical hub |
| 1 | 8.00-9.00 | 32 | 192 | 117 | 418 | 3.83 | 4.81 |
| 2 | 9.00-10.00 | 36 | 291 | 137 | 528 | 4.82 | 6.08 |
| 3 | 10.00-11.00 | 42 | 332 | 151 | 671 | 6.14 | 7.73 |
| 4 | 11.00-12.00 | 44 | 394 | 171 | 770 | 7.05 | 8.87 |
| 5 | 12.00-13.00 | 44.5 | 412 | 187 | 814 | 7.45 | 9.38 |
| 6 | 13.00-14.00 | 45 | 425 | 195 | 825 | 7.55 | 9.5 |
| 7 | 14.00-15.00 | 46 | 440 | 199 | 803 | 7.35 | 9.25 |
| 8 | 15.00-16.00 | 48 | 511 | 214 | 770 | 7.05 | 8.87 |
| 9 | 16.00-17.00 | 46 | 473 | 189 | 605 | 5.54 | 6.97 |
| 10 | 17.00-18.00 | 42 | 412 | 174 | 462 | 4.23 | 5.32 |
| 11 | 18.00-19.00 | 40 | 394 | 156 | 330 | 3.02 | 3.8 |
| 12 | 19.00-20.00 | 38 | 248 | 137 | 154 | 1.41 | 1.77 |

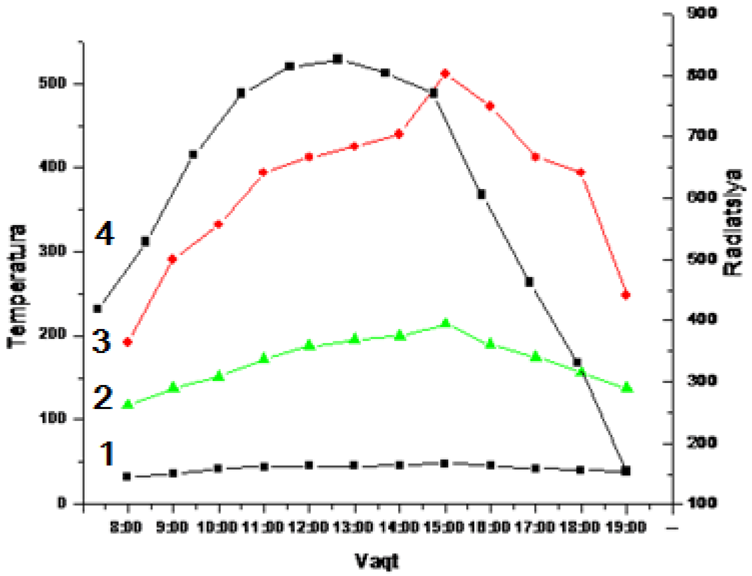


Fig. 3 Graph of the temperature in the foci of experimental plants on solar radiation in the hourly interval of the day: 1-ambient temperature; 2-temperature in focus of the parabolic cylinder concentrator; 3- temperature in focus of a parabolic concentrator; 4-solar radiation

Summarizing the above, we came to the conclusion that independently made solar concentrators of both types are 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 plants with steam engines in order to generate free electricity, as well as to continue experiments at both concentrators and at other times of the year to determine their efficiency and economic efficiency.

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