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TECHNOLOGY FOR CREATING ENERGY PARAMETERS AND THE GEOMETRIC SHAPE OF A JET TURBINE WITH A NOZZLE

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Abstract:

Objective. This article reflects the importance of low-pressure micro hydropower plants today, information about the problems, causes and ways to solve them. The problems of micro hydroelectric power stations continue to be studied all over the world. Opinions and recommendations are important because the scientific works and literature of about 20 world scientists and researchers were studied as sources, as well as scientific information.

Methods. About 20 literatures have been studied, which consider the design of microhydroelectric power plants operating in low-pressure water sources, the factors causing power losses in them. Based on the research results, the energy relationships between their constructive and geometric dimensions are analyzed. Factors affecting efficiency were calculated.

Results. Based on the analysis of the literature, calculations were made for the impeller of the turbine of a microhydroelectric power station. The number of nozzles in the turbine, the angle of inclination, the number of guide vanes, the central angle between the guide vanes, the water flow rate, the diameter of the guide device, the feed cylinder, the taper angle at which the water flow rate is the least energy in flat compression. The calculations were revised by introducing boundary conditions for several options. It has been established that when the radius R2 of the guiding cylinder is equal to the radius of the supply cylinder, the energy losses for energy expansion (compression) are minimal. It was found that the diameter of the impeller of a hydraulic turbine can be changed to fit the size of the nozzle, however, an increase in the diameter leads to an increase in the moment of inertia about its center and a sharp decrease in the rotational speed . The water intakes of the hydraulic turbine feed cylinder and the nozzle are made round, and the ratio between their surfaces is analyzed.

Conclusions. The diameter of the water supply cylinder of the hydroturbine has been increased in places where it is planned to work in sources with high water consumption and low pressure. This situation leads to an increase in the diameter of the impeller. Exceeding the critical value of the impeller diameter leads to an increase in the moment of inertia and a decrease in the speed of the impeller. This, in turn, leads to excessive energy losses due to the use of additional pulleys or gearboxes.

Keywords: Nozzle, jet turbine, microhydro, low pressure, Segner water wheel, gearboxes, Darcy coefficient.

Introduction. Under the influence of climate change in 2021, the volume of electricity generation based on hydroelectric power plants in Uzbekistan decreased by 23% compared to the previous year due to lack of water. This situation was observed not only in Uzbekistan, but also in the countries of Central Asia [1]. At the same time, over the past two years, Uzbekistan has resumed the import of electricity from neighboring countries of Central Asia to meet the needs of the population and industry at peak load, especially in winter [2].

According to the Ministry of Energy, according to the concept of the Republic of Uzbekistan, by 2030, the growth of electricity consumption in Uzbekistan is expected to reach 110 billion kWh. The concept provides for an increase in the share of renewable energy sources (NRES) in electricity generation in the country from 11 percent by 2030. It is determined that 5% of it is brought by the sun, 3% by the wind and 3.8% by hydropower [3].

Due to the fact that the slopes of the main parts of water sources such as rivers, channels, channels and irrigation systems in the world are small, the construction of small hydropower plants in them will cause damage to large areas of cultivated land and environments. In such places, there are many places where you can create a water pressure in the range of low 1.5-5 meters, where you can build and use thousands of micro hydroelectric power plants [4-6].

It is known that most of the existing rivers, canals and hydro sources in our region have a low head. Today, almost all over the world there is a special interest in the use of this hydropower potential for the production of electricity, and at the same time, hydropower is seen as an urgent task. Efficient use of environmentally friendly sources of hydropower is also one of the priorities of the country's economic development [7].

In the work carried out, the main part of micro HPPs using the water flow rate of a low-pressure turbine is made up of buckets, propellers, propeller parts, and their improvement is aimed at changing the angle of impact of water on the blades and changing the surface curvature or geometric shapes of the blades, as well as their focus on determining the optimal values of their sizes [8-14].

Methods. If you dwell on active hydro turbines designed to operate in a low-pressure water flow, you can see their pros and cons. For example, in [15], a catamaran-type floating hydraulic device with unstable operation was developed to change the water flow. [16] During operation, vane gearboxes transmit movement independently of each other to a vertically or horizontally mounted shaft through gears. This device has very large dimensions, and also works unstably when the amount of water flow changes. Also in scientific papers [17–21], large-sized active hydraulic turbines with low water consumption and low pressure and water wheels of 2–3 m were developed. Due to the high cost of low-speed, multi-pole generators, they are rarely produced in industry [22]. This situation leads to the use of gearboxes or multiple cascaded pulleys, resulting in wasted energy. As a result, the efficiency of the micro power plant decreases.

Existing designs of jet turbines (radial axial, propeller, with rotating blades, two-bladed) are characterized by efficient operation at heads of more than 4–5 m [23–24].

An analysis of information sources on hydraulic turbines shows that jet turbines have a significant drawback, that is, their efficiency changes dramatically with load changes, and a high efficiency zone is observed only in a narrow range of power changes. This disadvantage significantly reduces the efficiency of jet turbines when used in energy-deficient systems [25]. At low pressures, the efficiency of these turbines is sharply reduced, which gives unsatisfactory results at low pressure water flows.

In conclusion, from the above, it has become clear from the studies of jet turbines developed to date that the nozzles attached to the impeller of a jet turbine mainly have the geometric shapes shown below in Figure 1. They can be made from round or rectangular tubes.

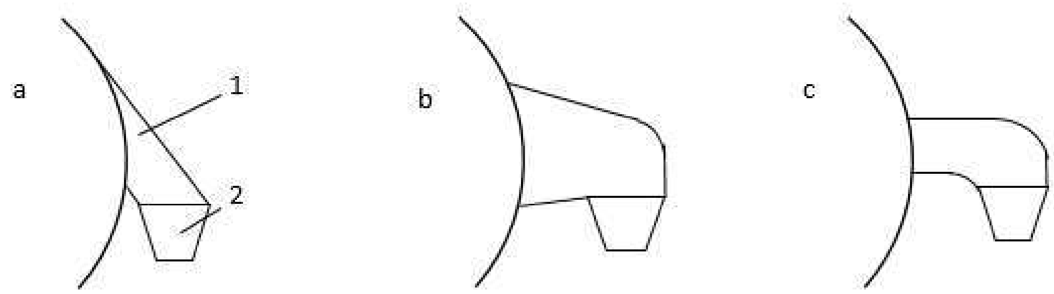

Figure 1. General scheme, top view of the hydro turbine nozzle nozzles. 1- nozzle water intake channel; 2- conical drainage channel

In works [8-11], the water nozzle shown in Fig. 1-a), consists of two parts, consisting of an inlet channel 1 and an outlet channel 2. In it, the water flow leaving in the radial direction is directed towards the inner wall of the water intake channel, under the influence of the linear speed of the rotational movement of the impeller, the water flow is slightly directed towards water outlet channel. However, the flow of water leaving the divertor practically returns in the radial direction due to its high absolute velocity. As a result, the water beams leaving the guide vane and returning from the inner wall of the nozzle interact with each other, creating a low-speed water flow inside the nozzle, which is in uneven non-uniform motion. This water flow is directed to the outlet channel under the action of water pressure. Due to the low speed of the water, the reactive force generated in the nozzle is small. In other words, due to such movement of the water flow, energy losses are observed. b) in the nozzle in the figure, the water jets returning from the inner wall at the nozzle inlet move towards the extreme points of the nozzle in the radial direction. At the center and bottom of the nozzle inlet, the flow to the nozzle is influenced by a second return flow from the top of the nozzle. In this case, as mentioned above, there is a loss of energy. In this case, the component of the impact force of the water column on the inner wall of the nozzle is acting perpendicular to the radial direction and the reactive force is equal to the change in the momentum of the water leaving the nozzle. rotated 90° to the outlet channel. In this case, the angle of rotation is equal to the drag coefficient ξ_{90}=1,25according to the formula of I.V. Semikin [12]. If the turn is at a large angle, a straight turn occurs, the energy loss is reduced. The reactive power generated in this nozzle is equal to the change in the momentum of the water jet emerging from it.

In works [13-14], they were carried out on a jet turbine with nozzles, but the change in the number of nozzles depending on the size of the impeller, as well as the method for determining the geometric shape, the dependence of its dimensions on the dimensions of the turbine does not light up. The general scheme of the top view of the horizontal section of the impeller of the hydraulic turbine is shown in fig. 2.

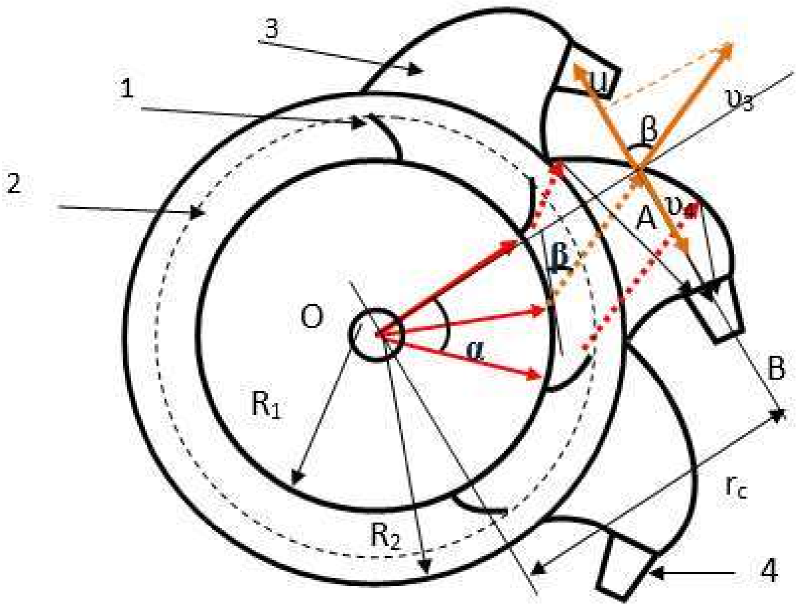

Figure 2. Top view of the horizontal section of the jet nozzle hydraulic turbine impeller [6]

On fig. 2 shows how part of the water entering the impeller nozzle with a speed of υ_3 interacts with point A and leaves the nozzle with an absolute speed of υ_4. The flow of water in a vertical pipe of radius R_2, spreading from the center along the radius, is directed to the water intake channel of the nozzle 3 through the 1st guide vane. Let the absolute speed of the water entering the nozzle υ_3 the linear speed of a point at a distance R_2 from the center of the cylinder be equal to u at dynamic equilibrium.

The water flow with speed υ_3 hits the inner walls of the nozzle 3 at an angle φ relative to the normal to it. As a result of the impact, a reactive force acts on the impeller in the direction of the speed u, proportional to the cosine of the angle. The water flow returning from the inner wall of the nozzle exits the nozzle through a conical baffle with a cone angle of 30°-35°. To calculate the reactive force FA created by water leaving the impeller nozzle, the change in the momentum of the incoming and outgoing water in it is determined, and the force acting on the nozzle at point A is expressed as follows [13]:

$$F = \rho S_3 \upsilon_3^2 \left(\cos\beta + \sqrt{\frac{S_3}{NS_4}\left(1 - \frac{S_3}{S_4}\right) + 1 - \frac{1}{2}\left(\xi_{S6} + \xi_2\right);} \right); \qquad (1)$$

This design power is the power generated by a single nozzle and is determined by multiplying the total reactive power by the number of nozzles.

It can be seen from formula (1) that the reactive force generated in the nozzle, the speed of the water leaving the nozzle, depends on the installation angle of the guide shovel relative to the radial direction β. The geometric shape of the nozzle ensures the angle of impact of the water jet against the inner walls of the nozzle and the direction of the nozzle back to the exit window of the water in such a way that the directed water flow creates a reactive force due to the uniform rotation in the nozzle. In accordance with the pressure and flow of water in these hydraulic turbines, the geometric dimensions and number of nozzles change. Depending on its geometric shape, its energy parameters also change. When the location of the water flow inlet to the nozzles along the perimeter of the impeller and a large distance between the nozzles, energy losses are observed as a result of the resistance of the water inlets and the influence of the walls of the working cylinder.

Results. Let the number of nozzles on the impeller of the hydraulic turbine be *m*. If the number of vanes located along the arc formed by one nozzle is equal to n, then the central angle between the two vanes corresponds to $\alpha = \frac{2\pi}{mn}$. Based on this, we will develop a method for determining the geometric shape of one nozzle. To do this, it is necessary to determine in advance the geometric dimensions of the impeller and guide device. Let us assume that a diversion device designed for water flow Q is attached to a supply cylinder with a diameter of d_2, a shovel of length ℓ_k direction is attached to the radial direction at an angle of β to the radial direction, and the water flow in nozzle mixers consumes the least energy in flat compression let the taper angle χ=30°-35° degrees [12].

The number of hydro turbine nozzles can be 2 or more. Below is a schematic drawing of a part of the impeller with four nozzles in the OXY plane (Fig. 3).

To determine the geometric shape and dimensions of the nozzle, initial conditions are needed. We include these conditions depending on the water flow and water pressure in the hydraulic turbine.

The radius of the feed cylinder of the hydraulic turbine R_1, the water flow Q is constant Q=const and the water pressure H, the relationship between which is as follows:

$$R_1 = \sqrt{\frac{Q}{\pi\varepsilon\varphi\sqrt{2gH}}}; \tag{2}$$

where φ is the water loss coefficient of the nozzle at the water inlet to the supply cylinder; ε is the ratio of the surface of the wetted perimeter of the water flow in the cylinder to the cross-sectional surface of the pipe. For injectors of medium quality $\varepsilon\varphi = 0.9$, you can get $\varphi = 0.95$ [15].

When the radius R_2 of the guiding cylinder is equal to the radius of the feed cylinder, the energy loss due to energy expansion (compression) is minimal. The inner radius of the guide cylinder, taking into account the wall thickness, is equal to $R_2 = 0.98R_1$. For the length of the guide vane, determined depending on the inner radius and its height in the radial direction, the following results were calculated:

$$\ell_k = \frac{R_2}{6\cos\frac{\pi}{m}}$$

$$h_k = R_2\left(\frac{\sin\frac{\pi}{m}\cos\beta}{\cos^2\frac{\pi}{m}} - \sqrt{tg^2\frac{\pi}{m} + 2(1-\cos\frac{\pi}{m}) - 2tg\frac{\pi}{m}\cdot\sqrt{2(1-\cos\frac{\pi}{m})}\cdot\cos\frac{\pi}{2m}}\right) \tag{3}$$

Impeller cylinder outer radius R_s, guider radius R_2, guide vane radial height h_k, distance between shovel and impeller cylinder inner wall δ and cylinder wall thickness b_s will add up:

$$R_S = R_2 + h_k + \delta + b_S; \quad (4)$$

By changing the diameter of the impeller of this hydraulic turbine to the size of the nozzle, it can be made of any size, but an increase in diameter leads to an increase in the moment of inertia about its center and a sharp decrease in the rotational speed. It is also necessary to use additional transmission parts. As a result, the efficiency of the hydro turbine will be low. To avoid these shortcomings, it is necessary to determine the optimal dimensions of the nozzle parts of the impeller. To do this, it is necessary to determine the rotational speed ω, suitable for the generator selected for the hydro turbine. The rotational speed depends on the speed of the water flow υ_3 entering and leaving the hydro turbine nozzle υ_4. The distance from the center of the water outlet from the nozzle to the center of the impeller r_0 is the force arm, and the optimal value of this force arm is determined by the water flow rate υ_3 entering the nozzle:

$$r_0 = \frac{1}{3\omega_Z}(t + \frac{1}{t} + 1); \quad (5)$$

this includes the following definitions:

$$t = \sqrt[3]{\frac{27\omega_Z^2 c + \sqrt{(27\omega_Z^2 c + c)^2 - 4} + 2}{2}};$$

$$c = \frac{S_3 \upsilon_3^2 (\cos\beta + \sigma)}{\pi \upsilon_4}; \qquad \sigma = \sqrt{\frac{S_3}{S_4}\left(\frac{S_3}{S_4} - 1\right) + 1 - \frac{1}{2}(\xi_{SK} + 1.25)};$$

In this case, the absolute velocity of the water jet leaving the nozzle is calculated by the following formulas [16]:

$$\upsilon_4 = \upsilon_3 \sigma$$

$$\upsilon_3 = \frac{\ell_k m \upsilon_2 \sin\alpha_1 \sin\beta}{2\pi R_2^2} e^{i(\alpha_2 - \beta)} + \upsilon_2 e^{i(\alpha_2 - \alpha_1)};$$

$$\upsilon_2 = \frac{\varphi}{R_2^2}\sqrt{2gH\left(R_1^4 - R_1^2 R_2^4 + R_2^4\right)};$$

$$\zeta_{SK} = 0{,}125\lambda \cdot \left(1 - \left(\frac{S_4}{S_3}\right)^2\right); \quad (6)$$

Here S_3, S_4 are the surfaces of the inlet and outlet of water from the nozzle, respectively; α_1 and α_2 are the angles of water entry and exit to guide vanes, respectively; β - installation angle of the guide vanes with respect to the radial direction; λ - Darcy coefficient.

The Darcy coefficient is determined depending on the degree of tortuosity of the pipe and the Reynolds number. Fluid flowing in turbulent mode in a smooth pipe with steady flow ($10^5 \leq \mathrm{Re} \leq 10^8$). The Darcy coefficient is determined by the Nikuradze formula [12; 160-b]:

$$\lambda = 0{,}0032 + 0{,}22 \cdot \mathrm{Re}^{-0{,}237} \quad (7)$$

The speed of the water jet leaving the deflector blades before entering the nozzle is reduced due to the expansion and resistance of the blades. Its absolute speed must be increased as much as possible so that the jet of water coming out of the nozzle acts on the nozzle with a large momentum of force. Therefore [13; 98-100 pp.], a condition has been developed for optimizing the ratio of the water surface entering the nozzle to the surface of the water leaving it. In it, the water intakes of the hydraulic turbine feed cylinder and nozzles are made round, and the following ratio is obtained between their surfaces:

$$\frac{S_2}{S_c} \geq \sqrt{\zeta_{90^0} - \zeta_{SK}} \; ; \qquad \xi_{90} = 1{,}25 \; ; \tag{8}$$

where S_s - exit from the nozzle - cross-sectional area;

ξ_{90} - coefficients of water resistance when rotated by 90° and ξ_{SK} - reduced section in the nozzle cone.

Determine the ratio of the water inlet and outlet surfaces of one nozzle as follows:

$$\frac{S_3}{S_4} = k \tag{9}$$

Taking the value k equal to 2 gave good results in the experiment [26]. leads to an increase in speed by a factor of 2 in accordance with the continuity equation. Increases its value by reducing water consumption and increasing seal mobility due to local resistance. This results in reduced efficiency.

This condition also applies to our case. And S_3 is determined by the arc length A_7N_0, where one nozzle is drawn into the working cylinder (Fig. 3). *p* percent of the entire length of the arc is occupied by the nozzle A_7A_6 hardening part to the working cylinder. The remaining *1-p* percent is water input. The height of the water intake of the nozzle is equal to the height of the guide vane L. In this case:

$$S_3 = (1 - \frac{p}{100}) \frac{2\pi}{m} R_S L; \qquad 10)$$

Using the continuity of water flow and (9), we determine the surface S_4:

$$S_4 = kS_3 \; ; \tag{11}$$

x nozzle outlet width:

$$x = k\left(1 - \frac{p}{100}\right)\frac{2\pi}{m} R_S \; ; \tag{12}$$

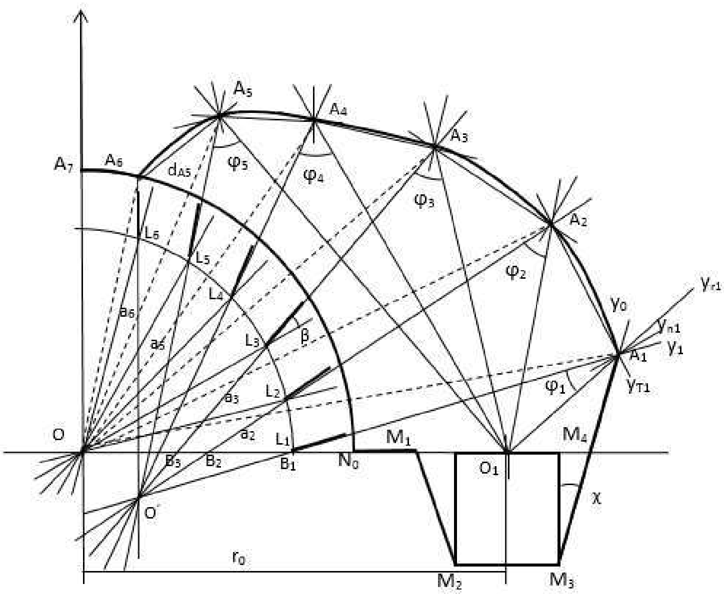

Figure 3. Method for creating the geometry of the nozzle impeller nozzle

Discussion. The force expressed by formula (1) is determined by the difference in momentum of the water jet entering and exiting the nozzle. In order for this force to reach its maximum value, the angle between the directions of the absolute velocities of the water flow entering and exiting the nozzle must be as large as possible and close to 180°. In this case, the jet of water coming out of each guide vane must be compressed in a straight line towards the outlet window. To analyze this situation, we divide the water flow from the nozzle guide vanes into separate small water bundles. In this case, we can assume that it obeys the law of geometric optics, neglecting the viscosity of water. Because if we assume that there is no viscosity between the molecules in the liquid layer, then they behave like an absolutely elastic body, while the water layer also obeys this law. Based on the foregoing, we introduce the appropriate conditions for the trajectory of the water jet, i.e. - the water flow from the guide vanes must hit the inner walls of the nozzle so that the water jet returning from the wall at an angle φi is directed towards the outlet window of the nozzle, without intersecting with neighboring jets of water. In this case, the water column, as it were, leaves the point O and goes to the inner wall of the nozzle (Fig. 3).

In the initial position, the top view of the confuser forms a trapezoid $M_1M_2M_3M_4$. Let the cycle frequency of a hydraulic turbine operating in a water source with a water flow rate Q and a head H be equal to ω, and the center of the water outlet of the corresponding nozzle be equal to O1. Distance from the center of the impeller to point O_1 r_0, spillway width in the radial direction $M_2M_3=2\ell_0$, $M_1M_4=4\ell_0$, $V_2M_4= \ell_0$ and nozzle cone angle baffle $\angle M_3= \chi$ Symbol χ input, A_i point identification work in progress on the next steps.

Let the water handle L_0N_0, L_1N_1, ... L_nN_n be directed to the points A_0, A_1, ... A_n through guide vanes. Let the water beams returning from these points arrive at the point O_1 of the nozzle. Then from Fig. 3 shows that if the coordinates of the points A_0, A_1, ... A_n are defined, then the curve passing through these points determines the shape of the top view and the geometric dimensions of the nozzle edge. Considering the coordinates of these points as a straight line, one can construct the equations of each straight line in the Cartesian coordinate system and determine the coordinates X_{Ai} and Y_{Ai}, respectively. In this case, taking a large number of spades along an arc corresponding to the angle occupied by the nozzle gives a good result for creating a straight curve of the geometric shape of the nozzle.

Conclusions. Based on the results obtained, the height of the designed nozzle in the radial direction decreases with an increase in the number of nozzles. Because the arc drawn into the central corner that the nozzle should occupy becomes smaller. As a result, the radius of curvature of the curve formed by connecting the points A_0, A_1, ... A_n, decreases. Based on these results, by changing the number of nozzles, it will be possible to control and calculate the power arm of the impeller, that is, the torque.

The diameter of the water supply cylinder of the hydroturbine is increased in places where it is planned to work in sources with high water consumption and low pressure. This situation leads to an increase in the diameter of the impeller. Exceeding the critical value of the impeller diameter leads to an increase in the moment of inertia and a decrease in the speed of the impeller. This, in turn, causes excessive energy losses due to the use of additional pulleys or gearboxes.

References

1. https://www.gazeta.uz/ru/2021/11/09/energy/

2. https://ru.wikipedia.org/wiki/энергетикаУзбекстана#гидроэнергетика.
3. https://www.uzanalytics.com/iqtisodiet/9961/
4. Uzbekov M.O., Begmatov E.M., Methods of supplying electricity in remote areas, Topical issues of energy efficiency of automated electromechanical and electrotechnological systems, International scientific and technical. conference, TSTU, Tashkent-2022, 2-qsm, March 3-4, 2022, 327-329 p.
5. Bozarov O.O., Uzbekov M.O., Egamberdiev Kh.A., Begmatov E.M., Analysis of the possibilities of using photo and hydropower potentials to create a micropower plant network (Part 1), Scientific-technical journal (STJ FerPI, FarPI ITZH , NJ FerPI, 2022, special issue No. 5, 82-85 p.
6. Uzbekov M.O, Bozarov O.O, Begmatov E.M, Kiryigitov B.A "Analysis of the possibilities of using photo and hydropower potentials to create a network of microelectric power stations (part 2)", Scientific-technical journal (STJ FerPi, FarPI ITJ , NTJ FerPI, 2022 special issue #7), 70-75.st ISSN 2181-7200.
7. Aliev R.U., Bozarov O.O., Abduqakhorova M., Current conditions for the development of small hydroelectric power sources in Uzbekistan. Scientific bulletin, ASU, 2018, No. 1, p.p. 16-23.
8. http://www.inset.ru/r/obor.htm
9. Gerald Muller, Klemens Kauppert. Old water mills Britain's new source of energy, // New civil engineer international. March. - 2003, p.p. 20-28.
10. Zhou D., Gui J., Deng D., Cheu H., Yu Y., Yu A., Yang C., Development of an ultralow head siphon hudro turbine using computational fluid dinamics.// Energy.-China, 2019.-Vol. 181.-p.p. 43-50.
11. Casila J.C., Duka M., Reyes R.D.L., Ureta J.C., Potential of the Molawin creek for mikro hydro power generation: An assessment.//Sustainable Energy Technologies and Assessments.-Phillipines, 2019, -Vol.32. p.p. 111-120.
12. Mamadierov E.K., Opredelenie osnovnykh parametrov mikrohydroenergeticheskoy ustanovki, Heliotechnika, 2010 (2), p.p. 68-71.
13. Sweet P.P. Razrabotka MIKRO-GESs asynchronous generators for selskohozyaystvennyx potrebiteley Avtoref. diss. sugar tech. science Barnaul, Altai GTU. 2007.
14. Loboyko V.F., Pyndak V.I., Ovchinnikov A.S., Zenin D.Yu. Hydroelectric plant. RU 2258154 MPK C2. F03B 7/00, 13/00. Publ. 10.08.2005 Bull. No. 22
15. Kuznetsov V.V., Kuznetsov D.V. Hydrogen generator (varianty). RU 2265750 MPK C1. F03B 7/00, 13/00, 17/00. Publ. 10.12.2005 Bull. No. 34
16. Ivanov V.M., Rodivilina T.Yu., Semkin B.V., Blinov A.A., Ivanova P.V., Sweet P.P., KleinG.O.. Device for conversion of water and electric energy. RU 2306453 MPK C2. F03B 7/00. Publ. 20.09.2007 Bull. No. 26
17. Yakovenko A.L., Zhigulenko I.V., Blade for tixohodnyx turbine (varianty). RU 2392488 MPK C2. F03D 3/00, F03D 5/00, F03B 7/00, F03B 9/00. Publ. 20.06.2010 Bull. No. 17
18. Tekhiev A.Sh., Hydraulic turbine. RU 2398129 MPK C1. F03B 7/00. Publ. 27.08.2010 Bull. No. 24
19. Chulkov I.N, Active hydraulic turbine. RU 2417329 MPK C2. F03B 17/06, F03B 7/00. Publ. 27.04.2011 Bull. No. 12
20. Biryulin I.B., Vetrova A.A., Belaya V.A., Bashilov I.B., Plavuchaya power station. RU 2432489 MPK C1. F03B 7/00, F03D 9/00. Publ. 27.10.2011 Bull. No. 30

21. Akimov A.P., Vasilev A.G., Pavlova N.A., Aleksandrov A.G., Ruslovaya vsesozonnaya hydroenergeticheskaya ustanovka. RU 2445507 MPK C2. F03B 7/00, F03B 17/06. Publ. 20.03.2012 Bull. No. 8

22. Chernyuk A.M., Analysis and optimization of the construction of a small hydroelectric power station for autonomous energy supply of military objects and infrastructure //Collection of scientific studies of the Kharkiv University of Vitry, 9 issue 4(45), 2015, p.p. 124-126.

23. http://weswen.ru/hydro_frensis/.

24. http://weswen.ru/hydro_kaplan/.

25. https://studopedia.ru/4_106730_reaktivnie-gidroturbini.html. 21 .01. 2015.

Bozarov O, Osarov X, Kiryigitov B, Use of an internal straightening device in a low-pressure jet hydroturbine. AndMI "Innovative solutions for the use of new types of alternative energy sources and the use of energy-saving devices in their use" republic-wide scientific and scientific-technical conference, Andijan 2022

ANALYSIS OF SOLAR ENERGY DEVICES

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Abstract: Analytical research on the effective use of solar energy in the conditions of Uzbekistan was conducted in the article. It was mainly analyzed that solar energy devices are more effective in using them according to their goals. The article contains theoretical conclusions based on the results of the research methods used in the literature. The data was analyzed using the "Methodological analysis" and "Meta-analysis" methods.

Keywords. solar air heater, solar water collector, tower solar power plant, parabolic cylindrical solar thermal power plant, solar photovoltaic panel.

Introduction. Currently, in order to meet the demand of energy consumers, nature is being damaged due to the use of organic fuels in the world. As a result, new types of diseases are appearing in the human and animal world (land and water). In addition, the sharp reduction of organic fuel reserves leads to an increase in indicators of the shortage of energy resources in various fields. Therefore, one of the main problems facing humanity is to provide energy consumers with environmentally friendly energy. Environmentally clean energy can be obtained only from energy sources that exist in nature and do not emit harmful gases and waste as a result of their use [1-23].

Methods. The use of solar energy is an unlimited source of energy for the planet earth. At present, scientific research is being conducted to achieve efficient use of solar energy based on the use of new technologies using various methods. In theory, solar energy has the potential to adequately meet the energy needs of the

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