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Evaluation of energy characteristics of low-pressure water flow

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ABSTRACT: With the growth of the world's population, the demand for energy consumption is increasing. Electricity is important for comprehensive development of remote areas. In the large-scale production of electricity, attention is being paid to environmentally friendly renewable energy sources, which cause less environmental pollution and climate change. In the article, as a solution to these problems, suggestions for designing a new hydro turbine with energetic characteristics of low-pressure water flow are given. The proposed hydro turbine is environmentally friendly, has low installation costs, and works efficiently in low-pressure water flows.

KEYWORDS: Turbine, renewable energy sources, water consumption, generator, gear, efficiency, power, screw.

I. INTRODUCTION

Today, the development of society is determined by its energy supply. But the daily increase in energy consumption, and the use of organic fuels for its production, is leading to global environmental pollution, and as a result, it poses a serious threat to human life. Therefore, one of the urgent issues of today's energy industry is the use of environmentally friendly, renewable non-traditional energy sources[1, 2, 4]. Water is characterized by inconsistency in time and space. In order to consider it as a source of energy, it is necessary to have enough information about it as a natural process. For effective use of water energy, it is necessary to determine the energy properties of the water flow. For many years, these quantities of water consumption Q (m^3/s), velocity v (m/s) and head H (m) are considered as flow standards. These values are taken as values for the average water flow in practice. If the above quantities are in constant geographical conditions and there are changes in the flow cycles of the river water at the same level of not less than two, then in practice it will not be possible to directly measure the data on the flow. The flow rates are calculated for the whole area and the archival sources of the flow module specified in the relevant literature are determined based on the maps [3].

The process of river flow formation is a multifactorial complex natural phenomenon. These factors include precipitation, the intensity of melting snow and rain, freezing and moisture of the soil, evaporation, etc. In these cases, when the event or event is caused by the sum or multiplication of unrelated or less related factors, according to the central limit theorem of probability theory, this event or process is eventful and obeys a definite statistical law. Therefore, mathematical statistical methods are used in the study of water flows. In addition, the general goal for the design of hydropower facilities is to determine the rate of flow in the implementation of hydrological calculations, as well as to calculate its probable fluctuations during the operation of the device [1, 2].

II. METHODS

Flow velocity in a river is the distance traveled by the water flow in one second. In practice, the flow rate can be observed by the movement of lightly floating objects (empty bottle, matchbox, bat, etc.) in the water. But it should be remembered that the object moves through the water at a speed that is upstream. The deeper the aquifer, the lower its flow rate. The true average speed for all layers of the flow is obtained at 2/3 of the depth. The river flow is studied by systematic measurement of water consumption Q (m^3/s) and levels on the cross-sectional surface of the river at time t [1, 5, 8]:

$$Q = Av \quad (1)$$

where: v - the average flow speed of the measured water in the studied river, m/s;
A - cross-sectional area of the river, m^2.

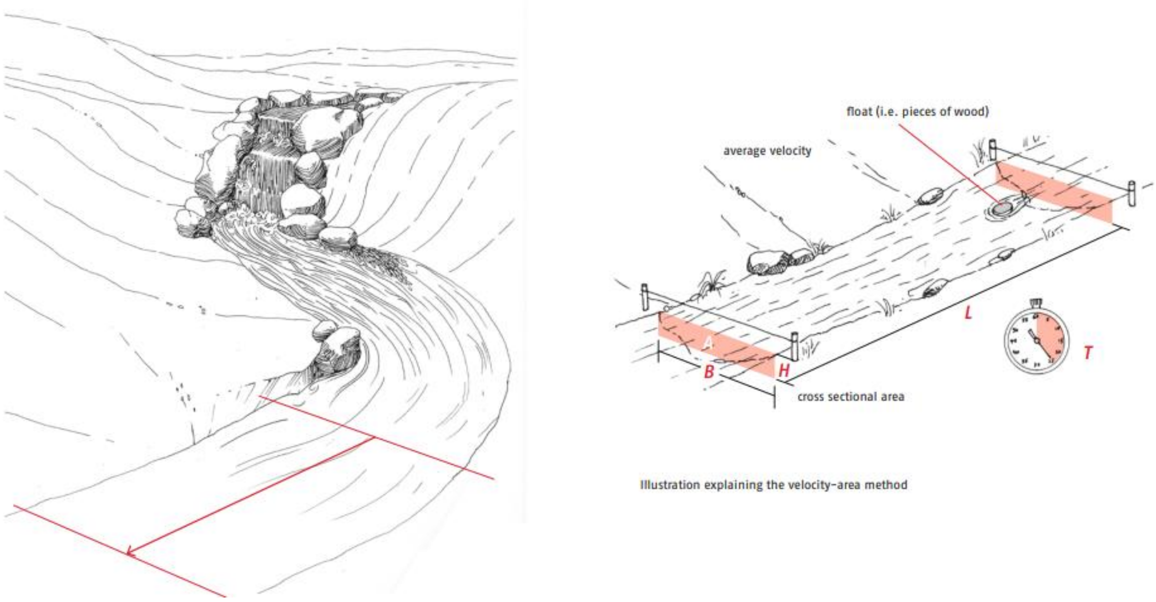

Fig. 1. Determining the flow rate by the velocity field method (approximate calculation) [5].

Determined water consumption is recorded in the record book of water resource surveyors. Along with the indicators of water consumption of the river, the following indicators of water flow are given.

Average annual water consumption $Q_{av.y}$:

$$Q_{av.y} = \frac{\sum_{i=1}^{T} Q_i}{T}, \quad m^3/s \quad (2)$$

where: $\sum_{i=1}^{T} Q_i$ -daily sum of average annual water consumption;
T – number of days in a year (T = 365 day or $31{,}54 \cdot 10^6$ s).

Annual flow of water V:

$$V = Q_{av.y} \cdot 31{,}54 \cdot 10^{6}, m^3 \quad (3)$$

where: $31{,}54 \cdot 10^{6}$ is the average number of seconds in a year.

Annual average volume of multi-year flows V_o:

$$V_0 = \frac{V_1 + V_2 + \ldots + V_n}{n}, \quad m^3 \quad (4)$$

where: $V_1, V_2, \ldots V_n$ - flow volumes for individual years; n - is the number of years in the period.

Average annual water consumption Q_0:

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$$Q_0 = \frac{\sum_1^n Q_{ўр.й}}{n} = \frac{V_0}{31{,}54 \cdot 10^6}, \qquad m^3/s \tag{5}$$

Taking into account the amount of water, the power (kW) of the microhydroelectric power station can be determined by the following formula:

$$P_{in} = \cdot\, \eta\, \rho\, g\, Q\, H \tag{6}$$

where: ρ – density of water 1000 kg/m^3;
g – gravitational constant 9.81m/s^2;
Q - the amount of water flowing in one second;
H – head.

III. RESEARCH AND RESULTS

This research work was carried out in the Ayud canal designed for the irrigation system located in Kibray district, which is supplied by Boz-suv canal, Tashkent region. Figure 3 shows the location of the Ayud channel. On March 3, 2022, the head part of the Ayud channel was measured using a modern doppler profilograph of the "Son Tek S5" model. According to the measurement results, water consumption Q=0.45m^3/sec is flowing in the source.

Time of measurement	3.03.2022 y 15:50 to 16:30
The channel is the upper width of the channel	2,99 m
Channel live section surface	1,21 m^2
Average speed of flow	0,37m/s
Maximum flow rate	0,85m/s
Maximum measured height	0,57m
Average water consumption	0,45m^3/s

Fig. 2. Parameters of the channel according to the measurement results

Hydropower analysis is the first step to determine the potential of electricity that can be produced by screw turbine micro hydropower plants for low pressure water flows. Data on the flow volume of the channel for 3 years, i.e. 2020, 2021 and 2022, were obtained, and this data is the basis for determining the average flow consumption in months and years.Average monthly water consumption and hydropower capacity based on the obtained data are presented in Table 1. From the values presented in the table, it can be concluded that the Ayud canal supplied by the Boz-Suv canal is connected to the irrigation networks, so it can be seen that the water consumption in the spring and autumn months is somewhat higher, and in the winter and summer months, it worked with a little less water consumption.

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Table 1
Hydropower indicators of the channel.

Months	Water consumption over the years [m³/s]			Average water consumption in months [m³/s]
	2020 й.	2021 й.	2022 й.	
January	0.789	0.803	0.812	0.801
February	0.875	0.796	0.751	0.807
March	0.562	0.498	0.452	0.504
April	2.568	2.581	2.512	2.553
May	2.321	2.512	2.361	2.398
June	2.361	2.426	2.283	2.356
July	2.501	2.569	2.472	2.514
August	2.469	2.512	2.448	2.476
September	2.481	2.419	2.165	2.355
October	1.689	1.690	1.771	1.716
November	1.231	1.419	1.323	1.324
December	0.761	0.819	0.842	0.807
average water consumption [m³/s]	**1.717**	**1.753**	**1.682**	**1.717**
3-year average water consumption[m³/s]	**1.717**			

The efficiency indicator of this screw turbine micro-hydroelectric power plant designed for Ayud channel is 70%, the effective flow height is 0.85 meters. And as a result, the annual dynamics of the calculated electric power is presented in Figure 3.

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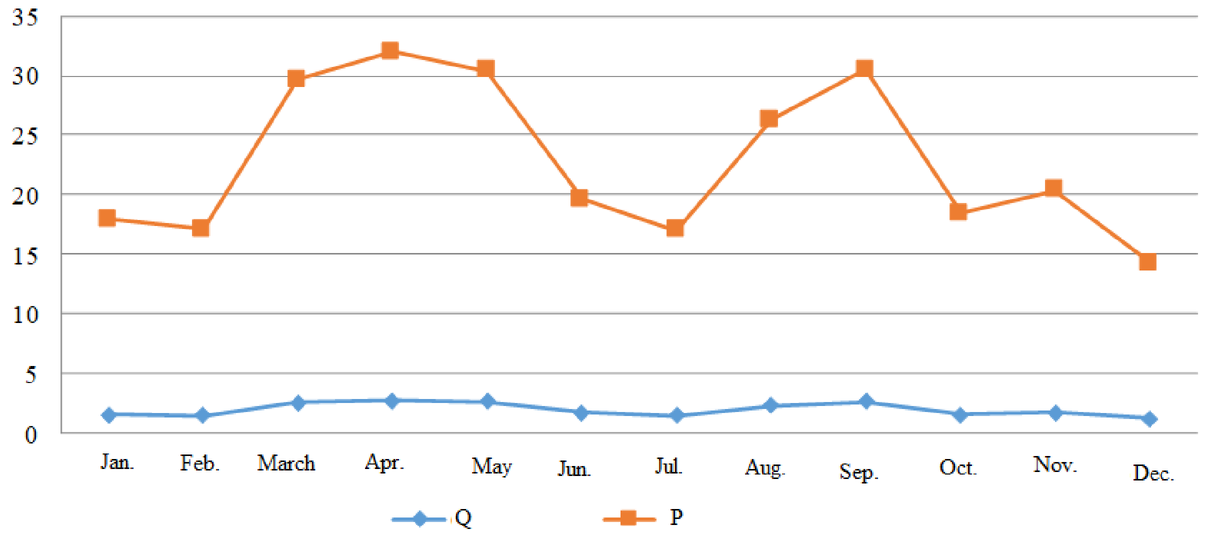

Fig. 3. Hydropower potential of the channel.

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IV. CONCLUSION

A mathematical description of the operation of a small hydropower plant, taking into account the amount of water flow, was created. The analysis showed that the proposed micro hydroelectric power plant model works effectively in low pressure water flows.

The flow rate of the water body was calculated. It was observed that the water flow of the Ayud canal, where the test is planned, changes seasonally for a year. The average value of the observed water flow was found to be 1.71 m^3/s. From this it can be concluded that a pilot model of a micro-hydroelectric power station can be installed in this area and research work can be carried out.

REFERENCES

[1]. D.B.Kodirov, D.T.Yusupov. Creation of a mobile microhydroelectric power plant for the mountainous regions of Uzbekistan // Bulletin of the South Ural State University. Ser. Power Engineering. 2017, vol. 17, no. 1, pp. 42–46.

[2]. Kodirov, D., Tursunov, O.: Calculation of Water Wheel Design Parameters for Micro Hy-droelectric Power Station. E3S Web of Conferences 97, 05042 (2019).

[3]. Kodirov, D., Tursunov, O., Parpieva, S., Toshpulatov, N., Kubyashev, K., Davirov, A., Klichov, O.: The implementation of small-scale hydropower stations in slow flow micro-rivers: A case study of Uzbekistan. E3S Web of Conferences 135, 01036 (2019).

[4]. Davirov A, Kodirov D, Tukhtaeva R, Ibragimov I and Urokova N 2023 Development and testing of a laboratory model of a two turbine small hydroelectric power plan IOP Conference Series: Earth and Environmental Science 012018.

[5]. Valentin Schnitzer. Micro Hydro Power – Scout Guide. Energy Climate. 2009

[6]. Davirov A, Kodirov D, Kushokov G. (2022) Small hydro power plant with two parallel turbines for low pressure water flows. Scientific and Technical Journal of NamIET. 847-853

[7]. YoosefDoost, A.; Lubitz, W.D. Archimedes screw turbines: A sustainable development solution for green and renewable energy generation-a review of potential and design procedures. Sustainability 2020, 12, 7352.

[8]. Neeraj Kumar Thakur, Robin Thakur, Kamal Kashyap, Bhaskar Goel. Efficiency enhancement in Archimedes screw turbine by varying different input parameters – An experimental study. Volume 52, Part 3, 2022, Pages 1161-1167