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PROSPECTS FOR USING MINI- AND MICRO HPP

Kiryigitov Bahriddin Abdusattarovich [1]

[1] Andijan Institute of Agriculture and Agricultural Technologies

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ABSTRACT

This work is devoted to the analysis of the state of use of sources of alternative energy sources, as well as the factors and reasons that led to the main focus on renewable energy sources. Consideration of the possibility of various types and classification of hydraulic structures is given.

Today, one of the main problems is the technical resource (potential) of small rivers (in Russia this figure is 382 billion kWh per year), and the degree of practical use of this potential is 2.2 billion kWh per year, or 0.58% [1]. This indicator of the received electricity is very and there is a tendency to increase this indicator all over the world.The meaning of "small" in relation to a hydroelectric power plant differs from country to country. So, in Russia - 10 MW, in China - 50 MW.

Electricity generation at small hydroelectric power plants (SHPPs) is growing in terms of the amount of electricity supplied, but their share is very small compared to the total generation using traditional sources of electricity. In China, more than 50 GW was generated, in Japan - about 5 GW. Switzerland and Austria account for 8.3% of all energy generated. In Russia, as of 2014, there were approximately 300 SHPPs with a total capacity of about 1.3 million kW [5]. An approximate estimate of the economic potential (resource) is 55% of the technical hydro potential [5]. The renewed interest in small hydroelectric power plants is due to the following advantages of this type of hydraulic structure:

- modern hydropower, in comparison with other traditional types of electric power, is considered the most economical and environmentally friendly way of generating electricity.

- in relation to other environmentally friendly renewable energy sources (sun, wind), small hydropower is practically independent of the weather and is able to provide a stable supply of electricity to the consumer.

- SHPPs can be controlled remotely, i.e. it is possible to remotely control the operation of hydrogenerators operating in the network or autonomously.

The source of energy is a watercourse. To determine its numerical value, it is necessary to take an arbitrary section of the river with a length L with the difference in water marks at the beginning and end of the section A-B = N.

Let's consider how the process of generating electricity takes place. In river beds, the mass of water under the influence of gravity moves from high to low elevations. Water is constantly doing work. Let's select a small fragment of a river section between sections 1-1 and 2-2 of length l within which a constant slope is maintained, the average water flow rate υ and sectional area S. The volume and mass of water in this section can be found using the formulas:

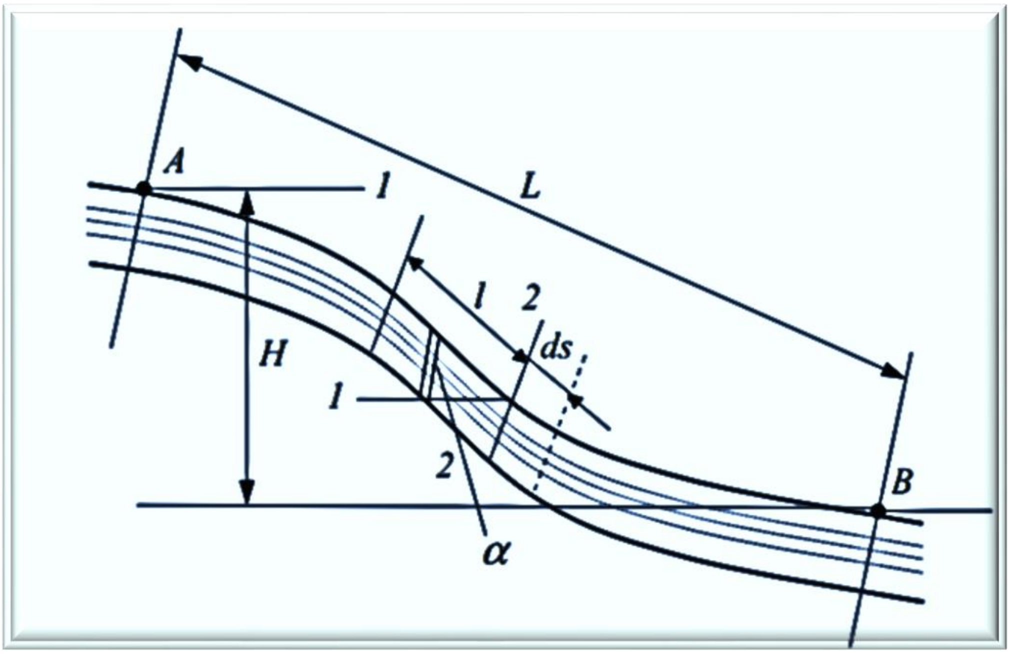

Fig. 1. Scheme for determining the power of the water flow

The total work done by gravity in the area l is found by the formula:

$$A = \rho \cdot g \cdot S \cdot l \cdot \sin\alpha \quad (2)$$

The power of the water flow in this area is:

$$N = A / t = \rho \cdot g \cdot Q \cdot h \quad (3)$$

where Q = S·h is the water discharge in the river, h = l·sinα is the elementary head (the projection of the length onto the vertical).

The power of the water flow in kW will have the form

$$N_{uch} = 9.81QH \quad (4)$$

where ρ = 1000 kg / m3, g = 9.81 m / s2.

The energy of water in this area, i.e. work during a period of T hours (it will be expressed in kWh) can be determined using the formula:

$$E_{uch} = N_{uch}T \quad (5)$$

These formulas express the potential power and energy of the water flow. It is impossible to fully use these energies at the MkHPP due to the fact that there are energy losses in the structures supplying water to the turbines, as well as in turbines and generators. The practical capacity of the SHPP will be as follows:

$$V = Sl,\ m = \rho \cdot S \cdot l \quad (1)$$

where ρ - is the density of water.

For a period of time dt, the element l under the influence of water ρgSl is displaced along the channel (Fig. 1).

$$NT = 9.81 \cdot Q \cdot H \cdot \eta_{gen} \quad (6)$$

where η_{gen} is the turbine efficiency.

The value of this value depends on the design, size of the turbine and changes with changes in load. The electrical power of the generator is determined by the following formula:

$$P_{\_gen} = N' \cdot T \cdot \eta_{gen} = 9.81 \cdot Q \cdot H \cdot \eta\_T \cdot \eta_{gen} \quad (7)$$

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T the dependences of the capacity of MkHES on the flow rate and water pressure are given (Fig. 2).

Here it should be borne in mind that the possibilities of this type of hydraulic structures make it possible to facilitate the energy supply of a remote region with electricity. Additionally receiving financial support in the form of a long-term source of electricity. It is possible to provide the population and small businesses with their own sources of electricity.

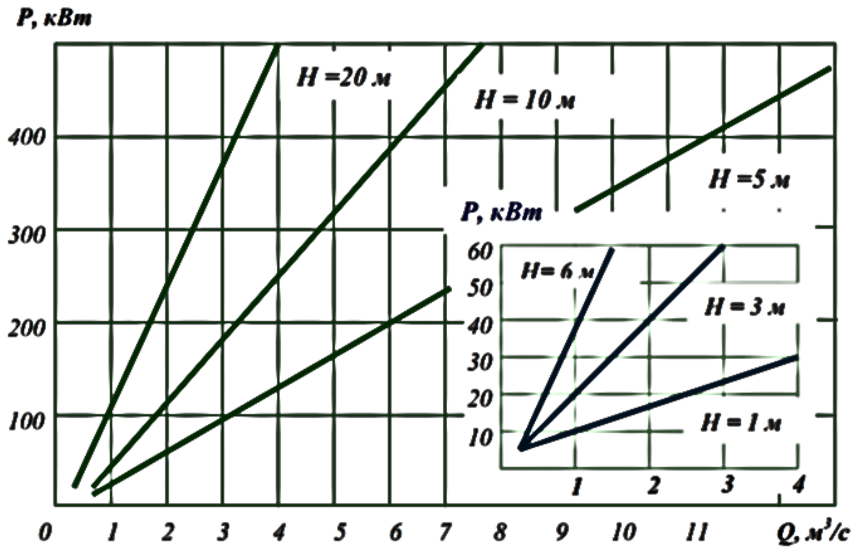

Fig. 2. Dependence of the capacity of MkHPP on the pressure and water flow rate at the efficiency of the hydroelectric unit η = 0.65-0.75.

For a MkHPP with unregulated turbines, the water flow can be found by the formula:

$$Q = \mu_T \cdot S_K \cdot \sqrt{q \cdot H}, \mu_T = \frac{1}{\sqrt{\frac{\lambda \cdot l}{D}+\xi_T}} \qquad (8)$$

where μ_T is the flow coefficient of the supply pipeline, S_K is the area of the impeller chamber, μ is the power factor, l and D are the length and diameter of the supply pipeline, μ_T is the resistance coefficient of the pipeline.

Fig.3. Type Mk- and MnHPP.

An important characteristic that determines the capabilities of the MkHPP turbine is the turbine rotation frequency. In the foothill and mountain rivers it has a value of 100-300 rpm. The frequency of the current in the power supply network of consumers is f = 50 Hz and the presence of multi-pole generators (use in the designs of speed reducers or multipliers), we obtain the frequency of the generated electric current by the formula:

$$f = (p \cdot n) / 60 \quad (9)$$

where p is the number of pairs of generator poles, n is the rotational speed of the turbine shaft.

The operation of the MkHPP can be carried out both in parallel with the grid, and autonomously (the received electricity is sent to a specific consumer) with a period of operation of the MkHPP not less than 40 years [5]. This service life includes a period of 5 years before the start of the equipment overhaul.

The problem of using renewable energy sources in the Fergana Valley is very urgent. The presence of water sources on the territory of the Andijan region makes the use of small hydroelectric power station attractive (for the irrigation system, the capacity of hydro generators in the micro hydroelectric power station and micro hydroelectric power station can reach 50-60% and up to 75% (respectively, in dry and good periods) [10, 12]. Because this region consumes electricity with an excess of up to 14%, since the main part of consumers is removed from the centralized electricity supply line. in addition, consumption has grown steadily in recent years. To solve the problem of reducing the load on the central power supply system, it is advisable to use the energy of hydro resources located in this territory. Additionally, low-pressure collector sources can be involved for this.

The problem of increasing the energy efficiency of hydroelectric generators is considered the main focus of many studies. Therefore, we have focused on the calculation of water flows with low heads. If possible, use a complex form of generating electricity (solar, wind, hydropower), so in this case, the share of generating electricity increases.

Thus, the development of SHPPs for remote power supply facilities is currently a promising direction and will contribute to the development of economic potential. It becomes possible to ensure a guaranteed supply of electricity for the needs of consumers located in remote areas.

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