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# DESIGN AND BASIC ENERGY PARAMETERS OF SOPLOL REACTIVE HYDROTURBINE MICRO-HYDROELECTRIC POWER STATION

**Egamberdiyev Hamidullo Abdullayevich[1], Xayitov Azizjon Mo'minjon o'g'li[2]**
**Karimov Jasurbek Xasanboyvich[3]**

*[1]Fergana Polytechnic Institute, Senior Lecturer, Fergana, Uzbekistan*

*[2]Fergana Polytechnic Institute, Senior Lecturer, Fergana, Uzbekistan*

*[3]Fergana Polytechnic Institute, Senior Lecturer, Fergana, Uzbekistan*

**ABSTRACT**

*The article investigates the dependence of the output parameters of a new device of a micro hydroelectric power station with a hydro-turbine operating on the basis of the reactive principle on the factors of water flow and design. It has been experimentally confirmed that the necessary calculations for a new design can be performed using a kind of differential equations for jet propulsion. It has been determined that the operational parameters obtained by experimental testing of the manufactured device of a micro hydroelectric power station differ from the calculation results by only 4 ÷ 5%.*

**KEY WORDS:** *micro hydroelectric power station, jet turbine, impeller, turbulent flow, efficiency.*

## INTRODUCTION

In the field of hydropower, consistent research is being conducted worldwide on the creation of efficient micro-hydropower plants operating on low-pressure watercourses. In recent years, special attention has been paid to this area in our country.

Due to the available natural water resources and conditions, the demand for small - 2 ÷ 100 kW micro-hydropower plants is growing in our country, as in all countries.

Micro-hydropower plants produced in Europe, China, the Netherlands and Russia are mainly made in the form of a paddle wheel [1]. Factors such as the force of water pressure on the large surface of the paddles, the reverse pressure due to the flow of water, the scattering of water on the paddles due to the angle of impact prevent the high torque and efficiency of the device.

Overcoming such shortcomings can be done by optimizing the device design or creating a device with a design that works on a reactive principle.

## THE MAIN PART

The new micro-hydropower plant proposed by the authors is designed to be used autonomously from the general electrical network and in low-pressure wastewater. The main working part of the micro-hydroelectric power plant is the structure of the hydro turbine, which is radically and structurally fundamentally different from conventional hydro turbines. The flow of water entering this turbine enters the impeller cylinder and exits the nozzle attached to it, creating a torque that rotates the impeller relative to the vertical axis OO1 shown in Figure 1. However, the rotational frequency and energy performance of the impeller depend not only on the forces acting on it, but also on its moment of inertia. However, the rotational frequency and energy performance of the impeller depend not only on the forces acting on it, but also on its moment of inertia. The change in torque over time of the amount of movement of the water coming out of the nozzle to

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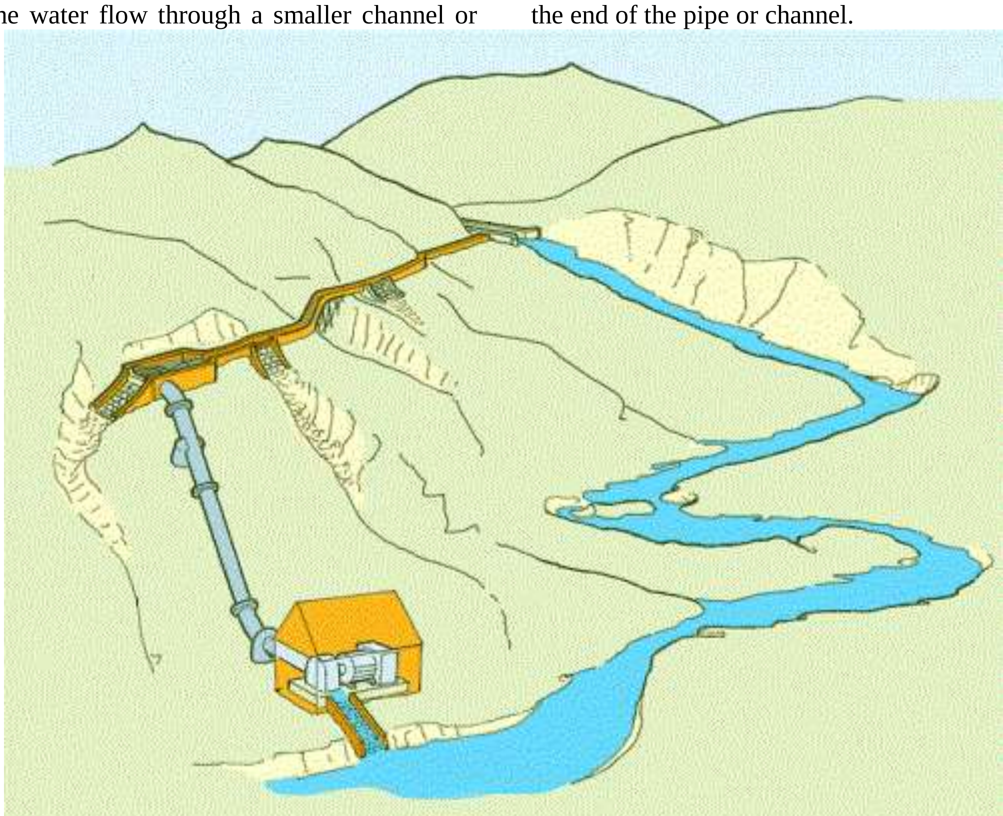
the impeller creates a torque. The moment of inertia of a rotating system is one of the main technical factors of a micro-HPP, as its increase leads to a decrease in the rotational motion energy. Therefore, it is necessary to calculate the moment of inertia of the system in advance.

To calculate the reactive force F generated by the water leaving the nozzle in the turbine, we calculate the difference in the amount of movement of the incoming and outgoing water in it.

Methods of building microHPPs. Micro-hydropower plants are divided into several types depending on the method of construction. Ozan micro-hydropower plants are built by building dams on a fast-flowing slope of a river or canal. The capacity of this type of micro-hydropower plant is much higher than that of other micro-hydropower plants. They are mainly built to provide electricity to smaller residential complexes.


View of Ozan type micro HPP.

Derevision type microHPPs. In this case, part of the water flow through a smaller channel or pipe is extended from the upper part of the channel flow to the lower part. A hydroturbine is installed at the end of the pipe or channel.



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Simple micro-hydropower plants built on the river itself without any changes to the river flow. They have the least power. MicroHPPs usually consist of a hydroturbine (generator), an output voltage regulator, a series of elements, ballast resistors and protective valves depending on the type of station. The most important device in microHPPs is its generator. In addition to converting mechanical energy into electrical energy, its generator is also involved in the process of adjusting its parameters. Therefore, it also serves as a controller for such devices. Synchronous machines are often used instead of such generators.

The difficulty of excitation in asynchronous generators, the low ability to adjust the output electrical parameters, leads to their low use. In such equipment, frequency and voltage adjustment is done in different ways. Adjusting the frequency by changing the angle of inclination of the working blades or reducing the water consumption. The disadvantage of this method is the length of the adjustment time (1.5-3 sec) using ballast resistors. In this case, a ballast resistor is connected to the generator output, and its voltage and frequency are adjusted to the consumers. Through the generator frequency adjustment device. It is mounted on the blade and the shaft connecting the generator, and helps keep the output frequency constant by giving the generator shaft a constant speed. Mashinno - through the valve source uskina. This device will replace the generator. It differs from other methods in that it produces high-precision voltage and frequency. But such equipment is very expensive, so they are rarely used in practice. The most widely used method today is the autoblast system voltage adjustment, which is also cost-effective. Generators (hydro turbines) used in micro HPPs are also divided into 2 types. Active hydroturbines. In doing so, the turbine produces energy at the expense of the kinetic energy of the water flow of the water flow to the nozzle. They are usually used freely in fast-reading, sloping channels. They mainly produce small power. Reactive hydrotubines. Such hydrotubines operate at the expense of the potential energy of the water flow. They are used in derecation and stream micro-hydropower plants. Examples of simple active generators are wheel mounted generators. Due to the large size and low FIC, wheeled hydrotubines are almost never used. Depending on the amount of water consumption and the height of the water pressure, hydrotubines are divided into Pelton, Tugro, Banki, Kaplan, Francis. Their average FIC is 75-80%. The primary energy carrier in microHPPs is water flow. Factors such as water flow rate, water consumption, water pressure, seasonal stability of water flow are important in the operation of hydropower plants. However, in many canals and rivers, water consumption and pressure are seasonally variable. This depends on the climate and the landscape of the area where the river is located. In addition, the slope of the river, the maximum and minimum annual water consumption are taken into account when designing micro-hydropower plants. Proper accounting will reduce capital expenditures and reduce energy costs. The choice of the location of micro-hydropower plants takes into account the strength of the river flow and the fact that the energy received from the same hydropower plant fully meets the energy needs of the consumer. In mountainous areas, micro-hydropower plants of the derevitation type are often used. Some of the water is sent to the lower part through a pipe or a specially dug canal through a dam that is smaller than the upper part of the river.

A jet turbine is installed at the end of the pipe or channel. We can increase the energy of the water flow through this pipe. In this case, the choice of generator takes into account the diameter of the pipe and the height between the bottom and top of the pipe. Micro HPP pipes can be made of steel, rubber, concrete or other hard materials. The choice of material and its cost depends on the shape of the terrain where the micro-hydropower plants are located. The location of the land surface in mountainous areas, the high slope of local rivers, or the presence of a slope in some parts of the flat-flowing rivers increase the possibility of using micro-hydropower plants. If the local water pressure would be less than 1 m, the construction of micro-hydropower plants in such areas would be inefficient. 404 Water consumption in rivers varies seasonally. Therefore, the study of local water consumption characteristics of micro HPP capacity also takes into account the minimum water consumption during drought. Another important factor is the freezing of rivers. That is, the duration of this degradation period also affects the capacity of micro-hydropower plants.

Even small changes in river flow can lead to changes in water quality and the lifestyle of the surrounding wildlife. Therefore, when constructing micro-hydropower plants, it is advisable not to use more than 10% of the river's total water consumption. The location of the station plays an important role in the technical and economic condition of the construction of micro-hydropower plants. They are: The average slope of the river. H (m). Average water consumption. Q (m3 / s). Average water flow rate. v (m / s). The duration of the flow during the year. (hours)

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