Installation types of micro hydropower plants

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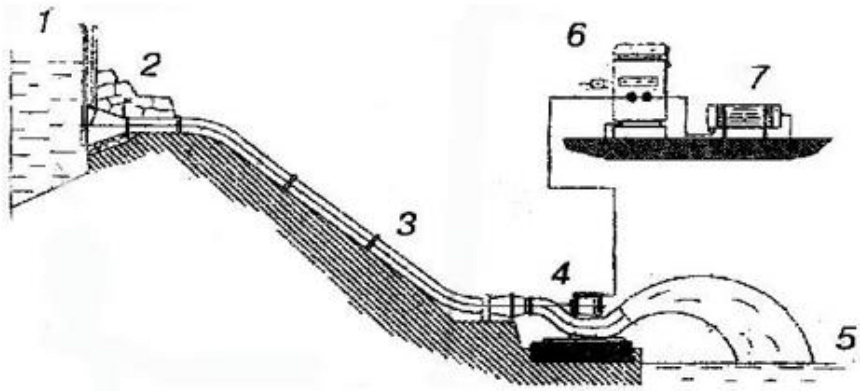
Abstract: Microhydroelectric power station is a power plant that provides the creation of a working head of the water column from 3.5 to 5.5 m with the speed of the water flow, for providing electricity to consumers in places located far from power transmission lines located near water bodies. was considered an intended autonomous device.

Keywords: Micro HPP, river, dam, hydro turbine, rotating blade, radial-axis, impulse

Micro HPP in its structure (Fig. 1) includes mandatory elements such as hydraulic turbine, electric machine generator, output voltage stabilization system and a number of elements, the availability and design of which depends on their type and characteristics. Micro HPP station: certain hydraulic structures, valves, ballast loads, a set of connecting cables, etc.

Micro HPP is an environmentally friendly source of electricity that does not pollute water and the environment.

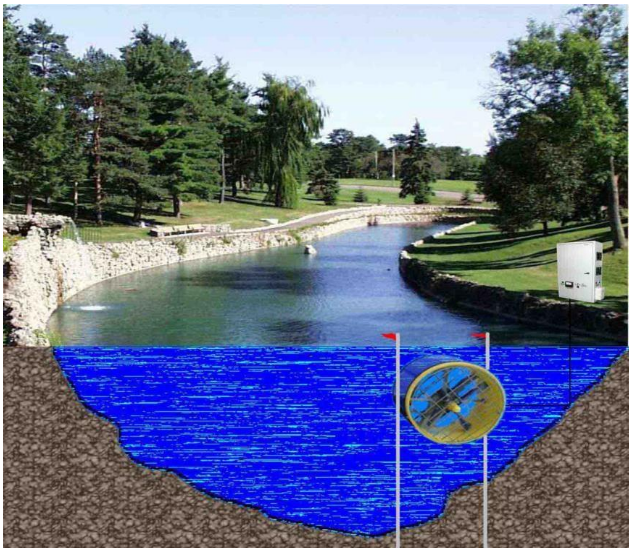


Picture. 1 Microhydroelectric power station installation scheme

Micro HPPs are distinguished by their different designs. They can be built like stronger stations using a dam, they can be a diversion or channel type using a pressure pipeline or channel. Finally, micro hydropower plants can be installed in the river flow without any hydraulic structures - free flow micro hydropower plants.

Free flow micro hydroelectric power plant

A free-flow floating micro hydropower plant with a power of up to 2000 W (Fig. 2.) is designed to operate at a depth of at least 1.3 m at a current speed of 0.6 m/s to 0.5 m/s and at least 3 m wide. Micro HPP is easily installed and dismantled.



Picture. 2.7. Free flow micro hydroelectric power plant

Unlike pressure hydroelectric plants, micro hydroelectric plants do not interfere with navigation and wooden rafting and do not require the creation of expensive dams or aqueducts. The installation consists of a submerged turbine, a power unit located on land near electricity consumers. When connecting several to a local network, there are no restrictions on the number of modules working together, which greatly expands it.

Micro HPP works in automatic mode. This significantly reduces operating costs.

Micro hydropower along the river

In a micro-hydroelectric power station located on the river bank, the power can be obtained both due to the water pressure created by the dam and due to the speed of the water flow in the hydroelectric power station. Micro hydroelectric power stations on the river are produced with a capacity of up to 20 kW.

Depending on the actual parameters of the water flow (H; Q), the projects of micro-hydroelectric stations diverting the water flow and in the river flow make it possible to equip them with generators of different capacities.

Equipment for micro hydropower plants on the river

Axial propeller, diagonal, radial-axial and bucket hydroturbines are produced for micro hydropower plants.

Bucket hydraulic turbine hydraulic units.

It is used in hydroelectric power plants with Pelton turbines (Fig. 2).

Picture 3. Bucket turbine hydraulic units

Picture 4. Radial-axis hydraulic units turbines produced with high water pressure and one or two nozzles with a horizontal rotor.

Radial-axial hydraulic turbines (Fig. 4) were completed.

Radial axial turbine hydroelectric units.

The hydroelectric power station ensures the horizontal location of the hydroturbine rotor

Axial turbine hydraulic devices(Fig. 5).

The hydraulic turbine can be installed in an open front chamber, concrete or metal spiral chamber.

Fig. 5 Axial turbine hydraulic units

All types of hydraulic turbines are used to one degree or another as hydraulic engines that convert flow energy into mechanical energy of a generator drive shaft: turbines with rotating blades, radial-axis, impulse, axial, horizontal and rotary axes, and others. [9,16].

As a rule, micro hydropower plants do not require the construction of complex hydrotechnical structures - dams. Therefore, their turbines are installed either in the free flow of water or in a special pressure pipeline. Active type hydraulic turbines are mainly used to work in the free flow of water, a typical example of which can be water mills. The advantage of active turbines is their maximum simplicity and relative rigidity of mechanical properties. However, the low rotational speed and low efficiency of active hydraulic motors limit their application in hydropower. The pressure pipeline allows to increase the energy of the working water flow, to use more efficient types of jet-type hydraulic turbines.

$$P_t = \gamma \frac{Q \cdot H}{\Omega} \eta_t$$

where g is the weight of a unit volume of water;

Q- water consumption;

H- working pressure;

Y- angular frequency of rotation;

Total efficiency of Ω-turbine.

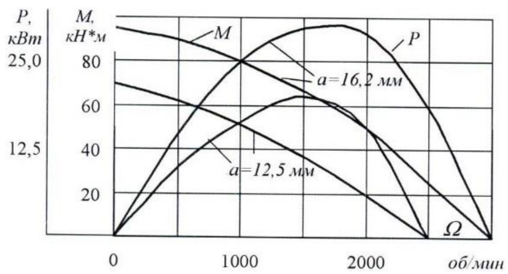
It can be seen that the power of the pressure pipe hydraulic turbine does not depend on the water regime of the river if its minimum flow exceeds the amount of water entering the pipe. The diameter of the pipe and the height difference between its upper and lower points determine the design capacity of the station. Micro hydropower pipeline can be made of steel, concrete, rubber and other pipes that are widely used in irrigation systems. Its price depends significantly on the terrain, which determines the feasibility of using microhydroelectric power stations, primarily in mountainous areas with large slopes of the river bed. Proper use of soil, as well as the simplest structures such as diversion channels

It should be noted that the power and rotational speed of the hydraulic turbine determine the design power of the generator, its mass, dimensions and cost. In general, these parameters are related by relation [3, 6]:

$$\frac{D^2 \cdot l_\delta \cdot \Omega}{P} = \sigma \frac{1}{A \cdot B_\delta} \quad (1)$$

where D is the inner diameter of the electric machine stator; ld is the approximate length of the air gap; P - estimated total power; Ω - rotation frequency; A - linear load; Bd - magnetic induction in the air gap; s is the proportionality coefficient.

With the design power of the generator and relatively constant values of electromagnetic loads, its volume is characterized by the product D2.*ld*, determined by the rotation frequency. From this point of view, high-speed hydraulic turbines have good weight and size characteristics and allow the use of low-cost generators. If the rotation speed of the microhydro turbine is low (in practice less than 400 rpm), it is recommended to use multipliers. This allows to achieve the maximum conversion efficiency and the minimum mass of the installation as a whole.



Picture. 2.11 Features of the hydro turbine

As for low-pressure micro hydropower plants, propeller-type hydroturbines with a nominal rotation speed of 1000 to 3000 rpm prevailed. This type of turbines allows to remove the multiplier from the structure of the hydroelectric power station. In the form. 2.11 shows the experimental characteristics

The equation of motion of the hydroturbine-generator system has the following form:

$$M_m = M_г + J\frac{d\Omega}{dt} \quad (2)$$

where Mm is the mechanical torque developed by the hydroturbine; Mg - resistance moment of the generator; J - moment of inertia of rotating parts; Ω is the angular frequency of hydraulic rotation.

$$e_\Sigma = e_г - e_m$$

$$e_г = \frac{dM_г}{d\Omega} \cdot \frac{M_{г.ном}}{\Omega_{ном}}$$

$$e_m = \frac{dM_m}{d\Omega} \cdot \frac{M_{m.ном}}{\Omega_{ном}} \quad (3)$$

The static stability of the "hydro turbine-generator" system and the error in stabilizing its rotation frequency is determined by the overall self-control coefficient of the microhydroelectric power plant: where eg, em are self-control coefficients of the generator and hydraulic turbine, respectively; Mg.nom - Mm,nom nominal (calculated) values of moments of the generator and hydraulic turbine at the nominal mode point; ũnom is the nominal frequency of hydraulic rotation.

Conclusion

Micro HPP is a promising environmentally friendly source of electricity for a wide range of purposes.

In hydroelectric power stations of the "micro" category, due to the corresponding simplification of hydraulic devices in most cases, there is a tendency for the electrical part of the devices that perform the functions of stabilizing the produced electricity to be somewhat complicated.

Depending on the operating conditions of the power station, it is possible to recommend the use of asynchronous generators if the station operates on a strong power grid or passive autonomous load. Micro hydroelectric power plants built on the basis of synchronous generators in autonomous operation mode at a load with a variable power factor have advantages.

References

1. Development of renewable energy sources in the Republic of Uzbekistan. Asian Development Bank, Department of East and Central Asia and the final report of the Ministry of Agriculture and Water Management of the Republic of Uzbekistan, Tashkent-2005.

2. Alternative energy sources: possibilities of use in Uzbekistan. Analytical report 2011/03. Center for Economic Research. Tashkent-2011.

3. VP Shuisky, SS Alabyan, AV Komissarov, OV Morozenkov. "World RES Markets and Russia's National Interests", Forecasting Issues, 2010 Issue 3.

4. "Prospects for the development of renewable energy in Uzbekistan". UNDP final report, Tashkent, 2007

5. Kopilov IP Mathematical modeling of electric machines.- M.: Higher School, 1987.-245 years.

6. Alp.Partnun, St. Antonyen. Micro HPP. Hassler Erwin, Electrical Engineer, Schweiz, 1985, 36, No. 12, pp. 49-51.

7. Karelin V.Ya., Volshanik VV Constructions and equipment of small hydroelectric power stations. - M.: Energoatomizdat, 1986.- 199 p.

8. Vane pumps: a manual. Under total ed. VAZimnitsky and VA Umova.-L.: Engineering. Leningrad. department, 1986. - 334 p.

9. Equipment for small hydroelectric power stations. "Int. Water Power and Dam Const." 1986, No. 38, No. 41-50.

10. Lukutin BV, Sipailov GA Use of mechanical energy from renewable natural sources for power supply of autonomous consumers. Frunze.: Ilim, 1987.- 135 p.