УДК 621.313.01

ПРОЕКТИРОВАНИЕ СИНХРОННЫХ ГИДРОГЕНЕРАТОРОВ НА ПОСТОЯННЫХ МАГНИТАХ ДЛЯ МАЛЫХ РЕК

Н. М. ПРИСМАКИН
Научный руководитель О. Н. ПАРФЕНОВИЧ, канд. техн. наук, доц.
Консультант А. В. КАРПЕНКО
БЕЛОРУССКО-РОССИЙСКИЙ УНИВЕРСИТЕТ

There exist about 21000 rivers in Belarus their total length being 91 thousand km. Small rivers and streams dominate as for their length and the number - they make up to 93 % of the total quantity and 53 % of the total length of all the rivers. There are 42 medium rivers (less than 500 km) in Belarus. Only nine rivers have the length of more than 500 km. They are represented by the Berezina (flows entirely on the territory of the Republic), the Neman, the Vilia (originates on the territory of Belarus), the Western Dvina, the Dnieper, the Sozh, the Pripyat, the Horyn and the Western Bug (transit river).

The average flow velocity of large and medium-sized rivers in Belarus is about 0,5–0,7 m/s, up to 0,8–1,5 m/s in the shallows, on the rapid areas of small rivers more than 1.5 m/s. Maximum speeds can be observed during floods, minimum, in mean water.

Power use of small streams and flows with micro and small hydrogenerators represents an effective direction of alternative hydropower engineering.

Microhydropower facilities have real advantages over large hydropower plants.

1. Environmental safety. Small devices affect neither the property nor the water quality.

2. The installation uses the power of small rivers and stream flows. Consequently, they do not require large reservoirs.

3. The microplants under consideration fit perfectly the existing landscape. The surroundings are not flooded.

4. Hydrogenerators are capable of power supply to energy-deficient and remote regions.

In the middle of 20th century, the USSR possessed more than 2000 small hydropower plants. Nowadays there are not more than 200.

Let us consider existing problems:

Microhydrogenerators on post-Soviet territory use asynchronous generators, therefore:

– they require triple output power reserve. Asynchronous generator is not able to endure peak loads;

– constant rotor speed is needed for power generation. Compensation of variable water pressure makes the design of the rotor more complicated;

– generation of electricity starts at velocities above 900 rev/min. Therefore, we have to use complicated gear units reducing the efficiency of the system;

– the plants of the given type require construction of special complex facilities.

Experience in the development and operation of microhydrogenerators proved that the most promising option is construction of damless design installations with autoload system of voltage stabilization. Most of the autonomous power supply systems are based on this principle. They successfully function in many countries: the USA, Japan, China, Denmark, Sweden, etc.

The total amount of the electricity generated using a stand-alone microhydrogenerator and its component in the power balance of economically developed countries has been increasing steadily. Many countries have developed their special state program for small power generation.

Private companies show growing interest in renewable sources of energy in recent years and not federal agencies. Steady rise in fossil fuel prices on the world market on the one hand, and improving technologies for the production of electricity from renewable energy sources on the other, lead to the inevitable reduction of the difference in cost of production. In this situation, micro-hydropower is one of the absolute leaders of unconventional power generation in terms of low costs of production and rapid payback periods of projects.

Russian level of developments in microhydropower is high enough. The proof of this is not only increasing production of power equipment for microhydro but also its exports to many countries. It is notable that in Belarus I am a pioneer in the development of microhydro.

Since modern designs of microhydrogenerators provide fully automated operation mode, the annual cost of the plant operation is reduced to periodic revision and cleaning the water intake and lubrication of mechanical rotating parts of the installation. Moreover, if foreign manufacturers offer microhydro costing 1500–2000 $/kW of the fixed power output, among the home manufacturers this figure ranges from 800 to 1200 $/kW.

Next, I would like to introduce to you the development of the Samara SPA “Storm”.

The design is the result of my cooperation with the above mentioned entity during the completion of my course project “Design of synchronous hydrogenerators for small rivers with excitation from permanent magnets” in Electric Machines. The advantage of the given type of hydrogenerator is that using a voltage inverter microhydropower plants autonomously generate electricity for consumers. At night when the user is asleep, and the load on the generator is insignificant, this type of design in combination with the inverter can transfer the excess power to the battery (in the case of private use of the device) or back to the network (in the case of its public use).

The plants are mounted into the existing water consumption systems (water or heat pipelines) and are installed on a simple foundation as well as embedded

into spillway systems at enterprises and installed underground. In the case of an extensive water flow, the installations operate efficiently with high volumes of water due to the parallel installation of several units. Since the given apparatus is low-speed, the microhydro can be used in cascade.

The main advantage of this power plant is the absence of complicated mechanical transmissions such as gearboxes (fig. 1) which seriously reduce the system efficiency – the fact that naturally affects the kW/h output respectively. Consequently your wallet.

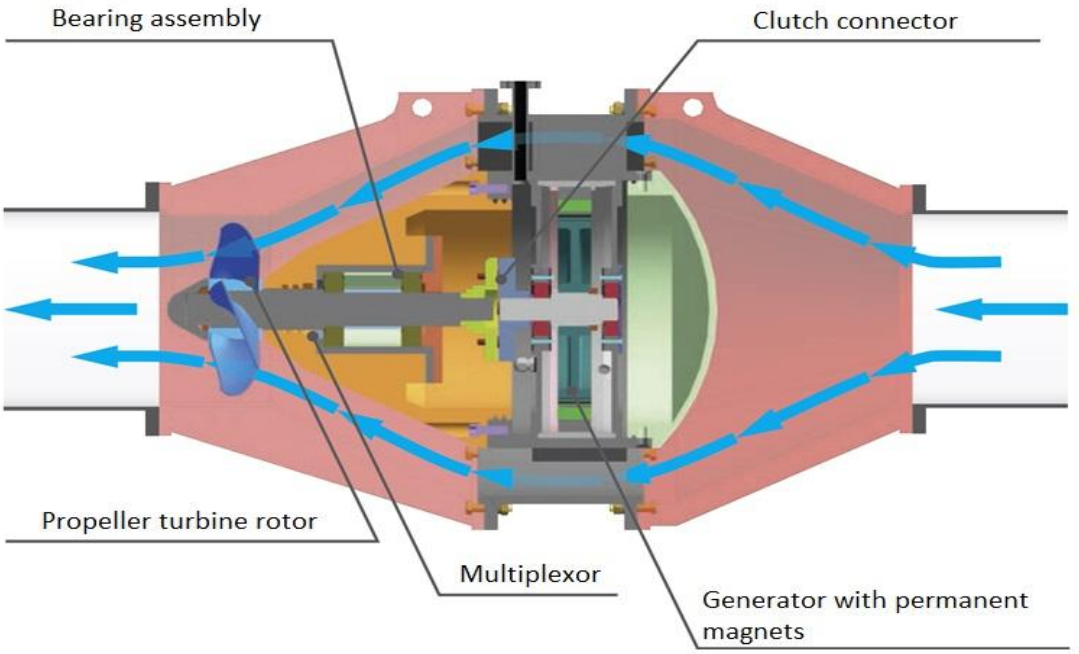

Fig. 1. Sectional drawing of typical hydrogenerator

What is very important: the installation generates the stabilized output voltage regardless of changing water flow, pressure, and network load.

Therefore, I suggest developing microhydropower engineering.

The reasons are:

– compact design of the introduced installation;
– using the power of small rivers, water supply and spillway systems;
– generation of stabilized voltage;
– absence of complicated mechanical transmissions;
– transformers and power transmission lines are not needed;
– low cost and rapid payback period.