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DEVELOPMENT OF A SIMULATION MODEL OF OPERATION MODES OF MICRO-HYDROELECTRIC POWER PLANTS

t.f.n. proffessor ***Sirojdin Fayozovich Ergashev***
Magistrant. ***Abdulazizov Sanjar Solijon o'g'li***
Fergana Polytechnic Institute

Abstract: In this state, with the use of the MATLAB Simulink modeling package, a model of the system of autonomous electrical supply of the village house with a power of 3 kW based on the micro-hydroelectric power plant is developed. A series of experiments was carried out using MATLAB software. And as a result of the experiments, the system electrical power supply system was studied and determined by different modes of operation.

Key words: imitation modeling; MATLAB Simulink; microhydroelectric power plant; generator.

Electricity plays an important role in today's economy. Today, the need to use renewable energy sources is evident. It is urgent to implement off-grid electricity production using renewable resources [1]. Microhydropower technology is relatively cheap and environmentally friendly, and other low-power renewable energy generation mechanisms can electrify a few backyards, villages, or roadside businesses, and can also be applied to mechanical drives for milling and turning [2; 3].

One of the main tasks of developing a methodological basis for the supply of electricity to autonomous consumers and designing a low-power micro-hydroelectric power plant is to develop a simulation model of a micro-hydroelectric power plant to determine energy production. Development of the Simulink model of micro-hydropower plants in Matlab software is used to identify errors.

The block diagram of a microhydroelectric power plant built on a valve converter with a phase-controlled ballast power stabilization system is shown in Figure 1, where GT is a hydraulic turbine; G - generator; N - payload; BN - ballast load, Ω - mechanical speed. The regulator valve control system (VRV) creates a certain control angle for the regulator thyristors (TR) depending on the magnitude of the control movement, which describes the deviation of the output electrical parameters of the installation from the nominal values. Based on this, it is possible to develop a simulation model in the matlab program.

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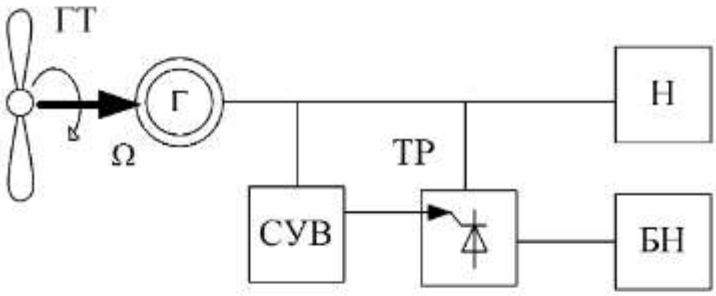

Fig 1. Structure scheme of microhydroelectric power plant

But it serves to avoid the absolute error that can be developed on the basis of mathematical equations.

Using the Matlab program, we simulate the following mathematical equations.

The electrical part of the machine model is described by a system of equations, with a rotor:

$$\frac{d}{dt} i_d = \frac{1}{L_d} U_d - \frac{R}{L_d} i_d + \frac{L_q}{L_d} p\omega_r i_q \quad (2)$$

$$\frac{d}{dt} i_q = \frac{1}{L_q} U_q - \frac{R}{L_q} i_q + \frac{L_d}{L_q} p\omega_r i_d - \frac{\lambda p \omega_r}{L_q} \quad (3)$$

$$T_e = 1{,}5p\,[\lambda i_q + (L_d - L_q)\, i_d\, i_q] \quad (4)$$

Here, the inductances and rotation speeds of the rotor on the d and q axes are calculated, and it is possible to obtain the current change characteristics on the axes.

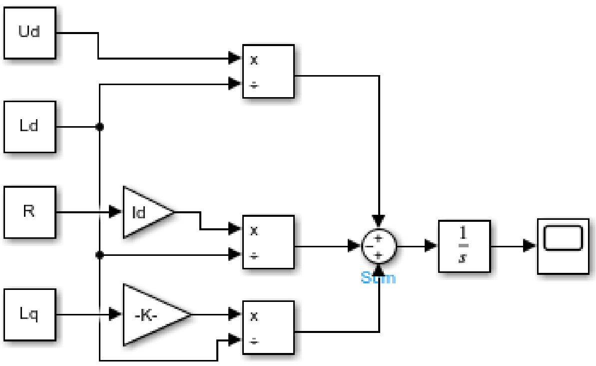

Fig 2. Simulation of a mathematical equation.

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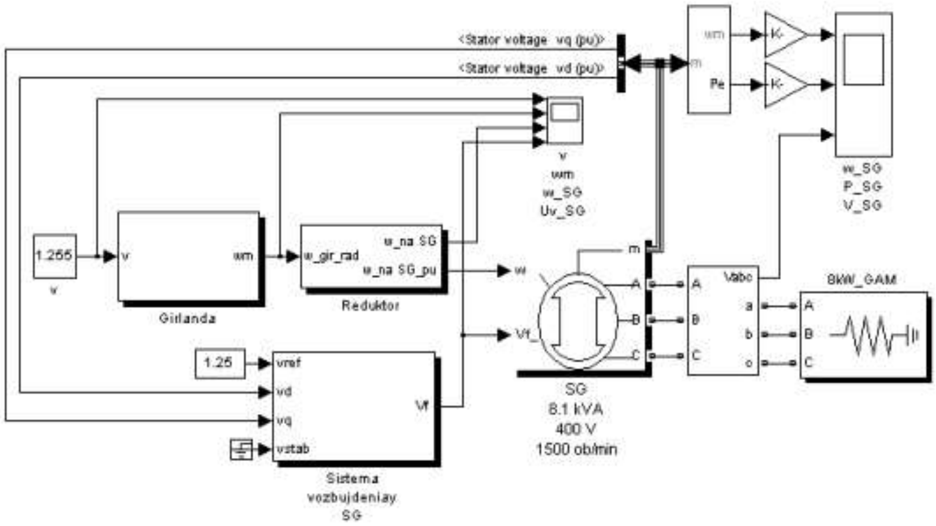
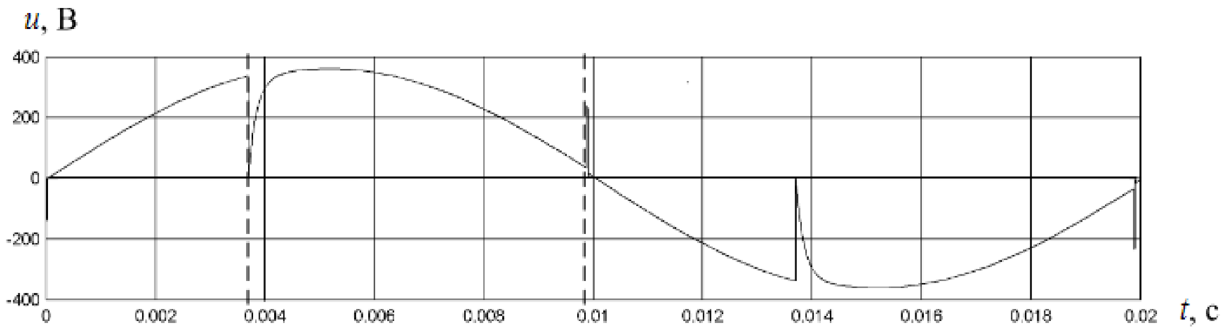


Fig 3. Structure of a mathematical model for microhydroelectric power stations

The next stage of research was modeling the operation of a station with an active ballast for a stabilization system built on fully controlled thyristors and thyristors with natural commutation. The installed ballast power was chosen equal to the active component of the rated power of the micro-hydroelectric power station generators. As an example in Fig. Figure 5 shows an oscillogram of the phase voltage obtained when the station was operating on active ballast with control angles α=66°, β=178°, corresponding to 40% of the payload power with cosφн=0.8.



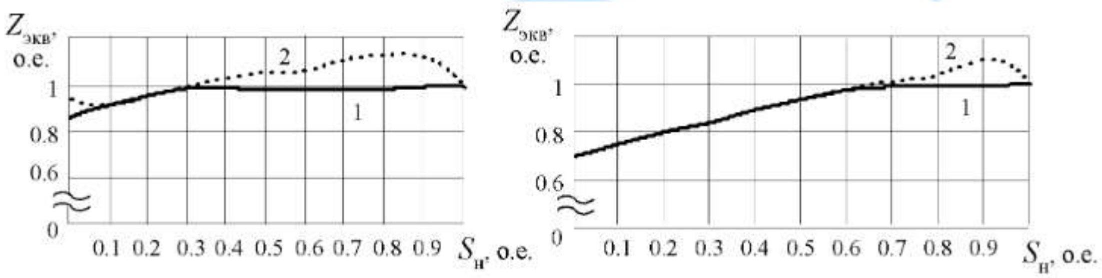


Fig 4. Characteristics obtained as a result of simulation

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