Analysis of various operating modes of the microhpp asynchronous generator using the matlab simulink program

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Abstract. This article analyzes changes in efficiency and power factor, as well as various operating modes in the capacitor element excitation method, which is increasingly used in asynchronous generators. In this case, the sinusoidal voltage and frequency produced by the induction generator are within the rated values and different operations are compared. The studies were carried out along with the parameters obtained using the simulation model as well as real experimental verification. The simulation model was built in the Matlab Simulink package, which consisted of a rectifier, filter circuit, IGBT transistors and included a control system. In the real experiment, an asynchronous generator with a low-power squirrel-cage rotor was chosen, and sensors for measuring current and voltage were installed on the experimental stand. As a result of the analysis of transient processes occurring in different operating modes of the generator, it was found that the values of voltage, current and frequency changed from the nominal value. The results were achieved by adjusting the speed through a variable speed drive to obtain the rated speed taking into account the speed supplied to the rotor from the hydraulic turbine. At the end of the study, it was concluded that the induction generator has a number of advantages over other types of generators, including simplicity of design, low cost, and the fact that it does not consume a direct current source.

1 Introduction

In recent years, in our country, in the field of electricity, there has been an emphasis on the use of renewable energy in order to increase the continuity and reliability of consumer electricity supply.

At the enterprises of economically developed countries, the production of Mini - and micro-GES with synchronous generators is divided into established, which are mainly intended to work in an autonomous mode. Some problems arise when using Mini - and micro-GES in parallel with electrical circuits, changing the flow of water requires adjusting the rotation speed of the expensive generator rotor and applying synchronization devices [1-5].

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It is known that asynchronous machines are mainly used in engine mode, so little attention is paid to its generator mode. Changing the primary energy parameters over a wide range of asynchronous motor in generator mode as well as rotor rotation speed and glide should change over large ranges. To switch from Motor mode to generator mode, the stator coil is connected to the grid using a primary motor to rotate the rotor of the asynchronous machine to the rotating side of the stator field, making the rotation frequency greater than the field rotation frequency (n > n1). The reactive power from the network is compensated using capacitor elements. In this case, the slip of the machine will have a negative signal and start working in generator mode [6-16].

The use of acixron generators in Mini - and micro-GES has several advantages. The main advantages of using acichron generators in Mini - and micro-GES include:

- Constructive simplicity of asynchronous generators;
- Low cost of asynchronous generators;
– Do not require the asynchronous generator to provide a constant current source;
- Ease of ecpulation work;

The frequency switch is in turn made up of a rectifier, filtering joint, inverter and control system. The rectifier function converts the alternating voltage to a oscillating constant voltage using a bridged diode rectifier. The filtering joint smoothes the rectified oscillating voltage. The inverter input receives a constant voltage from the filtering joint output, which the inverter converts to a three-phase alternating voltage. In most cases, the power part Shape of the inverter is in the form of a three-phase bridged circuit and is made up of six IGBT transistors with double conductivity. Adjusting the output frequency is carried out due to the influence of the signals of the control system on the inverter. In an inverter control system, the signal is converted into a sequence of pulses and given inverter IGBT transistors, thanks to which it is possible to adjust the output voltage and frequency amplitude. The value of the variable output voltage is determined from the adjusted voltage value [2, 3].

The research of microges asynchronous generators is relevant, taking into account the above.

2 Literature analysis and methods

To obtain the characteristics of computer-aided dynamic operating modes of a self-excitation asynchronous generator using a capacitor in microges devices, an imitation model for calculating electrical parameters was developed using the matlab package Simulink program, using first of all differential equations of a coved hydroturbine as well as a capacitor self-excitation asynchronous generator, mathematical description, mathematical model and structural schemes (Figure 1). This model makes it possible to determine the average quadratic value of IRMS current, URMS voltage value, hydroturbine input power, generator output power, Q reactive power, cosφ power factor, and asynchronous generator Fik [4]. To ensure the operation of the imitation model, it will be necessary to obtain data of phase voltage and current using an analog signal generator, in addition to sending the load-time voltages to the model in the form of numerical arrays. Then the amplitude processing of signals occurs.

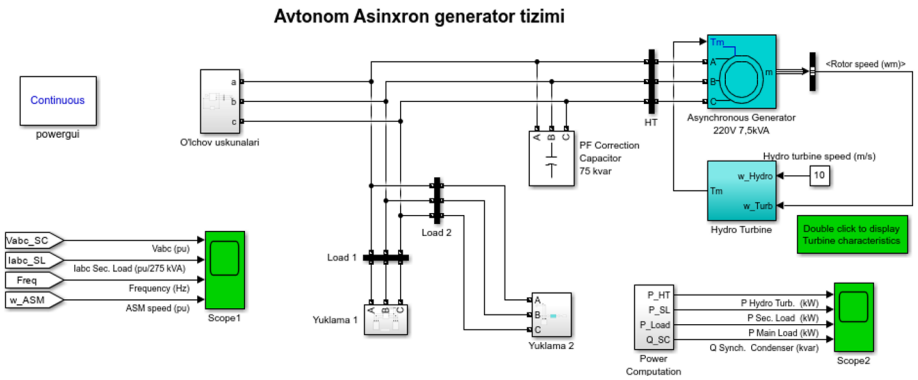

Fig. 1. Imitation model of autonomous microges asynchronous generator.

This imitation model used the following elements:

1) bucket hydroturbine – parameters of bucket hydroturbine in this element – diameter = 300 mm, length = 500 mm, bucket diameter = 100 mm, bucket number = 12, bucket size = 150 cm3, bucket shape – hemisphere.

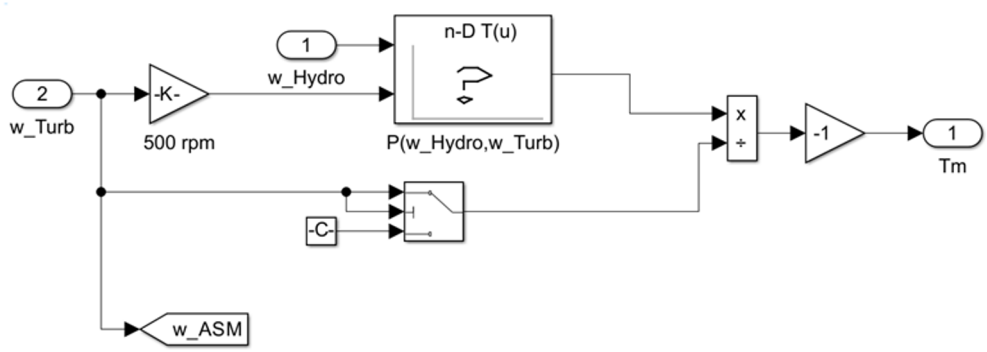

Fig. 2. Coved hydroturbine element.

In the coved hydroturbine element (Figure 2), w_turb is the rate at which a coved hydroturbine is subjected to water Enery, and the mechanical energy produced by its action is determined by a block of P (w_Hydro, w_Turb), with Tm mechanical moment being obtained as the result of the ushu element.

2) the parameters of the asynchronous generator – Rs, Ls, Rr, Lr, Lm, inertia, magnetic induction, produce electrical energy using mechanical energy being supplied from a coved hydro-turbine based on the number of pairs of Poles (Figures 3 and 4).

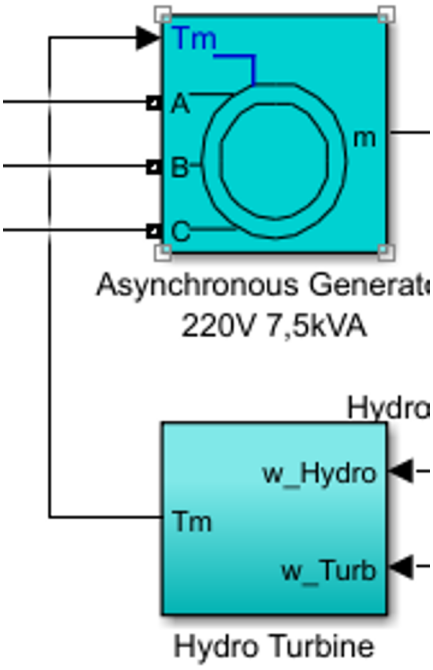

Fig. 3. Linkage of bucket hydroturbine and asynchronous generator elementers

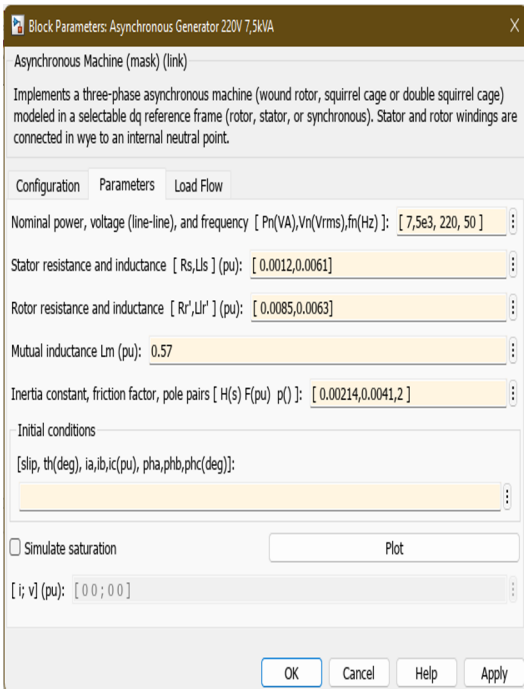

Fig. 4. Asynchronous generator parameters.

The capacitor shown in Figure 1 allows the asynchronous machine to operate in generator mode. The capacitor (Figure 5) provides the reactive power that the asynchronous machine receives from the network in engine mode at the time it starts, when the mechanical energy supplied from the hydrotrubine is given at a Speed 10% higher than the nominal speed of the asynchronous machine rotor, the asynchronous machine switches to the generator mode, generating variable sinusoidal voltage at the ends of the

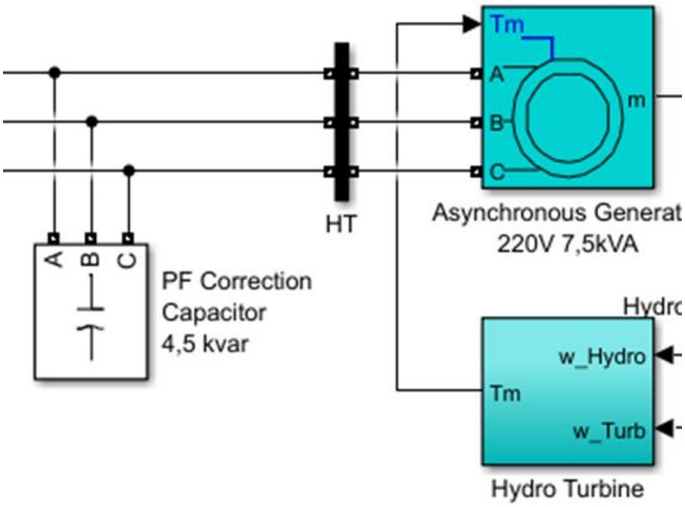

Fig. 5. Connection model of the capacitor in the network.

It is ensured that the phase voltage is 220 V at the time of operation without the asynchronous generator load. At the expense of the voltage drop at the time of connection of the load, there will be no 220 V on the network, in which the voltage will be 220 V with the help of measuring-control devices (Figure 6).

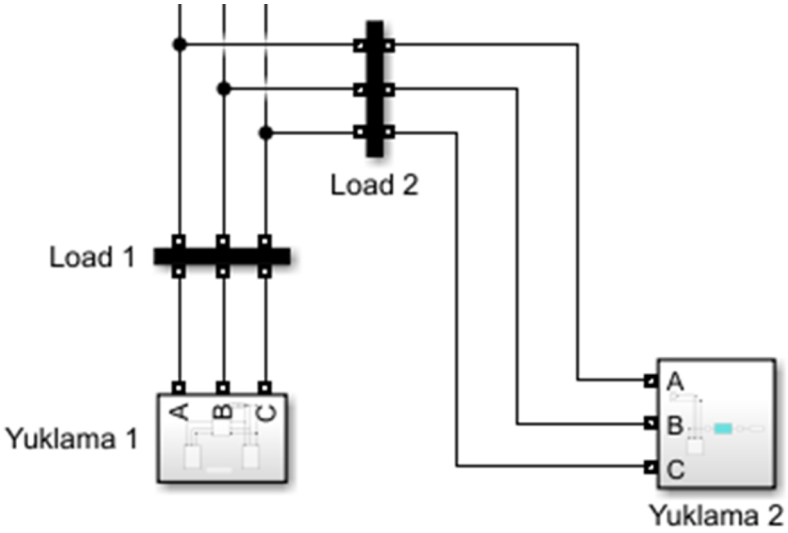

Fig. 6. Connection of downloads to the network.

In this case, with the help of a variator device, the speed supplied from the turbine is changed, at the expense of which the voltage emitted from the generator is adjusted.

3 Results and discussion

During the experiment carried out, microges made it possible to stabilize the voltage current network frequency of the electrical energy parameters being generated using an asynchronous generator.

The analysis of transient processes in the asynchronous generator during the connection of downloads to the network is analyzed using the characteristic obtained through the Scope element.

The instantaneous values of the voltages in the operating mode without loading are shown in Figure 7. The graph displays the variable three-phase voltage being produced by the asynchronous generator, with the phase voltage known to be at a value of 220 [V].

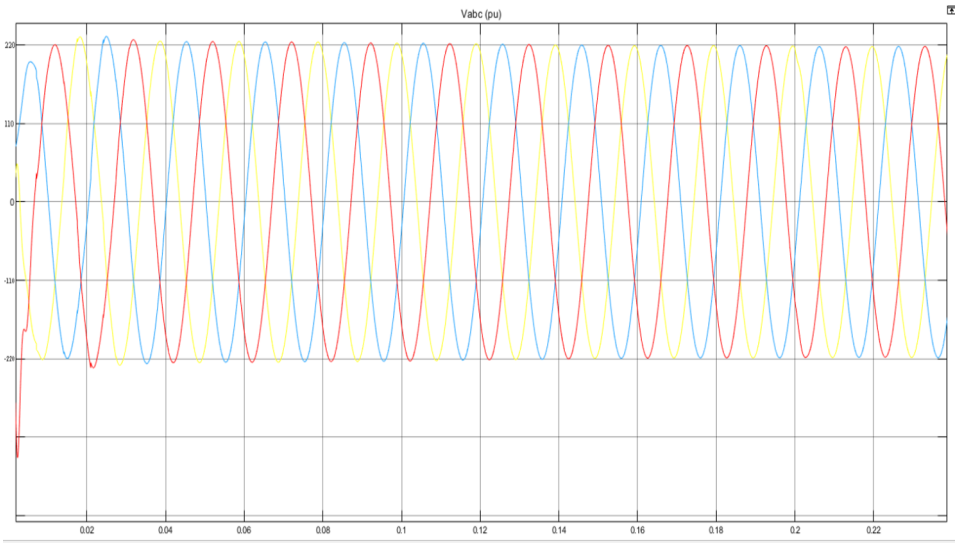

Fig. 7. Stator three-phase voltages at operating time without asynchronous generator load.

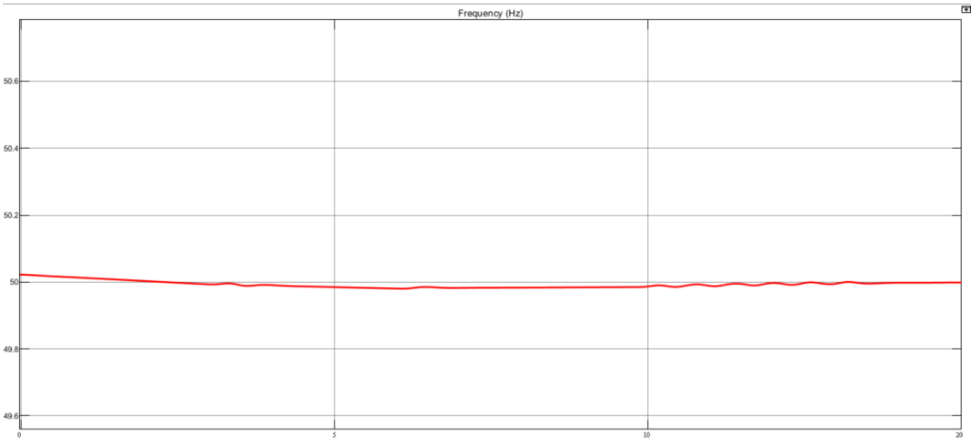

Fig. 8. Asynchronous generator start-up as well as the voltage frequency transferred to the network during operation without loading.

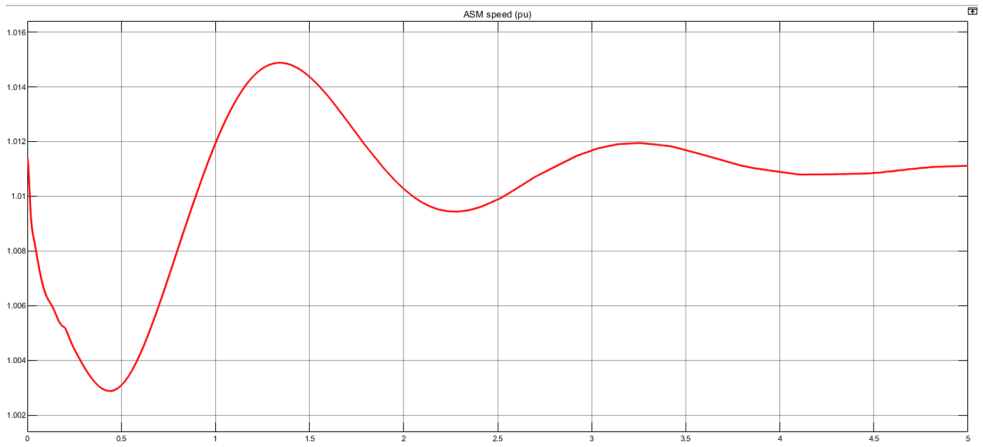

Fig. 9. Asynchronous generator rotor starting, load-free operation as well as changing rotor speed at load time.

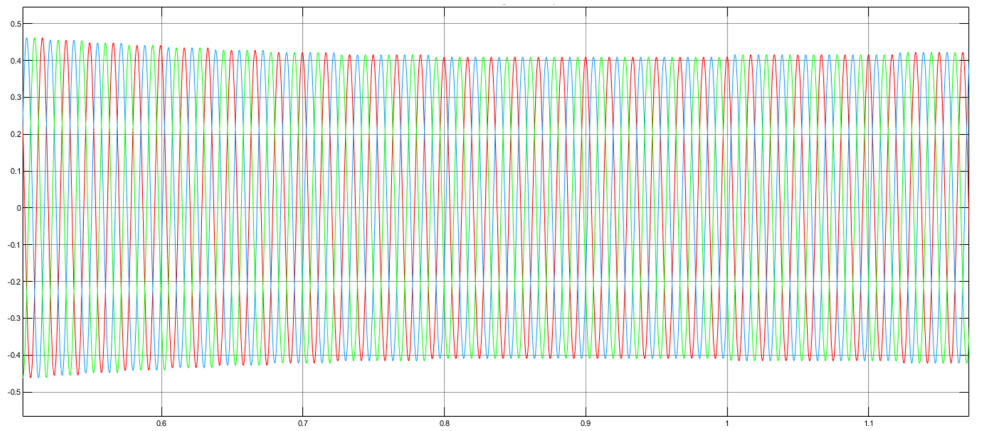

Fig. 10. Instantaneous values of currents in load-time stator phases.

4 Conclusion

Conclusions made on the basis of the developed imitation model and experimental results:
- Asynchronous generator the reactive power consumption through capacitor elements not from the network will have high efficiency;
– When the asynchronous generator works by self-excitation through the capacitor elements, the capacitor capacitance must be correctly assessed to the capacity of the generator;
– It is necessary to take into account external factors affecting the generator in order to bring the electrical energy parameters being produced to the nominal value.

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