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INDUCTION WIND GENERATOR USING EXCITATION CAPACITORS

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Annotation. *The development of autonomous energy is characterized by a growing need for autonomous sources of electricity of various capacities, increased requirements for the quality of electrical energy, reliability and efficiency. In this regard, the design and creation of autonomous sources of electricity based on induction generators with capacitor excitation is of certain interest. The possibility of using an induction generator, which is an induction machine with a squirrel-cage rotor and excitation capacitors, is analyzed, and the effectiveness of the proposed solution is shown.*

Keywords: *induction generator, excitation capacitors, magnetic characteristic.*

It is known that the simplest electromechanical energy converter in terms of design is an induction generator (IG), which is an induction machine (IM) with a squirrel-cage rotor and excitation capacitors. In addition, IG has a number of positive qualities: contactlessness, simplicity of design, strength and high reliability. These special advantages of IG are indicated by many domestic and foreign authors of theoretical and experimental works on the study of IG with capacitor excitation.

At the same time, IG with a squirrel-cage rotor in the usual design of the stator winding has limited capabilities during operation due to certain shortcomings. For example, in case of short circuits at the IG terminals, its voltage drops to zero with the possible disappearance of the residual magnetic flux in the IM, which complicates and delays the IG voltage recovery process in time. The studies conducted in [1, 2] showed that the existing shortcomings of IG can be successfully eliminated by using multi-winding IGs, i.e. IM with a different number of windings on the stator, connected according to different schemes, including autotransformer, with a spatial shift between the windings.

The use of conventional IM with one winding on the stator as generators has limited possibilities due to overloading of the electric machine with reactive current.

IM with two windings on the stator, connected according to different schemes, provide an improvement in the technical and economic indicators of IG [3]. In this case, there is a need for electromagnetic conversion and rewinding of IM for other voltages and speeds of rotation of the electromagnetic field of the machine. As a rule, the task of electromagnetic conversion includes not only the choice of the type of windings, but also the determination of electromagnetic loads, including the number of pole pairs, the cross-section of the winding wire and the required stator slot filling factor, etc.

In a conventional IM with one stator winding when operating in the AG mode, an increase in the load current leads to a decrease in the voltage on the excitation capacitors, which contributes to a progressive decrease in the capacitive shear capacity, which is in a quadratic dependence on the voltage. A generator in a two-phase design of stator windings, located in space at an angle of 90 electrical degrees and with a certain capacitance as an exciting element, obtains a balanced mode with a circular rotating magnetic field. However, to obtain a circular magnetic field at any rotor rotation speed, it is necessary to change the capacitance of the excitation capacitors or use two-phase stator windings connected according to an autotransformer circuit.

The magnetic characteristic of the IM not only allows us to judge the magnetic properties of the electric machine, but also makes it possible to determine the value of the capacitance required to excite the IM to a given voltage at idle and operate it as a generator according to the self-excitation scheme [4].

In Fig. 1, curve 2 represents the AC current, and the dependence of the voltage on the no-load current is expressed by the following equation

$$U_1 = I_c \omega L = f(I_{xp}) \text{ at } f = const , \quad (1)$$

where: $I_c = I_{xp} \sin(\varphi_{xx})$; I_{xp} - reactive current at idle.

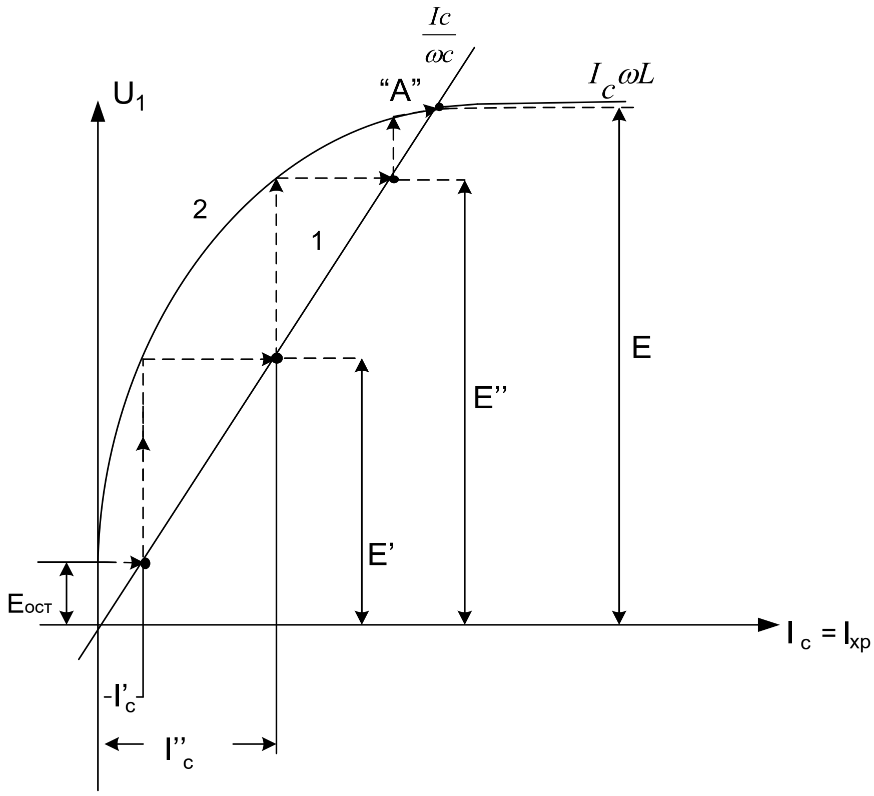

Fig. 1. The process of self-excitation of IG

The dependence of the voltage at the terminals of the excitation capacitors on the current flowing through them (line 1 in Fig. 1) can be written as follows:

$$U_1 = \frac{I_C}{\omega C} = f(I_C) \tag{2}$$

The process of self-excitation of an AM operating in the generator mode continues until $(x_1 + x_\mu)I_c > x_c I_c$ and ends at the equilibrium point "A" in Fig. 1, when the equality $(x_1 + x_\mu)I_c = x_c I_c$ occurs.

The equilibrium at point "A" makes it possible to determine the relationship between the total inductance of the IG and the excitation capacitance at a given frequency:

$$LC = \frac{1}{(2\pi f)^2} = \frac{1}{\omega^2} \tag{3}$$

The value of the reactive component of the current sinφ $_{xx}$ can be determined for a given voltage IM from the magnetic characteristic of the machine, and the value of the phase capacitance of the capacitor bank required for self-excitation of the IG to a given voltage at a given number of rotor revolutions can be determined by calculation using the following expression

$$C_\phi = \frac{I_x \sin\varphi \cdot 10^6}{\omega U_{xx}} \tag{4}$$

As can be seen from Fig. 1, self-excitation of IG is usually carried out at idle speed and is possible only in those cases when line "1" of the dependence of the voltage on the excitation capacitors on the current flowing through them intersects the idle curve "2" of the generators and if there is a residual magnetic field of the rotor.

Thus, the issue of capacitive self-excitation of IG is of some interest, both from an operational point of view and from the point of view of theoretical and experimental research of the operation of autonomous IG in various modes.

Conclusions.

Placing two windings on the IG stator allows, at a given generator voltage, to choose its excitation voltage of any value and to make the connection with the voltage of the working winding less dependent. It is worth considering that when using several IG stator windings, it becomes possible to apply an increased voltage to the excitation capacitors and a corresponding reduction in the required capacitor capacity. In addition, it is advisable to connect the stator windings according to an autotransformer scheme, which allows to increase the generator power.

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