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Electromotors

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Electric machines are widely used in power plants, industry, transport, aviation, automatic control and management systems, in everyday life.

Electrical machines convert mechanical energy into electrical energy, and vice versa. A machine that converts mechanical energy into electrical energy is called a generator. The conversion of electrical energy into mechanical energy is carried out by engines.

Any electric machine can be used both as a generator and as an electric motor. This property of an electric machine to change the direction of the energy it converts is called the reversibility of the machine. An electric machine can also be used to convert the electrical energy of one kind of current into the energy of another kind of current. These electrical machines are called *converters*.

Depending on the kind of current electrical installation in which the electric machine must operate, they are divided into DC and AC machines.

AC machines can be both single-phase and multi-phase. The most widely used three-phase *synchronous and asynchronous* machines and also categories AC machines that allow the economical speed control in a wide range.

Currently, asynchronous motors are the most common electrical machines. They consume about 50 % of the electricity produced by the country's power plants. Such widespread asynchronous electric motors received because of the constructive simplicity, low cost, high operational reliability. They have a relatively high efficiency if the power is more than 1kW, efficiency = 0.7:0.95 and only in micro-motors, he is reduced to 0.2 to 0.65.

Along with the great advantages asynchronous motors have some disadvantages: the consumption of reactive current from the network, necessary to create a magnetic flux, resulting in asynchronous motors operate with cos = 1. In addition, the ability to adjust the speed they are inferior to DC motors.

The most common among electric motors was a three-phase asynchronous motor, first designed by the famous Russian electrician M.O. Dolivo-Dobrovolsky. The asynchronous motor is simple in design and easy to maintain. Like any AC machine, the induction motor consists of two main parts – the rotor and the stator. The stator is the stationary part of the machine, the rotor is its rotating part. The asynchronous machine has the property of reversibility, that is, it can be used both in the generator mode and in the engine mode. Due to a number of significant drawbacks, asynchronous generators are practically not used, whereas asynchronous motors are very widespread.

The multi-phase AC winding creates a rotating magnetic field whose rotational speed per minute is calculated by the formula:

n1 = 60f1/p, where:

n is the rotation frequency of the magnetic field of the stator;

f - frequency current in the network;

p - is the number of pairs of poles.

If the rotor rotates at a frequency equal to the frequency of rotation of the magnetic field of the stator, then this frequency is called synchronous.

If the rotor rotates at a frequency not equal to the frequency of the magnetic field of the stator, then this frequency is called asynchronous.

In an asynchronous motor, the working process can occur only at an asynchronous frequency, that is, at a rotor speed not equal to the frequency of rotation of the magnetic field.

The nominal speed of the induction motor depends on the speed of the magnetic field of the stator and cannot be chosen arbitrarily. At the standard frequency of industrial current f1 = 50Hz possible synchronous speed (magnetic field speed) n1 = 60f1/p = 3000/p.

In asynchronous motors, the permanent magnet is replaced by a rotating magnetic field created by a three-phase stator winding when it is connected to an alternating current network.

The rotating magnetic field of the stator crosses the conductors of the rotor winding and induces EMF in them, that is, the electromotive force. If the rotor winding is closed to any resistance or shorted, then a current passes through it under the action of the induced electromotive force. As a result of the interaction of the current in the rotor winding with the rotating magnetic field of the stator winding, a rotating moment is created, under the action of which the rotor begins to rotate in the direction of rotation of the magnetic field [1].

Asynchronous motors produce power from several tens of watts to 15000kw at voltages up to 6 kV stator winding.

Between the stator and the rotor there is an air gap, the value of which has a significant impact on the operating properties of the engine.

Along with the important positive qualities – simple design and maintenance, low cost – asynchronous motor has some disadvantages, of which the most significant is the relatively low power factor (cos). In an asynchronous motor, the cos at full load can reach a value of 0.85-0.9; when the engine is underloaded, its cos decreases sharply and at idle is 0.2-0.3.

Special attention should be paid to *servomotors*:

These engines occupy a special place where precision changes in position and speed of movement are required. These are space technology, robotics, CNC machines, etc.

This engine is different types of transport because small diameter is light-weight. This speeds up the process, i.e. fast movements. These engines usually have a feedback sensor system that allows you to increase the accuracy of movement and implement complex algorithms for movement and interaction of various systems [2].

Synchronous servomotors – these classic three-phase synchronous motors, driven by several permanent magnets. Additionally, they have a built-in rotor position sensor.

The whole structure is very compact and reliable. The main advantage of such engines is the absence of inertia. They are accelerated and stopped in thousandths of a second, they are perfectly combined with various pulse machines and systems, and also due to their linearity they are perfectly controlled using computer programs [3].

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