THE MOST APPLIED POWER ASYNCHRONOUS MOTORS LABOUR CHARACTERISTICS

Anna Shymanska, Ph.D., Evhen Dubchak, senior lecturer, Yaroslav Novitskyi, student
Igor Sikorsky Kyiv Polytechnic Institute, Departament of Electromechanics

Introduction. The most common in Ukraine are motors with a nominal power of 0.6 - 400 kW, operating at voltages up to 1000 V. Mostly the needs of consumers of electric motors are met by domestic suppliers, but in most cases only motors up to 20 kW. For motors with a capacity of more than 20 kW, the quality of foreign electric motors is much higher, and although the price is also quite high, the main criteria in choosing electric motors of this power are reliability and durability, so in this regard, quality is more important than price [1]. Due to the absence of contact brushes in asynchronous electric motors that can cause sparks and electric arcs, such motors in normal operation do not pose a risk of fire. Under the condition of high-quality cooling of windings and operation in the nominal mode, the service life of the motor can be measured for decades.

In electric motors that have a phase rotor in their design, contact pairs are used in the form of copper rings and graphite brushes that can spark during operation. This action is similar to the operation of DC motors and can cause fire hazards accordingly. According to statistics, motors often fail due to overheating of the windings that occurs during maximum mechanical loads on the shaft. This leads to overheating and damage to the insulation of the windings and a possible short-circuit or breakdown on the motor housing.

Also the emergency mode can be a mode that occurs when the voltage on one of the phases of the motor supply (blown fuse or oxidation of contact pairs). In this emergency mode the current increases sharply, the motor begins to heat up quickly and can burn [2]. Maintenance of asynchronous motors involves scheduled maintenance in which bearings are lubricated, contact pairs and brushes are wiped and cleaned and replaced if necessary, insulation resistance is checked (to check for electrical breakdown on the housing), and threaded connections are tightened if necessary. The cooling conditions of the engine as overheating can damage the insulation, cause electric shock and fire must be monitored.

Asynchronous AC motors are usually equipped with direct thermal protection systems against overheating, the action of which is based on thermal current protection. Such protection has low accuracy, reacts poorly to short-term changes in temperature of motor windings. Another way of protection is not direct. It is not the motor temperature that is measured, but the current consumed by it. If this current exceeds the maximum allowable norms, the motor is automatically disconnected from the mains. Since this protection does not react to the motor temperature, but to the current consumed and does not take into account the period of operation in extreme loads, the actual cooling conditions and ambient temperature, this is a significant disadvantage. Such protection is defective because it cannot fully take into account the overload capacity of the induction motor, which in turn leads to a decrease in productivity during repeated short-term operation [3].

The aim of the work. To analyze the features of manufacturing and use of three-phase asynchronous motors of the most applied power (nominal power 0.6 - 400 kW) on the example of a three-phase asynchronous motor with a capacity of 7.5 kW, calculation and analysis of its labour characteristics.

Materials of research. After analyzing the graphs of the dependences, we found that during idling, the electric current consumed is small, and the torque caused by this current is almost zero. In this mode, the speed of rotation of the shaft almost coincides with the frequency of rotation of the magnetic field. If we start to load the engine we observe decrease in speed of rotation and increase in sliding. This increase in slip leads to a proportional increase to the electromotive force (EMF) in the rotor, which in turn increases the current in the rotor and, accordingly, increase the torque. For a short period of time, this increase stops and an equilibrium occurs between the torque of the load and the torque of the magnetic field of the coils at a lower speed.

The graph of the dependence $n_2=f(P_2)$ shows a slight dependence of the change n_2 when changing P_2. This decrease at rated load is usually not more than 1-8%. In this mode of small slip, the engine operates in a fairly economical mode, because the electrical losses in the rotor are proportional to the slip. The net power of the motor is equal to the product of the net torque on the motor shaft and the angular velocity of the rotor: P_2 = $M_2\omega_2$. The graph of correspondence $M_2 = f(P_2)$ is not linear, because with increasing load P_2 the speed decreases. The graph of current dependence $I_1 = f(P_2)$ is close to a straight line because with increasing load the current I_1 increases in proportion to the power P_2. This graph does not originate from the origin because during idling the motor consumes from the mains idling current I_0 which is although small, but always greater than zero. It is due to the loss of energy on the mechanical forces of friction resistance and the loss of magnetic flux in the air gap. In induction motors the idling current can be in the range from 20% to 30% of the nominal. There are also special low-power motors in which the no-load current can significantly exceed these values. From the graph $\cos\varphi_1 = f(P_2)$ we found that at low loads φ_1 lies within 0.2 ÷ 0.3. As the load increases the power factor increases. Its maximum value can be 0.75 ÷ 0.85 when the load corresponds to the nominal rate. It is due to the fact that at any engine load in any case uses from the network reactive current of approximately the same magnitude.

The current consumption of the electrical network contains a reactive component, which is present regardless of whether the motor is running under load and at idle and this is the reason for the low value of $\cos\varphi_1$. Increasing the load, respectively, increases the active component of the current I_1, and increases the power factor. At sufficiently large loads when the shaft speed drops significantly, we observe a very large slip, cosφ1 decreases, because the inductive resistance of the rotor winding increases with increasing slip. After analyzing all the data obtained, we see that the operating characteristics of the motor correspond to the standard characteristics of induction motors used in production. From this we can conclude that the construction of the engine was done correctly.

The performance of an induction motor is the dependence of various electrical and mechanical parameters of the motor on the power on the shaft under conditions of operation at rated voltage and mains frequency.

There are the following labour characteristics: $n_2 = f(P_2)$ – the dependence of the rotor speed on the power on the shaft; $s = f(P_2)$ – dependence of sliding on power on the shaft; $I_1 = f(P_2)$ – the dependence of the line current consumed from the network on the power on the shaft; $P_1 = f(P_2)$ – the dependence of power consumed from the network on the power on the shaft; $M_2 = f(P_2)$ – the dependence of the torque on the shaft on the power on the shaft; $\eta = f(P_2)$ – the dependence of the efficiency of the engine on the power on the shaft; $\cos\varphi_1 = f(P_2)$ – the dependence of the power factor on the power on the shaft (Fig. 1).

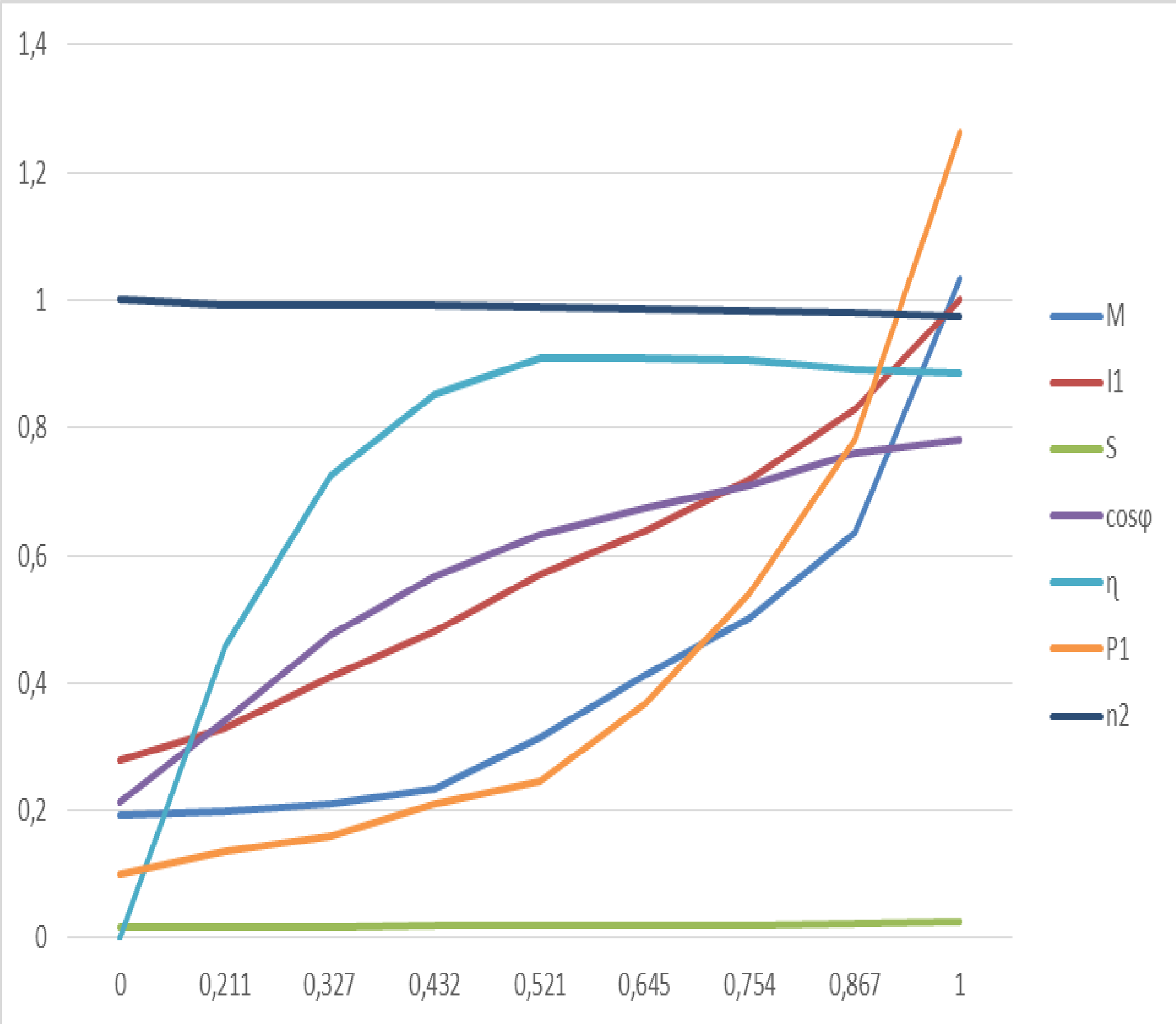

Figure 1 – Dependence of rotor speed, slip, linear current consumed from the network, power consumed from the network, torque on the shaft, efficiency of the engine, power factor on the power on the shaft

Labour characteristics can be taken experimentally, i.e. gradually load the engine and measure all the necessary values. According to the passport data, it is possible to calculate the nominal power consumption from the network, the nominal slip and the nominal torque. Therefore, normalized labour characteristics are often built in relative units.

Conclusions. The main results of the work can be summarized by the following conclusions: 1) 7.5 kW asynchronous motor with a short-circuited rotor winding is widely used in production so there is often a need for motors of the same power, but with better performance and starting characteristics; 2) currently in Ukraine the most common asynchronous motors with power from 0.06 to 400 kW operating at voltages up to 1 kV (the most popular and make up about 90% of the industrial fleet); 3) reducing the cross section of the stator winding achieved a reduction in starting current was achieved; 4) the labour characteristics of the induction motor were calculated, constructed the analyzed; The curve does not originate from the origin because during idling the motor consumes from the mains idling current which, although small, but always greater than zero. This is due to the loss of energy on the mechanical forces of friction resistance, the loss of magnetic flux in the air gap. In induction motors, the idling current can be in the range from 20% to 30% of the nominal. There are also special low-power motors in which the no-load current can significantly exceed these values; This is due to the fact that at any engine load in any case uses from the network reactive current of approximately the same magnitude. The current consumption of the electrical network contains a reactive component, which is present regardless of whether the motor is running under load and at idle and this is the reason for the low value of cosφ1. Increasing the load, respectively, increases the active component of the stator current and increases the power factor.

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