Device for measuring the magnetic scattering field of the frontal part of the stator winding of a traction asynchronous electric motor of an electric rolling stock

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Abstract. The article deals with the issues of improving the energy efficiency of mainline locomotives with asynchronous traction motors by determining the characteristics of the traction drive using a device for measuring the magnetic scattering field of the frontal part of the stator winding.

1 Introduction

To date, asynchronous traction motors have found wide application in railway transport. In the Republic of Uzbekistan, about 80% of all electric locomotives in operation are equipped with asynchronous traction motors (ATM). Increasing the energy performance of rolling stock is one of the urgent problems of railway transport. One of the ways to achieve these tasks is to determine the characteristics of the traction drive. The accuracy of determining the parameters and characteristics of asynchronous traction motors at the present stage of the development of electrical engineering has quite high requirements. The parameters of equivalent replacement circuits of these electric machines are the initial data when using algorithms for calculating transients of electric machine systems. The character of the transient processes of machines is more influenced by the magnetic field of the scattering of windings [1-7]. The magnetic field in the area of the frontal parts of the stator winding of electric machines has a complex distribution. The magnetic field in the zone of the frontal parts of the stator winding of electric machines has a complex distribution. Knowledge of the field pattern is necessary to determine the electrodynamic forces acting on the frontal parts of the stator windings and the structures surrounding them to determine the inductive resistance of the frontal parts, to determine losses in the end parts of the stator core and in the massive structural elements of the end zone of electric motors [8-14].

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2 Objects and methods of research

The object of the study is ATM, in particular the magnetic scattering field of the frontal part of the stator winding. One of the well-known methods of modeling the magnetic field of scattering of the frontal part of the stator winding and the rotor of a synchronous machine is the work of Novozhilov A.N. [15].

Modeling of the magnetic field of frontal scattering of windings of synchronous machines in operational modes of operation is carried out by dividing the process into two stages. At the first stage, the magnetic field of one turn of the stator section and the rotor winding coil with a current I = 1 A is simulated. In calculations, the stator section is considered symmetrical. Then, according to the known distribution of the magnetic field of one turn, the location of the sections in the stator core, the magnetic field from the frontal part of the stator phase is modeled by the superposition method. At the second stage, the magnetic field from the frontal part of the stator phase of the synchronous machine is determined by the known induction dependencies $B_{ylv}(X)$ and $B_{zlv}(X)$. The disadvantage of this method is the complexity and inaccuracy, since the results of calculating the magnetic field induction by this method do not satisfy the boundary conditions due to the asymmetry of the currents.

The second known method of modeling the magnetic field of scattering of the frontal part of the stator winding of AC machines with a compact stator winding is the work of Tabachinsky A.S. [16]. To study electromagnetic processes in the active and end parts of AC machines with compact stator winding, 2D field models were created in the Elcut software package. The disadvantage of this method is the inaccuracy of measurements, since in the model three conductors in the stator groove layer are replaced by one equivalent.

A device is also known for experimental investigation of the electromagnetic field in the area of the frontal parts of the stator winding in the presence of conductive screens [17]. The studies were carried out on a static model of the end part of the stator of a two-pole shock generator with a single-phase concentric winding, the frontal parts of which are 90 °. The modeling winding consisted of two sequentially connected coil groups, six coils in each group. The coils were wound with a rectangular copper wire measuring 10x2.5 mm and had one turn each. The power supply was carried out by alternating voltage with a frequency of 50 Hz. For the convenience of measuring the scattering magnetic field and subsequent processing of the experimental results, a special probe with three Hall sensors was manufactured. The disadvantage of this method is the complexity of the design of the modeling winding and the inaccuracy of measuring the magnetic scattering field of the frontal part of the stator winding of an electric machine.

3 Results and their discussion

This article solves the problem of simplifying the measuring conductor and improving the accuracy of measuring the magnetic scattering field of the frontal part of the stator winding of a traction asynchronous electric motor of an electric rolling stock. The problem is solved by the fact that in this device for the experimental study of the electromagnetic scattering field in the zone of the frontal parts of the stator winding, including a winding made of a copper conductor and powered by an alternating voltage with a frequency of 50 Hz, as well as a magnetic scattering field meter fixed in the stator, a meter (measuring conductor) of the magnetic scattering field of the frontal part of the stator winding mounted against the frontal part of the stator winding in the form of an arc with a length equal to the pole division and radius, equal to the radius of the location of the heads of the frontal parts of the stator winding. At the same time, a measuring conductor for measuring the magnetic scattering field of the frontal part of the stator winding is installed in the bearing shield against the frontal part of the stator winding. The advantage of this method of measuring the magnetic scattering field of the frontal part of the stator winding is a simplified circuit and high measurement accuracy [20].

Figure 1 shows an electrical diagram of a device for measuring the magnetic scattering field of the frontal part of the stator winding of an ATED of an electric rolling stock.

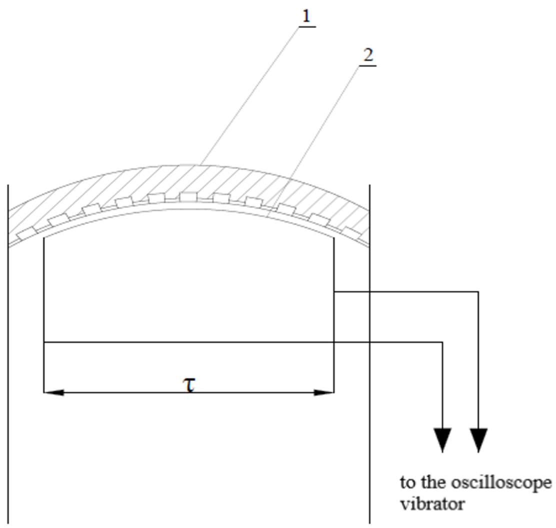

Fig. 1. Electrical diagram of the method for measuring the magnetic scattering field of the frontal part of the stator winding ATM

According to Figure 1, the frontal part of the stator winding 1 is presented, opposite the frontal part of the stator winding 1 there is a measuring conductor 2 installed in the bearing shield 3 in the form of an arc with a length equal to the pole division and a radius equal to the radius of the location of the frontal parts of the stator winding. To measure the magnetic scattering field of the frontal part of the stator winding, the input ends of the measuring conductor 2 are connected to the oscilloscope vibrator.

Figure 2 shows the mounting and location of the measuring conductor in two projections:

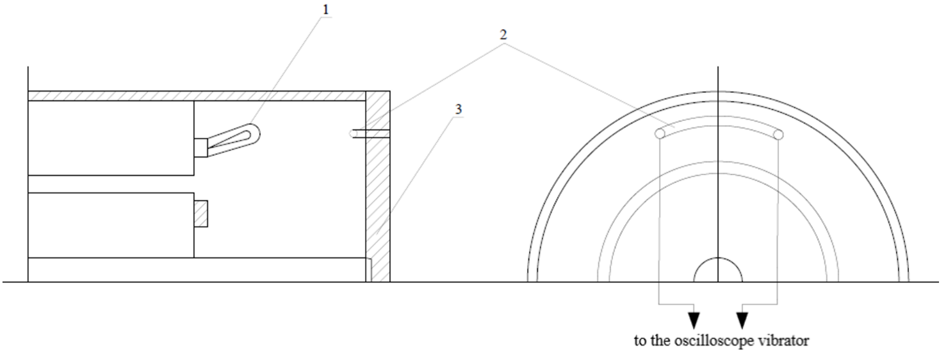

Fig. 2. Mounting and positioning of the measuring conductor in the stator winding in two projections.

Figure 3 shows the change in the magnetic scattering field of the frontal part of the stator winding of a traction asynchronous electric motor of an electric rolling stock.

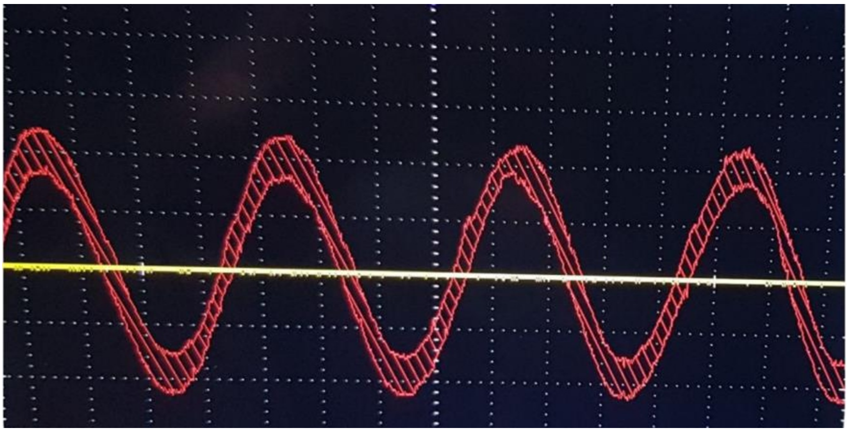

Fig. 3. Magnetic scattering field of the frontal part of the stator winding ATM

The device works as follows: when a three-phase power supply is connected to the terminals of the stator winding, a magnetic scattering field of the frontal part of the stator winding occurs in the frontal part of the stator winding. At the same time, the magnetic scattering field of the frontal part of the stator winding induces an EMF in the measuring conductor, if necessary, oscillography of the magnetic scattering field of the frontal part of the stator winding, the output ends of the measuring conductor are connected to the oscilloscope vibrator.

4 Conclusions

The proposed method and device for measuring the magnetic scattering field of the frontal part of the stator winding of the ATED of an electric rolling stock makes it possible to significantly simplify the measurement of the magnetic scattering field of the frontal part of the stator winding, the accuracy of measurements and increases energy efficiency due to constructive measures, the implementation of which will reduce losses in the end zones. Also, this method can be used in design institutes to measure losses in the end parts of the designed models for further research.

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