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ANALYSIS OF THE PROPERTIES OF HIGH-VOLTAGE INSULATION OF TRACTION ELECTRIC MOTORS OF LOCOMOTIVES

Tursunov Khurshid Makhmudzhanovich¹, Zhuraev Zohid Zahirovich²

¹ Candidate of Technical Sciences, docent, Tashkent State Transport University, Uzbekistan, Tashkent,

² Master's student, Tashkent State Transport University Uzbekistan, Tashkent

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ABSTRACT

The article presents an analysis of properties of high-voltage insulation of locomotive traction electric engines and offers ways to improve their operational reliability.

Analysis of the results of long-term operation in the world of traction rolling stock testifies that of all variety of elements of traction electrical equipment, the most low operational reliability is characterized by high-voltage insulation, especially insulation of winding of locomotive traction engines, due to breakdown of which up to 20 % of engine failures occur in operation [1,2,3].

It should be showed; that the cost of high-voltage insulation in modern traction electric machines reaches 50% of the total cost of materials used for their production, and restoration of failed insulation is comparable in cost with the cost of machine overhaul.

In order to choose the correct ways to improve operational reliability of electric traction insulation and objective methods of diagnostics, it is necessary, first, to study

physical essence of processes occurring in insulation under the influence of different types of loads, to identify the causes of intensive reduction of electric strength. Breakdowns and inter-turn short circuits of armature windings, pole and compensating coils cause more than 40% of the total number of damages of electric locomotive traction motors. The greatest number of these damages occurs in winter and spring-winter seasons and especially during snowstorms, snowfalls, as well as ambient temperature fluctuations, i.e. in conditions contributing to dampening of insulation. It should be noted that surface wetting of windings of "healthy" insulation is usually not dangerous. The danger is a deep moistening, which becomes possible when the insulation has cracks, abrasions, porosity and other sometimes-invisible damage, through which the moisture mixed



with impurities penetrates deep into the winding. Thus, insulation breakdown can be considered as a combination of unfavorable factors - defects in insulation and moisture, contamination. The more defects in the insulation, the faster they manifest themselves, and at the same time, the more moisture, the more dangerous the presence of even small damage to the insulation becomes, especially for DC traction motors of electric locomotives, the insulation of which is designed for 3000 V.

Therefore, to improve the reliability of insulation of traction motors, it is necessary to ensure high quality of manufacturing and repair of windings, as well as proper operation and maintenance of machines.

It should be noted that insulation aging is a natural and irreversible process, since the operating temperature of the windings inevitably causes gradual destruction of the insulation. However, this process can be significantly slowed down with proper operation of electric machines. It is known that increasing the operating temperature of the windings by 10 ° C reduces the service life of their insulation by half. Therefore, special attention should be paid to the heating of machine windings, which is determined by correct choice of train weight and strict implementation of its control mode, observance of the established modes of traction engine ventilation. In addition, it is necessary to ensure that the current distribution between traction motors on electric locomotives is uniform.

The existing cycle of scheduled preventive repairs of electric machines is developed from the conditions of ensuring restoration of insulating properties of windings depending on the mileage of machines. This system provides for complete replacement of insulation at

overhaul after mileage of 1320 thousand km and its restoration at average repair after mileage of 330 thousand km on average in the railroad network.

In case of overhaul it is obligatory to replace all the armature and compensator winding insulation, impregnate the armature three or two times (including one vacuum-pressure impregnation) in thermosetting varnish. Obligatory replace the case insulation of pole coils, check their insulation between turns and between layers, double compounding of pole coils and coating the armature and pole windings with electric insulation enamel.

Before impregnation, anchor bands must be removed from the armature ends. Vacuuming the windings and the subsequent injection of varnish under pressure with the winding ends open creates conditions for deep penetration of the varnish inside the insulation. The varnish, filling the defective places, improves the structure of the insulation, cements the winding, and protects it from the environment. A similar effect is produced by compounding pole coils.

For armatures impregnation thermoactive varnish fl-98 is used which main advantage (in comparison with previously used oil-bitumen varnishes) is curing ability in a thick layer and not softening at repeated heating. These lacquer properties exclude the possibility of its leakage at working heat of the windings in operation. For protective coatings of electric machine windings, ES-91 and GF-92-GS hot-drying electric insulating enamels are used.

After impregnation of armature windings, compounding of pole coils and their drying, the windings are covered with electric insulating enamel, which forms a



strong uniform surface film, providing protection of the basic insulation against oxidation by air oxygen, as well as against dust, moisture and oil.

During depot repairs of traction engines, as well as between these repairs, measures are taken to restore and maintain the insulation properties of the windings. At all scheduled depot repairs obligatory cleaning, drying and covering of armature and pole windings with electric insulating enamel is performed [2, 3].

Special attention should be paid to repair of compensation windings of traction motors. These windings are made on bitumen-oil varnishes, so it is advisable to impregnate them by filling the frame with varnish during depot repair. If the coils are loose in the grooves, then before impregnation, the wedges are knocked out, the coils are sealed by putting gaskets

(made of fiberglass or electric cardboard soaked in linseed oil) between the coils and the walls of the groove, as well as under the wedges.

In operation, systematic control of insulation resistance of traction motors is performed. In all cases of decrease of resistance below the established norm, insulation drying is performed. Hot air from stationary heaters is used for this purpose. Current drying is also allowed, which is made by passing electric current through the windings of traction motors from sources of voltage up to 110 V, or combined drying - with hot air and current [3]. Accurate, proactive and technically competent implementation of the rules of operation and maintenance of electrical machines is one of the most important factors in improving the reliability of windings and traction motors as a whole.

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