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ANALYSIS OF INCREASING THE OPERATIONAL RELIABILITY OF ELECTRICAL INSTALLATIONS

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Abstract: *This article reviews the current literature on the various factors that cause electrical wiring failure, such as temperature, humidity, and vibration, and best practices and techniques for improving electrical wiring reliability.*
Keywords: *Electricity, temperature, reliability, insulation.*

Agriculture is an important sector of the world economy, contributing to food security, job creation and economic growth. In recent years, the use of electric drives, which replace traditional mechanical and hydraulic systems, has become increasingly widespread in agriculture. Electric drives have a number of advantages over traditional systems, such as increased energy efficiency, lower maintenance costs, and increased efficiency. However, their operational reliability remains a challenge, especially in harsh agricultural environments.

This article is aimed at solving the issue of operational reliability of electric drives used in agriculture. The article examines the various factors that contribute to the failure of electric drives and reviews the available literature on best practices and methods to improve their reliability. In addition, the article suggests new solutions that can be implemented to improve the reliability of electric drives in agriculture.

The proposed strategies can be implemented at various stages of the design, development and maintenance of electrical equipment used in agriculture.

For a long time, it is known that the main and decisive factor affecting the reliability of insulation of electric machines is thermal wear. Therefore, methods for calculating the rate of thermal wear of insulation for the analysis of different operating modes are of particular importance. A model is proposed that connects temperature and insulation service life:

$$T_r = T_{r0} * e^{-\beta\theta} \quad (1)$$

The dispersion in the values of the β coefficient obtained during the processing of the experimental results did not have a well-founded explanation. For the convenience of using the expression (1), a rule was proposed, according to which overheating of the insulation by 8 °C halves the service life and leads to the following expression:

$$T_r = T_{r0} * 2^{-\frac{\theta}{\Delta\theta}} \quad (2)$$

Expressions (1) and (2) describe the process of thermal wear of insulation in the same way, therefore, based on their equality, the following model is obtained:

$$T_r = T_{r0} * e^{-ln2\frac{\theta}{\Delta\theta}} \quad (3)$$

Nevertheless, the model described by the expression (3) expanded the possibility of further research and served as the beginning of the formulation of new rules for levels.

To assess reliability and determine an indicator capable of evaluating operating conditions, it seems to us that the Montzinger model is the most appropriate, in which the magnitude of the temperature rise is taken as an indicator of insulation wear under certain operating conditions and is determined from the following expression:

$$\Delta\theta = \frac{-ln2*\theta}{lnT_r^{'} - lnT_{r0}^{'}} \quad (4)$$

It can be seen from the expression (4) that the value of insulation wear index Δth is directly proportional to the increase in the temperature of the coil and the failure of the electric motor, and is inversely proportional to the difference between the logarithms of the initial resource obtained by observing the dynamics . Table 1 shows the dependence of the working time of the electric motor on $\Delta\theta$.

Table 1.

Average time between failures of electric motors by test mode.

Test mode for electric motors with heat resistance class "E" insulation.	average working time	$\Delta\theta$, ^{0}C
1. Thermal wear at artificial load mode at t = 160 0C	1432	10.11
2. Wear at temperature t = 160 0C and vibration acceleration with A = 1.5 g	593	9.37
3. wear at temperature t = 160 0C in idle mode and reverse mode at A = 0.5 g	330	8.92

In Table 2, different classes of heat resistance determined during the production process are defined for insulation

Table 2.

Temperature design limits

Issiqlikka qarshilik sinfi.	A	E	B	F
Issiqlik qarshilik sinflariga mos keladigan harorat, $\Delta\theta$ ^{0}C	105	120	130	155

To determine a single indicator that reflects the entire set of operating conditions, we propose the well-known Montzinger expression, in which the value of Δth depends on the complete set of operating conditions.

$$T_r = T_{r0} * e^{-ln2\frac{\theta}{\Delta\theta_{st}*K}} \quad (2.6)$$

Eliminating all dominant factors leads to an eightfold increase in resources. Correctly selected and well-tuned protection is required to eliminate faults related to overload and open-phase modes.

Ways to increase operational reliability. The most effective solution to increase operational reliability is related to the limitation of the maximum possible temperature of the insulation of the windings of electric motors, which reduces the level of destruction from the effects of aggressive environments in agricultural production and, in case of emergency overload, inevitable overheating elimination of departure.

Conclusions. In order to evaluate the operational reliability of electric motors working in real technological processes of agricultural production, an integral index of working conditions (K) is proposed and the range of its change from 0.6 to 1.2 is determined. For the exponential law of the distribution of random variables, the method of separation of influencing factors, Weybull - Gnedenko and a model that allows forecasting of the resource in the elimination of failures and individual causes that take into account the influence of individual operational factors are proposed.

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