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Electrical Drive Reliability Assessment Method

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ABSTRACT: Electric drives are one of the most significant part of the industrial applications, which are used in the conversion of electric power into mechanical power. Today, the drives are being integrated more and more into the system and hence, the reliability of the electric drives has become a major problem. A common electric drive system consists of many number of components such as an electric machine, power converters, controllers, sensors as well as other communication devices. So the major focus in the modern era has been to increase the reliability of the electric drive system as a whole. This article presents a method of assessing the reliability of electrical drives. The theory of probabilities is used in this work.

KEY WORDS: electrical drive, reliability, failure probability, mathematical expectation, dispersion

I.INTRODUCTION

An electric drive is a device consisting of an electric motor, electrical devices that control it (start it, adjust its speed, brake it and stop it) and a mechanical transmission between the motor and the working machine [1-3].

Electric drives are affected by many factors that reduce their performance during operation. Ensuring the perfect operation of electrical drives is one of the urgent problems today.

II. MATERIAL AND METHODS

Probability theory was used to determine the reliability of electrical drives.

III. RESULTS AND DISCUSSION

The probability of reliable operation of electric drives P(t) is the probability that there will be no malfunctions in certain modes and operating conditions in a certain period of time [1,4]:

$$P(t) = \{T \geq t\}, \qquad (1)$$

Here: T is the time of continuous operation of the system until the first failure. This function fully determines the reliability of the system and its individual elements. In practice, knowing the statistical (operational) information about failures, it can be determined by the following expression (2) [2-4].

$$P(t) = \frac{N-n}{N}, \qquad (2)$$

Here: N is the total number of researched electrical drives; n- the number of failures of electric drives. The probability of failure of electrical drives Q(t), i.e. the probability of at least one failure occurring in a certain time interval t :

$$Q(t) = P\{T \leq t\}, \qquad (3)$$

Since the probability of failure of electrical drives and the probability of their reliable operation are incompatible and contradictory events, the following (4) corresponds to the expression [4].

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$$Q(t) = 1 - P(t), \qquad (4)$$

We can use the formula (5) to statistically determine the probability of failure of electrical drives [2-4]

$$Q(t) = \frac{n}{N}, \qquad (5)$$

The failure rate λ(t) is the conditional density of the probability of failure for the considered moment of time, if no failure has occurred until now :

$$\lambda(t) = \frac{1}{P(t)} * \frac{dQ(t)}{dt} = \frac{n(t)}{[N-n]*t}, \qquad (6)$$

The physical meaning of failure probability density is the number of failures of elements in any sufficiently small time interval (unit of measurement – 1/year or year-1).

The average time to failure is T_0, which is the average time from the start-up period of the element to its failure [4].

$$T_0 = \frac{\sum_{i=0}^{N} t_{pi}}{N}, \qquad (7)$$

Here: N- the number of tested samples; t_{pi} is the service time of sample i

The distribution function of the random variable given by the exponential distribution function is given in the formula (8) [4].

$$Q(t) = 1 - e^{-\lambda t}, \qquad (8)$$

The probability density of the exponential distribution is determined by the following expression (9).

$$f(t) = \frac{dQ(t)}{dt} = \lambda e^{-\lambda t}, \qquad (9)$$

The distribution function describes the probability that the object will fail. The probability of reliable operation of electrical drives can be determined as follows (10):

$$P(t) = 1 - Q(t) = e^{\int_0^t \lambda(t)dt} = e^{-\lambda t}, \qquad (10)$$

Here: $\lambda -$ level of unreliable performance; if the $\lambda \leq 0{,}1$ condition is fulfilled, the equality $P(t) \approx 1 - \lambda t$ can be accepted.

Mathematical expectation

$$M_i = P_i t_i \qquad (11)$$

Statistical variance:

$$D(t) = \sum[P_i(t_i - M(t))^2] \qquad (12)$$

Mean square deviation:

$$\sigma(t) = \sqrt{D(t)} \qquad (13)$$

Coefficient of variation

$$V(t) = \frac{\sigma(t)}{M(t)} \qquad (14)$$

In statistical research, the following properties are often used: arithmetic mean squared error in determining mathematical expectation[5]:

$$\Delta M(t) = \frac{\sigma(t)}{\sqrt{n}} \qquad (15)$$

The mean squared error in calculating the mean squared deviation[6]:

$$\Delta\sigma(t) = \frac{\sigma(t)}{\sqrt{2n}} \qquad (16)$$

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IV. CONCLUSION

The Failure Modes, Effects and Analysis procedure has been widely used as a tool in wide variety of processes and products for reducing the occurrence of the faults associated with the system and hence improving the standards of productivity in industries[7].With the help of the formulas presented above, it is possible to calculate the reliability of electrical circuits and their perfect operation times.

REFERENCES

[1]. Link: https://hal.archives-ouvertes.fr/hal-00531231/document
[2]. Link: http://ltu.diva-portal.org/smash/record.jsf?pid=diva2:1012750
[3]. Link: https://www.iosrjournals.org/iosr-jeee/Papers/Vol6-issue6/E0663236.pdf?id=5788
[4]. Link: http://ilmiy.bmti.uz/blib/files/66/A.%20Rasulov%20-%20Ehtimollar%20nazariyasi%20va%20matematik%20statistika.pdf
[5]. Link: https://uzjournals.edu.uz/tashiit/vol15/iss3/29
[6]. Link: https://qmii.uz/uploads/documents/3_35_%D0%B6%D1%83%D1%80%D0%BD%D0%B0%D0%BB-6-compressed.pdf
[7]. Link: https://www.researchgate.net/publication/313422123_Reliability_Analysis_in_an_Electrical_Drive_System