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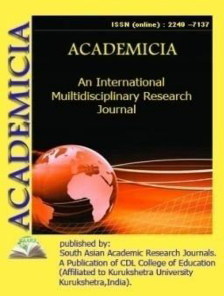
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RELIABILITY OF THE BRUSK PACKAGE ON ACS

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ABSTRACT

DC motors are widely used in industry due to their deep, smooth and economical speed control.However, the reliability of AC machines is lower than that of asynchronous machines due to the presence of a sliding contact collector-brush combination.Statistical analysis shows that in terms of reliability in AC machines, four "weak sets" should be distinguished: collector-brush set, bearing ring, armature ring, drive we will focus on the brush set, taking into account the above.

KEYWORDS: *Reliability, Brush, Brush Apparatus, Probability Of Continuous Operation, In AC Machines (Acs), Standard Deviation, Acs (Acs).*

INTRODUCTION

Reliability is the ability to store the values of all parameters within the specified limits in a given mode and conditions of use, maintenance, repair, assembly and transportation, which characterizes the ability of the object to perform the required functions over time.

Reliability is divided into units that describe a single property and aggregates that describe several properties. The unit index is mainly used for the description of individual elements, complex - for load nodes and for the whole system.

The concept of reliability is inextricably linked with the concepts of ability to work and failure.

Performance is the state of an object that is able to perform all or part of a given function in full or in part. If all the given functions are completed, it is considered to be fully functional. If none of the given functions are performed, it is not fully functional. In all other cases, the object is partially functional.

Accidental failure is a failure of the ability to work, which consists of the transition from a state of complete incapacity for work to a state of partial or complete incapacity for work.

AC machines are widely used in electric vehicles, automatic adjustment systems, lathes, hoisting cranes, excavators, metalworking machines, and the textile industry.AC generators are used as a source of AC energy (for example, to supply high-power ACs with alternating current).

Brushes are part of an electrical circuit through which electricity is transmitted from the power supply to the rACor.Brushes are classified according to the materials used and the characteristics of the manufacturing process.. The design and dimensions of the brushes comply with GOST 12232-89 and industry standards. Depending on the orientation of the edges and the location of the wires, electric car brushes are made in different ways. Dimensions of brushes, marking and strengthening of edges correspond to GOST 21888-82.

Brushes are made of graphite or ACher materials. An AC machine includes a pair of brushes or more. One of the two brushes is positive and the ACher is connected to the negative side of the power supply.

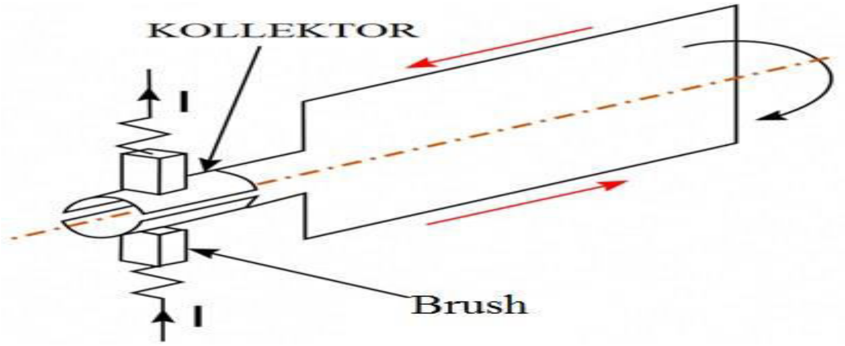

Figure 1 Soda view of the collector-brush system

opper, iron, and bronze brushes, which did very well on the first AC machines in the late 19th century, did nAC turn out to be very good materials in terms of friction. They quickly became obsolete and were replaced with carbon and graphite in new machine designs.

Currently, almost only carbon brushes, which are permanent graphite mixtures for AC machines, are used for AC machines, depending on the percentage of graphite and the names of the carbon-graphite, graphite or electrographite, depending on the method of making the brushes. Only low-voltage machines up to 30 V use metal-carbon brushes, which provide a low voltage drop in the contact (transition) layer in the collector[1-9].

Carbon brushes are made of pure graphite, retort charcoal and carbon black in various proportions. Charcoal is a self-lubricating material that does not damage the abrasive surface and does not wear out quickly.

Graphite brushes are made of pure natural graphite. Graphite is crushed into a fine powder and then pressed into branches of the required size under very high pressure. Coal and graphite are excellent conductors of electricity.

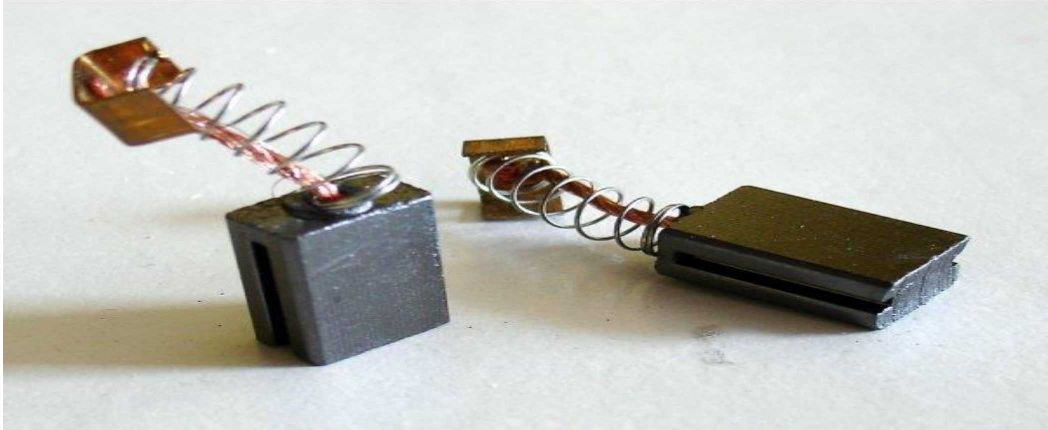

Figure 2 Appearance of an electrographic brush

Electrographic brushes are mainly carbon brushes, but are exposed to high temperatures in an electric furnace and are converted to graphite. These brushes have excellent grinding properties.

Metal-Carbon brushes are made of coal and copper, ground to a fine powder, and sometimes anACher crushed metal (usually tin) is added. The production of these brushes is carried out in such a way as to have the best conductivity in the axial direction, where the working current of the machine passes and poor conductivity in the transverse direction (high electrical resistance) . additional currents of switched-off sections are switched off during switching.

Brushes for electric cars are standardized. This power transmission technology, which is more than a hundred years old, is still widely used today. Carbon brushes can still be found in many electric cars. Toys, electric kitchen utensils, electric windows, razors, washing machines, hair dryers, vacuum cleaners or power tools (electric drills, angle grinders, brush cutters, circular saws, etc.) range from small motors, and so on.

From brushes to electric locomACives, submarines and power plant generators, as well as wind turbines and AC machines. The geometric and electrical characteristics of carbon brushes vary accordingly.

The number of zones of the brushes in the collector (forming the cylindrical surface of the collector) is usually equal to the number of poles of the machine. The number of brushes in each zone depends on the magnitude of the flow and the allowable flow density under the brush for a particular type of brush, but less than two brushes in each zone can only be found on very small machines, as each it is difficult to ensure the reliability of contact with a single brush in the zone. A set of brushes in the same area is called a set of zones, and the sum of all the sets of zones in a given machine is called a complete set of brushes.

The electric brush is a non-renewable element, the reliability of which is assessed by the possibility of continuous operation. The operating time of the electric brush

$$t=(h-h_{pr})/v_{ш}, \quad (3.1)$$

where h and hnp are the initial and maximum allowable heights of the electric brush in mm, and vshch is the brushing speed in mm / h.

The degree of friction depends on the brush pressure, the rACational speed, the current density, the design and material of the collector, and ACher random variables. Observations of the performance of long-term system brushes show that the distribution of values of the rate of reduction of electric brushes is in accordance with the usual law. Testing of electric brushes (accelerated or normal conditions) revealed the average statistical characteristics of the sample:

$$\overrightarrow{v\text{Щ}} = \frac{1}{n}\sum_{t=1}^{n} \quad V_{\text{щ}}(3,2)$$

$$\sigma_{\text{щ}} = \frac{\sqrt{\sum_{t=1}^{n}(Vsh - \overrightarrow{v\text{Щ}})^2}}{n-1} (3.3)$$

where: vshch is a mathematical estimate of the rate of reduction of the electric brush, $\boldsymbol{\sigma}_{\text{SH}}$ch is the estimation of the standard deviation, n is the number of electric brushes.

The probability of continuous operation at t-time has the following form

P(t)=1-Q(t)(3.4)

Failure can be detected in t-time

$$\mathrm{Q(t)} = \frac{1}{\sigma\sqrt{2\pi}}\int_{0}^{1} exp\left[\frac{(t-T)^2}{2\sigma^2}\right] d(t). \tag{3.5}$$

Determine the average downtime and standard deviation.

$$\vec{T} = \frac{1}{n}\sum_{t=1}^{n} t_i; \qquad \sigma = \sqrt{\frac{1}{n-1}\sum_{t=1}^{n}(t_i - \vec{T})^2} \tag{3.6}$$

Here: t1 is the partial value of the downtime and t_x - $\vec{T}$ is the probability of continuous operation of the brush.

$P(t)=1-Q(t)=0,5-F[(t_j - \vec{T})/\boldsymbol{\sigma}]$. (3.7)

If the AC machine in question belongs to a class of machines determined by the reliability of the collector-brush set, then

$R_k(t) = R_{\text{ща}}(t)$ (3.8)

The collector-brush assembly and brush machine electric machine has N brushes of the same brand. If the failure of a single brush leads to the failure of the entire brush apparatus, then the reliability of the brush apparatus is determined as follows.

$R_{\text{ша}}(t)=[p(t)]^N$(3.9)

In many cases, the coefficient of the brush apparatus is considered as a kind of redundancy system with a reserve ratio

$$kp = \frac{\mathrm{N}}{\mathrm{N-n1}} \qquad (3.10)$$

Here n1 is the minimum allowable damage to the electric brush that will nAC cause the entire brush unit to malfunction.

Thus, if the number of faults in the set of electric brushes is n1, the probability of a subsequent event and therefore the probability of continuous operation of the brush apparatus should nAC exceed the faults n1 determined according to Bernoulli's formula during the N tests:

$$R_{\text{ща}}(t)=P_{n,N}=\sum_{k=0}^{n_1} C_N^k\ P(t)^{N-k}\,[1-P(t)]^k \qquad (3.11)$$

Here: $S_N^k = N!/K!\,(N-K)!$ (3.12)

Thus, if we consider the set of electric brushes in a machine characterized by the reliability of P (t) as an example of the volume N of the tACal population, we can calculate the continuous operation of the brush apparatus.

For example, if T = 10000 hours, **σ**1 = 3000 hours, N = 4, p1 = 2. If so, create a continuous probability curve for a separate P (t) brush and a Pshcha (t) brush apparatus.

:

t_1 = 10,000 hours after setting:

$$R(10\,000)=0{,}5\text{-f}\ (f = \frac{t-T}{\sigma 1})=0.5\text{-f}\ (\frac{10000-10000}{3000})=0{,}5$$

$$R_{\text{ща}}(10000)= \sum_{k=0}^{2} (S\,{}^{2}_{4}) R\ \ (t)^{4-2}\, Q(t)^2 =$$

$$=0.5^4+(\frac{4!}{1!(4-1)!})0.5{*}0.5^3+(\frac{4!}{2!(4-2)!})0.5^2{*}0.5^2=0.7$$

t_2 = 8 000 hours after setting:

$$R(8\,000)=0{,}5 - F(\frac{8000-10000}{3000})=0.5\text{-}F(-0.66)=0.74;$$

$$R_{\text{sha}}(8\,000)=1\bullet 0.74^4+4{*}0.26\bullet 0.74^3+6\bullet 0{,}26^2\bullet 0{,}74^2=0{,}94.$$

t_3 = 6 000 hours after setting:

$$R(6\,000)=0{,}5 - F(\frac{6000-10000}{3000})=0.5\text{-}F(-1.33)=0.9;$$

$$R_{\text{ща}}(\ 6000) = 1\ \bullet 0.9^4+4\text{-}0\ ,1\bullet 0.9^3+6\bullet 0{,}12\bullet 0{,}92=0.955$$

t_1. t_2. For the values corresponding to t_3, the points P (t) and Pshcha (t) are set, along which the probability curves of continuous operation are constructed.

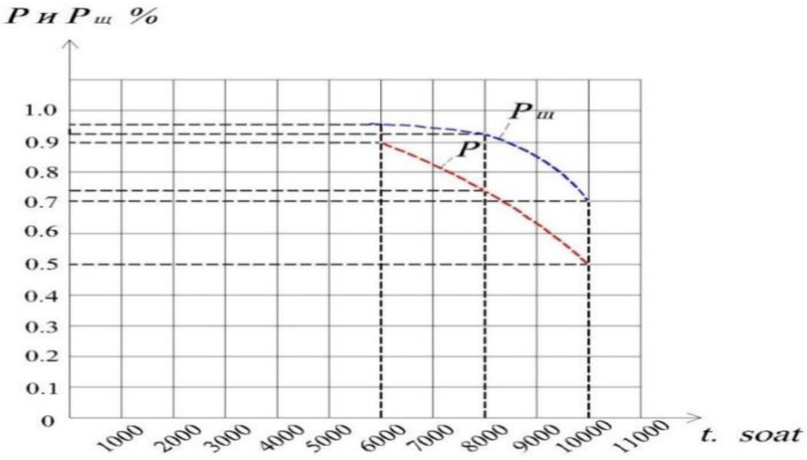

Figure 3. Probability curves for continuous operation for P (t) brush and Pshcha (t) brush apparatus

CONCLUSION

In conclusion, it should be noted that the issues of reliability remain relevant even if they are considered at the level of any detail, device or system as a whole, because reliability is a continuous operation, the elimination of failures is the most important economic efficiency.

When it comes to the reliability of AC electric brushes, it is important to create the most reliable brush models based on the results of tests and experiments. the use of structural and functional models opens up great opportunities in assessing the reliability characteristics of brushes at the design stage. The obtained mathematical models give accurate and reliable results of brush parameters in the calculation of reliability. This is confirmed by the graphical dependences obtained on the basis of the proposed computational methods and experimental data performed in real working conditions.

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