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A Physical Model of Tribology Investigation of Electrolytic Iron/Nickel/Cadmium (Fe/Ni/Cd) Coatings

KEYWORDS: tribology, model, electrolytic coating

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ABSTRACT *The investigation procedure of a physical model and the dynamics of its changing during friction in the process of bedding and wearing are considered in this article. The physical model and the values of operation parameters during the friction and wearing of Fe/Ni/Cd restored coatings.*

Introduction.
The physical model of tribology investigations is chosen on the basis of the structural characteristic of new and worn out shafts [1]. It is expressed with the features and the parameters of the rubbing couple. The main features of the model for investigation are:

- The relative movement of the rubbing surfaces;
- The friction environment;
- Wearing.

Al these features are determined by the resources of the chosen machine for friction and wearing.

A large number of the restored worn out details work in the conditions of sliding friction [1].

Presentation.
The procedure of investigation envisages the use of a machine for friction and wearing SMC-2 , allowing wearing of the rubbing surface during sliding, rolling and rolling with sliding through the scheme roller/sector and roller/roller, which are modelling shafts, bearings, gearings, and other similar couples.

The most widespread and loaded units working during sliding friction in farming machinery and farm tractors are the couples shaft/sliding bearing. The physical model of the rubbing couple shaft/bearing is the couple roller/sector with the corresponding parameters of geometric and physical similarity (Fig. 1).

The test-machine for wearing allows the test to be done in environment of liquid or semi-liquid lubricant, abrasive or corrosive environment, as most often a liquid lubricant is used.

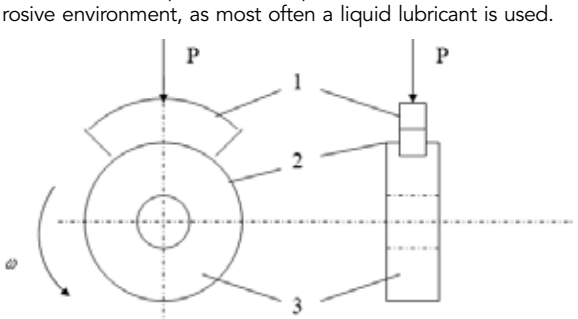

Fig. 1. A physical model of rubbing couple: 1 –a sector; 2 – an electrolytic alloy coating; 3 – a roller.

In accordance with the environment the chosen conditions and friction operations, the wearing can be mechanical, molecular-mechanical, or corrosive-mechanical, and it must correspond to the behavior of details wearing in exploitation conditions. The environment of friction and wearing is determined by the conditions for liquid lubrication with motor oil $M10D_2E_1$ or CD according to BDS or API, respectively. The motor oil has standard characteristics and is widely used in the process of development and exploitation of details in farming machinery and farm tractors.

The physical model parameters of tribology investigations are four types – geometrical, mechanical, physical, and technological. These parameters are chosen on the basis of statistical analysis of constructional-technological and exploitation structural characteristics of the respective couples.

The geometrical parameters include couple dimensions, macro- and microgeometry of the rubbing surfaces. The geometric dimensions of the couple are the diameter and the width of the roller and sector, as well as the clearance between them. The macro-geometry is expressed by nonalignment and perpendicularity of the roller, and inaccuracy of the surfaces of couple sector, while the microgeometry is expressed by the roughness of the rubbing surfaces of roller and sector.

The mechanical parameters include the inside stresses, the physical ones include the mass of the roller and sector, while the technological parameters include the coating thickness, macro- and micro-structure of the surface layer of roller and sector.

The sectors for testing are manufactured from gray cast iron 25, aluminum alloy or poured with antifriction alloy SOS6-6, composed by 6 % Sn (tin), 6 % Sb (antimony), and the rest is Pb (lead) [2], as the length of the rubbing sector surface is 20 mm, while the area of the supported surface is 2 cm^2. The couple clearance must be 0,02 mm in order a uniform bedding to be got at the necessary oil wedge according to the operation manual of the machine SMC-2.

Rollers manufactured of steel 40X with width of 12 mm and diameter 50 $^{+0,02}$ mm are used for the investigation of the worn out details. Before the deposition of a coating these rollers are ground on the centering marks of the shaft and roller at velocity V = 20 m/s with abundant cooling of the processed surface.

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After the deposition of the alloy restored coating the grounding operation is repeated as the roughness should not be above R_a= 0,32 μm. Upon one of the lateral surfaces of each roller a number is marked out.

The cybernetics model is closely connected with the procedure of tribology investigations. The regime of testing of the rubbing couple is determined by three kinds of parameters – dynamic, kinematic, and thermodynamic [1]. Dynamic are the loading parameters of the rubbing couple such as size, degree, velocity and time of loading, the kinematic are rotation frequency and speed of sliding of the rubbing surfaces, while the thermodynamic include temperature of rubbing surface and temperature of lubricant environment.

The loading of the rubbing couple roller/sector is realized with the means of a special spring and worm gear, as upon graduated flywheel are read indexing. The accuracy of one indexing is 0,7 kg. The non-staged loading is done with loading speed 1 MPa/min and loading duration 5 min at loading size F = 100 daN per a roller, made of steel 40X, , and measuring accuracy 1 daN, which provides a pressure of 5 MPa. This load is close to the boundary one and it could be undertaken from the different kinds of friction bearings.

The testing is done by the scheme roller/sector at rotation frequency 540 min^{-1} and roller diameter $50^{+0,02}$ mm, as the obtained sliding speed is 1,41m/s. These values are accepted in accordance with the admissible limits of loading of the friction bearings. The total covered road of friction is $27,5.10^4$ m for the respective number of cycles during the carried out comparative investigations.

The preliminary investigations showed that a suitable friction frequency of the roller is 540 min^{-1}. At this rotation frequency a noticeable and measurable wearing of the roller and sector is got for considerably short time of 60-90 min at bedding and 3-4 hours at fixed wearing. The frequency increase leads to an increase of the absolute wearing and increase of testing time.

The oil temperature in the volume chamber for friction and wearing in the process of bedding is found in the range 303÷313 K, and is kept during fixed wearing at 313 K. These temperatures correspond to the operation regime of the engines of farming machinery and farm tractors during the period of starting, when a significant wearing occurs.

The machine for friction and wearing is designed for testing of different materials during sliding and rolling with sliding. It is driven by synchronous motor and has three degrees of rotation frequency – 300, 500 and 1000 min^{-1}.

The moment of friction is read by means of potentiometer which receives a signal from inductive transducer placed between the reducer and the spindle of the machine.

The measurement of the total rotation frequency is done with special electronic system UB-1, which is getting signals for rotation frequency of the driving shaft from inductive transducer mounted between the reducer and the inductive transducer measuring the moment of friction.

The implementation of testing of the surfaces rubbing in a liquid environment is ensured by special hermetic chamber, and as a lubricant could be used an oil [4].

Conclusion.

A physical model and the parameters values of friction and wearing of Fe/Ni/Cd restored coatings are shown.

The dynamic of bedding and wearing during non-staged loading and the time for making experiments until the establishment of rubbing surfaces wearing are determined.

REFERENCE 1. Kangalov, P. G. Investigation of the recovery of friction bearings in farm machinery and farm tractors, Rousse. 2001. 2. Spiridonov, G. Wearing and aging of the details in farming machineries, Sofia, Zemizdat, 1980. 3. Stanev, L.G. A comparative investigation of tribology and technical characteristics of anti-fraction materials in the process of bedding and wearing, Scientific Conference with International Participation, AMTEC, Plovdiv, A symposium of reprints "Tribology", 1999. 4. Stanev, L. G., G. P. Tonchev. Investigation of bedding of details in repaired motors SMD-62 during their manufacturing repair, Farm Machinery, vol. 6, 1989.