ЛИТЕРАТУРА

1. Биргер,И.А., Шорр,Б.Ф., Шнейдерович, Р.М. Расчет на прочность деталей машин. - М.: Машиностроение, 1966.-С.263. 2. Горячева, И.Г., Добычин, М.Н. Контактные задачи в трибологии.-М.: Машиностроение, 1988.-С.256. 3. Солдатенков,И.А. Контактные задачи при наличии износа поршневого кольца в условиях нестационарного нагружения. Трение и износ.- М.-1989.-Т10-№3-С.422-427. 4. Солдатенков, И.А. Задачи об изнашивании поршневого кольца с расширителем при действии внешнего давления. Трение и износ.- М.-1991.-Т.12.-№1.-С.39-45. 5. Писаренко, Г.С., Яковлев,А.П., Матвеев,В.В. Справочник по сопротивлению материалов.-2-е изд-Киев: Наукова думка, 1988.-С.736. 6. Федосеев,В.И. Избранные задачи и вопросы по сопротивлению материалов.-М.: Наука, 1967.-С.376.

UDK 621.791.92

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WEAR-RESISTEMENT AND TIREDNESS DURABILITY OF COVERINGS OBTAINED BY SURFACING OF POWDERS FROM HIGH-SPEED STEELS IN AN ELECTROMAGNETIC FIELD

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Different ways of drawing of coverings that allow to receive a working surface with required operational properties are applied to restore and harden the details of machines. Every way of drawing of coverings due to its features has rational sphere of application and not always solves tasks caused by necessity of restoration and increasing of durability of details of machines. Therefore, in line with the improving of known ways of drawing of coverings it is necessary to develop the new ways to add already known and to expand their technological possibilities. To combine the ways of the restoration and hardening of articles using combined influence of flows of different kinds of energy on a processable surface is urgent. It allows to receive the qualitatively new operational characteristics of surfaces of details, and also to raise productivity, to reduce power consumption and cost of price of processes.

It is necessary to note, that many details of machines coming to the restoration, have a significant stock of residual durability, the using of which makes the basic source of an economical efficiency of machines repairing. So Japan satisfies its requirement of spare details on 40 % by restoration of worn out details, the USA, Germany, Austria - on 30...35 %, and the former USSR satisfied this requirement on 18% in 1990 [1].

Recently the electromagnetic surfacing (EMS) using the energy of magnetic and electric fields has been widely investigated and received practical application. It allows to change the conditions of restoration and hardening of the details of machines [2].

The combined method of electromagnetic surfacing with the superficial plastic deformation (EMS with SPD) developed by the Technology of metals department of the Belarusian State Agrarian and Technical University together with State Enterprise "MAF" has increased a resource of details such as bodies of rotation working in conditions of hard work and intensive abrasive wear process in 1,3 ... 1,4 times. Such result has been received because of a new method of hardening of details. This method combines the drawing, heat treatment and hardening deformation of a covering, reducing attrition of a surface at the expense of formation of structure of a superficial layer. The operational characteristics of the combined method are defined by electromagnetic and deformation influences on the hardening surface. Electromagnetic surfacing with SPD has high durability of joint of surfacing covering with the base, improved wear-resistement and

minimal secretion heat. That's why electromagnetic surfacing is very effective at hardening of friction surfaces and landing surfaces under bearings and gear wheels.

The use of heat in EMS process for hardening of SPD allows to combine the operations of surfacing and termadeformation hardening and to create the conditions for combined deformation of parameters of quality of a superficial layer, which are the most complete from the point of view of an operational heredity of parameters of process, adequating to auxiliary of details of machines.

It is known [3], that surfacing metals differs by heterogeneity of structure and chemical composition by presence of welding defects, fluctuations of hardness, internal intensity and other defects, that's why a comparative estimation of operational properties of coverings received by EMS and EMS with SPD, powders from highspeed steels is of interest. The powders high-speed steels are widely used for drawing coverings by other methods. They are standardized have constant chemical and granulometric composition, keep high hardness and wear-resistement in the generated coverings up to 600...620°C. That is very important because of inconstancy of temperature conditions on the surface of connected and frictioned details.

The wear-resistement of coverings received by EMS and EMS with SPD has been studied in conditions of hydroabrasive wear process at friction of sliding by the machine for test of materials for friction and deterioration 2070 CMT-1 under the circuit "the shaft - to - boat" by linear method.

The 1 mm per diameter coverings have been rendered at the samples made of steel 45 with 40 mm outside diameter, 16 mm internal diameter and 12 mm height exposed to normalization. A shoe made of cast-iron CTW has had 10 mm height, that has allowed to keep measuring base, as the cylindrical ribbons have been remained on the edges of the sample. The measurement of the samples has made in two mutual perpendicular planes on two sections, using optical measure of length, the accuracy of which has been made 0,001 mm. An oil-abrasive mixture (industrial oil 20, containing 2 % of carbide pine forest by granularity 4...5) has been used to accelerate the process of wear. The 40 ml mixture has been filled in the oil chamber. A fresh portion of mixture has been used for each part of tested samples.

Abrasive particles in suspense during the testing period has been supported by flow, created by the impeller blades, put on the same shaft with a sample, and temperature condition stability of the mixture has been supported by the filtering of water through double bottom of the chamber.

The samples were exposed to mechanical processing after the drawing of covering. Then they have been attrition with the shoe. The termination of the attrition has been defined by stabilization of the moment of friction of pair registered by the equipment of the machine.

The testing conditions have been met the stipulation of details work of autotractor and agricultural machines, for which the speed of sliding up to 2,5 m/s and specific loading 1,5...3,0 MPa is characteristic. Five samples lots have been tested.

The results of tests have been compared to the standard (steel 45 normalized and hardening with heating HFC on depth 1,2...1,6 mm up to 52...54 HRC). Besides, the abrasive wear process has mechanical destructive character of the surface. This has been taken into account. Its intensity, as it is known [4], depends on hardness of revolving materials, specific work and speed of moving most of all.

The tests of operational properties of coverings have been carried out on the samples, surfaced and processed at optimum conditions of processes established in research work [2] (samples after EMS and EMS with SPD have been process by abrasive grinding and magnetic-abrasive polishing for obtaining of the roughness surface Ra=0,8 - 0,6 microns).

Table. Tribotechnical characteristics of coverings obtained by EMS and EMS with SPD

Material of powder	Parameter				
	Intensity of wear process, micron / km	the moment of friction, nm		factor of friction	
		with oil 1-20	dry	with oil 1-20	dry
P6M5	2,5/1,9	0,79/0,74	1,11/1,05	0,13/0,12	0,18/0,16

Продолжение Table. Tribotechnical characteristics of coverings obtained by EMS and EMS					
Р6М5Ф3	2,2/1,7	0,73/0,69	0,87/0,82	0,11/0,10	0,15/0,14
Р6М5К5	1,9/1,4	0,72/0,68	0,82/0,79	0,11/0,10	0,15/0,14
Steel 45 (standard)	4,1	0,84	1,26	0,12	0,19

Tribotechnical characteristics of coverings have been given in the table, where the research results of coverings received by EMS are submitted in numerator, and the research results of coverings received by EMS with SPD are submitted in denominator. Their analysis shows, that the main influence on wear-resistement of coverings renders chemical and phase compositions of coverings and method of their drawing. Thus the coverings received by EMS with SPD, for all testing materials of powders have a much more higher wear-resistement in comparison with coverings received by EMS. As a result SPD raises the density and uniformity of covering, making it more dispersing; brings to the change of character of distribution of hardening layer, which is transformed with the complete hardening. That's why hardness of coverings and the resistance to their mechanical destruction raise. At the same time the moment of friction and the factor of friction for methods of drawing of coverings have no essential distinctions, and they are significant for powders.

It is visible, that the coverings from the P6M5K5 powder have the greatest wear-resistement. The wear-resistement of all coverings is more higher than the wear-resistement of the standard (steel 45). In decreasing order of covering wear-resistement the latter is possible to arrange both for EMS and for EMS with SPD in the following sequence:

P6M5K5→P6M5Ф3→P6M5.

The comparison of dispersion tests of covering wear-resistement shows that the disorder of experimental data did not exceed 17 % for EMS and 12 % for EMS with SPD. That's why the surfacing in an electromagnetic field is stable.

The tiredness of metal is the basis reason of destruction of details working in the cyclic load conditions. The tiredness of destruction begins from the superficial layer, the limit of endurance depends on the physic-mechanical properties of this layer.

That's why the tests of tiredness of durability of details hardening by EMS with SPD has been carried out. The influence on the tiredness durability of surfacing surfaces has been tested from the point of method surfacing and chemical composition of powder.

The tests have been carried out with the samples of round section from the normalized steel 45, having a parity l/d=15, where l=150 mm - length and d=10 mm -diameter. P6M5K5 and P6M5Ф3 have been applied as powders. After surfacing the samples have been exposed to abrasive to grinding, providing a roughness of a surface Ra=0,8...0,6 microns. The tests of the samples on the tiredness durability have been carried out by the machine such as Y - 20M in conditions of action variability of loading with constant amplitude.

The curves of endurance have been built in double logarithmic system of coordinates, the functional dependence of pressures from the number of cycles $\sigma = f(N)$ has been submitted by the equation:
$m\lg+\lg N=\lg C$, where σ - pressure, MPa; m - parameter of a curve, m=10; N - number of load cycles; C - factor.

As a result, curvilinear dependence $\sigma = f(N)$ in logarithmic coordinates has been given to the equation of a straight line. This has allowed to apply a method of linear correlation.

The analysis of the obtained testing results shows (figure) that at cyclic loading of samples the coverings have various ability to resist to the tiredness destruction. It can be explained by unequal sensitivity of coverings materials to dislocation sliding, to the influencing processes to the tiredness destruction. It is visible, that the tiredness durability of surfaces surfacing by powders P6M5K5 and P6M5Ф3 is higher than the standard accordingly in 1,45 and 1,34 times. As a result EMS with SPD makes the residual pressure of compression in the system covering - basis, increases zone of thermal influence [2, 5]. Besides there is an allocation dispersion carbides and metallides, blocking shifts on a plane of sliding. It provides the increasing of superficial durability especially shown in coverings with the following structures: martensite, alloy dispersion carbide and metallide [5]. Besides EMS with SPD reduces porosity [2]. It also raises the tiredness durability of surfacing surfaces.

Thus, the application surfacing in an electromagnetic field from high-speed steels for restoration and hardening of details of machines working in conditions of raised abrasive wear process, and cyclic loading allows to increase their wear-resistement up to 2,5 times and tiredness durability up to 1,5 times by technological methods in comparison with steel 45, hardening from heating HFC

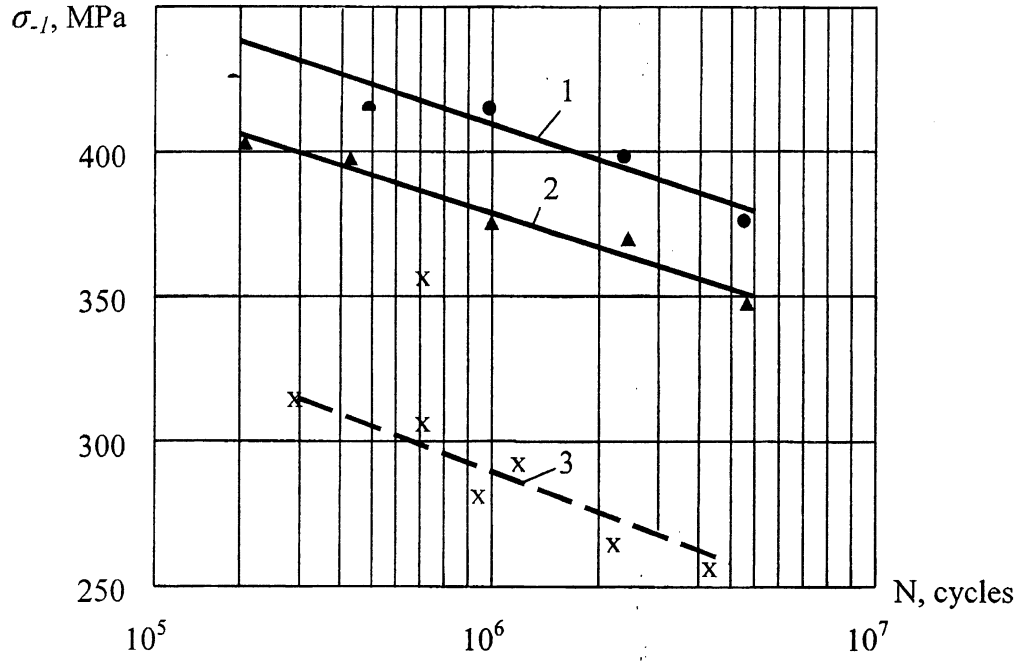

Figure. Influence of chemical structure of a powder on tiredness durability hardening electromagnetic surfacing with superficial plastic deformation of samples 1 - Р6М5К5; 2 - Р6М5Ф3; 3 - steel 45

Taking into account, that more than 80 % of machines and mechanisms failures are caused by processes of wear process or complex reasons, in which the wear process plays a dominant role and that about 90 % of details have the deterioration no more than 0,6 mm, where the cylindrical surfaces (shaft, axes, rods, fingers and others) make 52 % [6, 7], it is possible to recommend the effective process of EMS with SPD of alloy powders on an iron basis for their restoration and hardening.

LITERATURE

1. Иванов,В.П. Сбережение остаточного ресурса деталей и сопряжений при их восстановлении // Агропанорама. 2000. N 2. - С. 15-18. 2. Мрочек,Ж.А., Кожуро, Л.М., Филонов, И.П. Прогрессивные технологии восстановления и упрочнения деталей машин. - Минск: УП "Технопринт", 2000.-268 с. 3. Барвинок,В.А. Управление напряженным состоянием и свойства плазменных покрытий. - М.: Машиностроение, 1990. - 384 с. 4. Филонов, И.П., Кожуро, Л.М., Фельдштейн,Е.Э. Износостойкость покрытий, полученных электромагнитной наплавкой / XXIII jesienna szhola tri-bologiczna. - Zielona Gora - Lubiatow, 21-24 worzesien, 1999. - S. 35 - 38. 5. Ящерицын,П.И., Кожуро,Л.М., Ракомсин,А.П. и др. Технолгические основы обработки изделий в магнитном поле. - Минск: Изд-во ФТИ НАН Беларуси, 1997.-416 с. 6. Кершенбаум,В.Я. Механическое деформирование поверхностей трения. - М.: Машиностроение, 1987. - 232 с. 7. Воловик,Е.Л. Справочник по восстановлению деталей. - М.: Колос, 1981.-351 с.