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Increase of the Wear Resistance of Metal Details on the Basis of a Simultaneous Application of the High-Test Cover and Ultrasonic Vibrations.

O.V. Burlachenko[a], D.P. Klochkov[a,]*

[a] *Volgograd State University of Architecture and Civil Engineering (VSUACE), 1 Akademicheskaya str, Volgograd, 400074, Russian Federation.*

Abstract

The research study is devoted to solving the urgent problem of improving the wear resistance of metal friction surfaces of modern machinery and technological equipment. This one presents an alternative method of treatment based on changing the friction surfaces (their geometrical, mechanical and physical-chemical characteristics). The combined effect on the friction surface of a dynamic method of surface plastic deformation based on collision of working substances (fraction) from the surface to be treated under the influence of an ultrasonic field with simultaneous diffusion into the metal surface of the composite coating system based on the Fe-Ni-Cr-B-Si-Mn is investigated. In the research analytical expressions have been shown to determine the optimal chemical composition of the powder (coating system based on the Fe-Ni-Cr-B-Si-Mn), and also the expression to determine processing parameters including penetration depth of pellets on the surface. To confirm the effectiveness of the considered method for processing, laboratory tests were conducted that were aimed at determination of the depth of diffusion of the chemical powder (iron coating systems based on the Fe-Ni-Cr-B-Si-Mn) in the process of the treatment and the test of wear resistance.
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* Corresponding author Tel.:+ 7 (927)506-46-65.
E-mail address: oburlachenko@yandex.ru.

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1. Introduction

Development of the modern mechanical engineering is connected with construction meshing of the machinery and manufacture. Moreover it is connected with meshing of the operational conditions such as increasing speed, tensions, thermal conditions and so on. As a result there is an actual problem of the reduction of the wear resistance of metal surfaces which is the main reason of the engineering breaking.

The increasing of the wear resistance is the priority problem of the modern mechanical engineering. Nowadays there is not optimal method of the friction surface treatment including the best result and small cost price.

Application of the dynamic method treatments (surface plastic deformation (SPD)) of the metal surfaces lets increase its hardness and wear resistance. The efficient application of the shot blasting of metal surfaces is shown in research [1-4]. Moreover using at the same time doping material and ultrasonic vibrations while shot blasting lets obtain metal surfaces with different mechanical and physical properties.

Using ultrasonic vibrations while treatment of the metal surfaces is characterized by specific process proceeding into metal surface and doping material:

- sound-capillary effect is characterized by deep invasion of fluid and the smallest elements into capillaries and cracks of the material under the influence of ultrasonic vibrations [1, 2];
- intense process of the dispersion of powder stuff doping material;
- friction reduction and increase of the plasticity of the metal with both parallel and normal orientation vibrational displacement relative to the boundary surface [1].

It's shown in the research [3] that introduction to the friction zone ultrasonic vibration causes structural and thermal activation of the contact surfaces as a result there is an increase of the energy state and reactivity of that contact surfaces. All this intensifies formation into the friction zone of solid oxide and adsorbed films which cause "shielding" effect on the adhesion processes which result in reducing the friction coefficient [3].

2. Applying chemical dopants

The various chemical compounds (molybdenum disulfide, graphite powder PGML-2) may be used as dopants. Thus, increasing the depth of diffusion of lubricants in the metal surface can significantly extend the life of the friction surfaces without significantly changing of their hardness.

There are various ways to diffuse the lubricant in the metal surface including treatment with a surface plastic deformation. It should be noted that the wear resistance of frictional surfaces dependence on the depth of diffusion of dopants and SPD processing modes is not completely understood. Thus, it is interesting to determine the tribological properties of the friction surfaces of the modes of methods SPD and applied doping material.

To detect this depending, laboratory tests have been conducted in which the metal surface have been reinforced with a composite cover via SPD [4]. The efficiency of coating iron- system based on the Fe-Ni-Cr-B-Si-Mn on the technical, economic and environmental indicators had been detected in the research [5], that is in contrast to the existing methods that allowing to make the best decision only on the technical and economic efficiency of the considered variants. The determination of the optimal chemical composition of the powder was carried out to bring the parameter optimization, which allows to take into account the hardness, wear resistance, the cost of a coverage, as well as the mass fraction of recyclable waste [5]:

$$K_e = \frac{HR\overline{C} \cdot \overline{\varepsilon}}{S \cdot \lambda_1}, \qquad (1)$$

Where:

$HR\overline{C}$: relative hardness of the coating.

$\overline{\varepsilon}$: relative wearing capacity.

S : relative value.

λ_1 : coefficient taking into account the degree of anthropogenic impact in the production phase.

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