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MONITORING THE QUALITY OF THE SURFACE LAYER OF DETAILS REPLACED BY DIFFERENT METHODS OF HARDENING

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Reliability and service life of machines, as one of the main indicators of their quality, are determined by the operational properties of parts and their connections: fatigue strength, corrosion resistance, contact strength, wear resistance, etc. These operational properties of engineering parts are largely determined by the quality of their working surfaces. When solving the problem of improving the quality and reliability of machines, wide application of various kinds of coatings is of great importance, which allows saving scarce materials, prolonging the service life of the restored parts, and significantly increasing the operational performance of machines. Therefore, the task of technological quality assurance of the surface layer of machine parts, and in particular of the restored parts, is one of the most important in solving the problem of improving the reliability and life of machines.

Under the quality of the surface layer of parts reconstructed by various hardening methods (HTO, dynamic, laser hardening methods), we mean a set of surface microgeometry characteristics, a physical-mechanical state, microstructures of the surface layer material, and residual stresses. However, this definition is inaccurate, since the surface layer is formed as a result of force interaction and is largely determined by the features of this interaction. The state of the surface layer should be considered as an external manifestation of the integrative properties of the forming system, which can be described by a combination of quality characteristics-microgeometry, stress-strain and phase-structure state. The evaluation of the quality of the surface layer of the reconstructed parts can be carried out by the results of a quantitative assessment of its state by direct measurement or as a result of simulation modeling.

It should be noted that the evaluation of qualitative indicators of the microgeometry of the surface of the restored parts has a number of distinctive features that are determined by the physicochemical properties of these materials. First of all, it is the adhesive and cohesive strength of the material, the modulus of elasticity and the Poisson's ratio.

It is known that the functional properties of parts restored using hardening coatings depend to a large extent on the chemical composition and structure of the coating material, and in turn on the base material and the physico-chemical processes that occur when the coating is created. Thus, the quality of the hardening coating is provided by the ability to apply the material with the maximum functional properties. Coatings with maximum properties are created by methods in which the base material in the form of a sheath is joined to the substrate without any structural and chemical changes - shearing, ultrasound, gluing, diffusion welding, soldering at low temperatures, etc.

Another criterion for the quality of the coating for parts operating under high or extreme loads is the strength of the structure (static or cyclic strength of the coated product).

The durability of parts restored by various hardening methods is proportional to the functional properties of the material and the thickness of the coating. The coating thickness range is determined by the method of its creation and ranges from fractions of a micrometer to several tens of millimeters. As a rule, the thickness of the strengthened layer is controlled by the following methods: magnetic (magnetic flux method, ponderomotive method, induction method), eddy current, thermoelectric and ionizing radiation.

A necessary condition for the reliability and durability of coated products is the absence of high residual stresses and the stability of the original characteristics (properties) of the base-coating system. Residual stresses are an integral characteristic of the restored part, and their absence is the exception rather than the rule. In most cases, residual stresses in composites arise during their manufacture and operation and reduce the strength and functional properties of the coated product.

Restoration of parts using hardening coatings with low residual stresses is possible due to the creation between the coating and the base of a relaxation layer of highly plastic material.

Reduction of residual stresses arising in the coating during its deformation during operation is ensured by the correct selection of starting materials. Reduction of residual stresses, caused by phase transformation, is achieved by chemical compatibility.

In addition to measures to reduce stress during the manufacture of coating, in some cases there is a need for their reduction even after coating. There are thermal, mechanical, thermomechanical, ultrasonic methods to reduce residual stresses. The choice of this or that method of stress reduction is determined by specific tasks.

It should also be noted that in some cases residual stresses play a positive role, increasing the wear resistance of the coating. The compressive stresses in the coating reduce the likelihood of cracking when the product is subjected to tensile stress. The creation by plastic deformation of the surface layer with residual stresses increases the fatigue strength of the product, etc. In these cases, in order to increase the reliability and durability of the restored part, it is necessary not only to reduce, but even to create, residual stresses of a certain magnitude.

The procedure and rules for the performance of work to assess the quality of a number of hardening coatings are governed by the requirements of state standards. However, existing standards apply only to certain coverages. Therefore, there is a need to create a new specialized standard that allows to assess the quality of the whole gamut of existing hardening coatings.