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INCREASING THE WEAR RESISTANCE OF CUTTING SURFACES OF SOIL PROCESSING MACHINES BY CARBIDE ARC STRENGTHENING

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Currently, in order to increase the wear resistance of the working bodies of tillage machines, ceramic and metal-ceramic materials are the most promising. Ceramic materials have significantly greater wear resistance than hard alloys. However, their main drawback is increased fragility. This, in turn, significantly limits the use of ceramic materials for strengthening the arrow paws of tillage tools operated under conditions of significant impact loads. Metal-ceramic materials are a composite material consisting of a metal steel base (matrix) and ceramic components included in its composition (oxides, carbides, nitrides, etc.). The matrix provides these materials with the necessary impact strength, and the ceramic components provide high hardness and wear resistance. When strengthening working organs, metal-ceramic materials are most often applied from their cutting surface as coatings.

The analysis of modern scientific publications in this direction showed that currently there are a limited number of methods of obtaining metal-ceramic coatings on the cutting surfaces of arrow paws of tillage tools. Moreover, most of the known methods differ in the complexity and high cost of the equipment and materials used, and also do not provide the possibility of strengthening a wide range of arrow legs of different weights and configurations. Therefore, research aimed at creating metal-ceramic coatings on the cutting surfaces of arrow paws is currently relevant and in demand and contributes to the solution of the current national economic problem of increasing the wear resistance of the working bodies of domestic and foreign tillage tools. Currently, a promising method is carbon-vibro-arc strengthening (KVDZ) using metal-ceramic pastes. With KVDZ, a paste containing a metal matrix, ceramic components, and cryolite is applied to the surface being strengthened. After drying, the paste is melted using a vibrating carbon electrode of a KVDZ installation. During the burning of an electric arc on the cutting surface, which is strengthened, a metal-ceramic coating is formed from the components of the paste. At the same time, the metal of the arrowhead is saturated with carbon due to diffusion during sublimation of the electrode [1, 2].

Soil cultivation plays an important role in the production of agricultural crops. Therefore, the quality of soil cultivation significantly affects the yield and efficiency of agricultural production [3]. Currently, a large number of methods of strengthening the working surfaces of various parts are known. However, not all of them are suitable for increasing wear resistance, which work in conditions of intensive abrasive wear under significant loads. To strengthen arrow paws, heat treatment (hardening) is widely used, which can be carried out to the entire depth of the paw, and with the use of high-frequency currents to a hardness of at least 40 HRC for a hardening depth of 1...2 mm [3].

The thickness and basic physical and mechanical properties of metal-ceramic coatings obtained by KVDZ depend on the composition of the used metal-ceramic pastes and hardening modes. The composition includes a metal matrix, a solid component (ceramic components) and cryolite. The matrix is a composite framework of the paste. As a matrix material, it is advisable to use steel surfacing powders with high hardness and abrasion resistance. The conducted analysis showed that powders PG-10N-01, PG-US25, PG-FBH6-2, PG-SR4, ПР-Н70Х17С3Р4 are most often used as a matrix of pastes used in KVDZ. The matrix provides the metal-ceramic coating with the necessary impact strength. Carbides, oxides, nitrides and borides of such metals as boron, tungsten, titanium, chromium, etc. can be used as a solid component of metal-ceramic pastes used for KVDU. However, when using borides, strengthening coatings have increased brittleness, and nitrides have a high cost and are difficult to obtain. Thus, as a solid component of metal-ceramic pastes, oxides and carbides are most often used. In KVDZ, aluminum oxide Al2O3, silicon oxide are most often used as ceramic components of pastes SiO_2 and boron carbide B4C. Currently, the KVDU method is in a state of development. So far, issues related to the choice of optimal strengthening regimes and compositions of the metal-ceramic pastes used have not been fully explored. There are practically no comprehensive studies on the use of carbides (primarily boron carbide) as ceramic components of metal-ceramic pastes in the published scientific works in this direction. The results of the research showed that the thickness of the applied paste layer has the main influence on the thickness of the metal-ceramic coating. There is an almost linear increase in the thickness of the coating, regardless of which ceramic components are used in the composition of the paste. This is due to the fact that a thicker paste also contains a larger number of the main components included in its composition. The largest thickness of the metal-ceramic coating is achieved with a paste layer thickness of 2.3...2.4 mm. However, when the paste is more than 2.5 mm thick, the metal-ceramic coating begins to decrease sharply, and its integrity deteriorates. When the thickness of the paste layer is 2.6...2.7 mm and more, a high-quality metal-ceramic coating is not formed on the surface that is being strengthened. This is due to the fact that with a given thickness of the paste layer, the intensity of the electric field decreases to values at which it becomes impossible to ignite an arc. During the wear tests, reinforced KVSU and non-reinforced samples were tested at the same contact pressure and test duration. Metal-ceramic coatings on the surface of samples 60% matrix powder PG-10N-01, 30% ceramic components and 10% cryolite at the following modes: current strength - 75A, frequency of oscillations of the carbon electrode - 25 Hz, amplitude - 0.5 mm. The results of comparative tests on the wear of strengthened KVSU and non-reinforced reference samples made of steel 65G showed that the reference samples have the highest average wear (0.47 g). Samples strengthened by KVSU have significantly less wear. At the same time, minimal wear is provided by coatings obtained on pastes containing boron carbide. It is 0.16 mm. The conducted operational tests made it possible to establish that the dependence of the wear of the nose part of the KSHU-12H cultivator paws on the working hours when working on loamy soils is almost linear (Figure 3.16). Moreover, this dependence applies to all tested paws.

The thickness of the applied paste layer has the main effect on the thickness of the metal-ceramic coating obtained by KVDZ. The largest coating thickness (0.9-1.0 mm) is achieved with a paste layer thickness of 2.1-2.4 mm. When the thickness of the paste layer increases to more than 2.5 mm, the thickness of the metal-ceramic coating begins to decrease sharply, and its integrity deteriorates. When the thickness of the paste layer is 2.6...2.7 mm and more, a high-quality metal-ceramic coating is not formed on the surface that is being strengthened.

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