PROVIDING OF HIGH LONGEVITY OF OPERATING PARTS OF SMALL-SCALE MACHINERY IN AGRICULTURE

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Abstract. *The author of the article considers the scientific approaches to increasing the longevity of high-loaded operating parts of small agricultural machines by forming the technological repair units when choosing the optimal methods of hardening the functional surfaces with anti-wear low-cost material.*

Key words: unit for drilling, reclamation, drill, technological repair unit, hardening, surfacing, white cast iron, electric spark welding.

INTRODUCTION

The parameters value of technological processes and construction of agricultural machines and their operating parts is determined by laws of interdependencies between the combined impact of the functional surfaces of these machines and reaction of abrasive and corrosive environment to them. In modern conditions of farm machinery operation one of the important tasks is that of maximum maintenance and restoration of functional properties of the parts exposed to different types of wear.

The solution of this problem consists in the preliminary determination, systematization and identification quality indicators of functional surfaces (tribocharacteristics) for specific operation conditions, their interrelations, creation of logic of making the information model of the technological repair unit. [5] The choice of methods for renewal and hardening of new and worn machine parts (renewal of form, size, characteristics of functional surfaces (basing, operating) and connecting) taking into account the operation conditions, the formation of economically effective technological repair units (taking into account the specific production facilities) is a complex multiple-choice task .

The concept when choosing a repair method on the basis of the technological repair unit, taking into account the identification of analytical interrelations at the study of the operating part of the unit for drilling planting holes with different methods of hardening the functional surfaces was crucial in the study of the most promising of them.

MATERIAL AND METHODS

The scientists of technology of metals and machinery repair department and research laboratory of the Kemerovo State Agricultural Institute developed the unit for drilling planting holes when planting seedlings with fibrous root system for biological reclamation of Kuzbass mine tips. [1] The unit (see Figure 1) consists of a power block and mounted equipment. The mounted equipment is a drilling block with a turning mechanism, a motor-reducer and a flow control cylinder. The rod with a drill is attached to the flow control cylinder rod by means of the slider. To transmit the torque from rototiller to the hydraulic pump on the power take-off shaft of the rototiller the oil gear pump is installed.

The research on developing the unit, choosing of the method of hardening and the kind of surfacing material was carried out as a part of scientific research using the grant of the Ministry of Education and Science of the Russian Federation (state contract № 02.740.11.5200 dated 12.03.2010) [4]. Also the theme of the scientific work is registered in the Russian scientific and technical information centre (registration number 01200956909). [3]

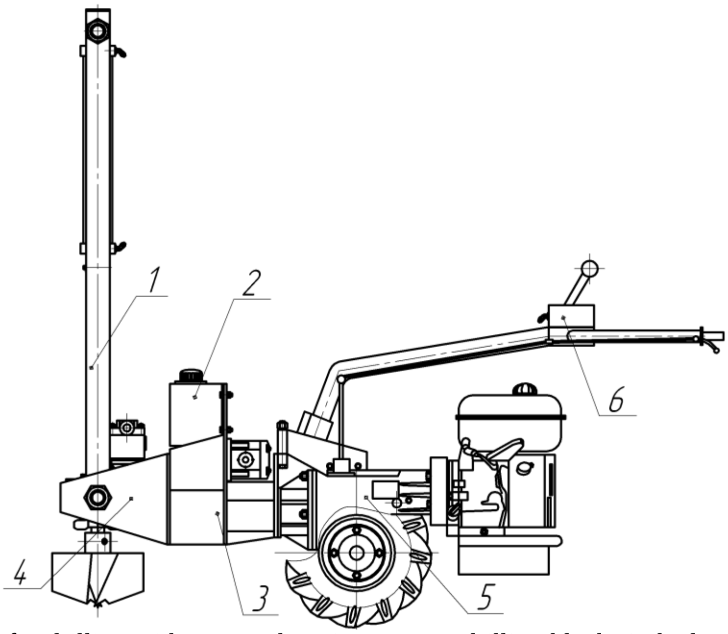

Figure 1 - Unit for drilling with mounted equipment: 1 - drilling block, 2- hydraulic tank, 3 - frame 4 – motor-reducer, 5 - rototiller, 6 - flow control device.

To ensure the highest quality at the mechanized drilling the planting holes a laboratory unit which allowed us to determine the optimum geometrical parameters of the operating part for the different types of soil was also developed (Figure 2 a).

The operating part (drill) of the given unit is designed to reduce the time required to form the planting hole and increase productivity through the availability of a functional side wall (Figure 2 b).

As a material for manufacturing the drill the steel 45 was chosen, as it has a sufficient strength in the normal state at a lower ductility and a rather good machinability by cutting in the annealed condition.

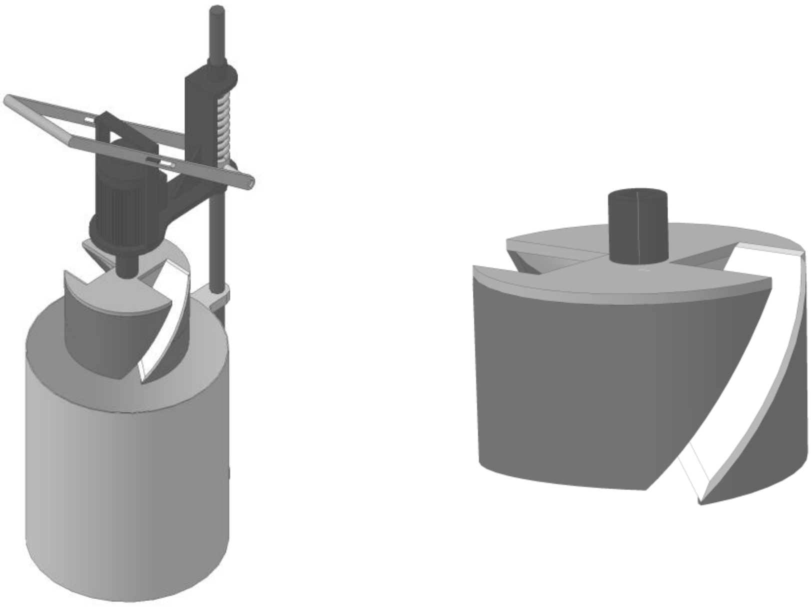

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Figure 2 - Laboratory unit for drilling the planting holes (a), an operating part of the unit for drilling the planting holes (b).

The synthesis of the technological repair unit has revealed the optimal methods of obtaining anti-wear coatings to improve durability of the functional surfaces of the operating part of the unit for drilling by means of electric-arc and electric-spark surfacing with unalloyed white cast iron [2, 6].

After studying various methods of surfacing the anti-wear coatings, the method of electric-spark welding has been developed, it includes contact processing by a rotating electrode and differs from the existing methods in that during surfacing the coating the removal of the defective layer from an operating surface of a rotating electrode is done continuously.

During electric-spark surfacing the thickness of coating increases in due course according to a curve with saturation, i.e. coating rate decreases. The closer to the processing time is to the saturation time, the lower the quality of the surface is. Counter transference of the material of the part (cathode) to the electrode (anode) is done by cathode sputtering, as well as by diffusion at the time of contact of the electrode and the surface of the part.

RESULTS AND DISCUSSIONS

In this regard, as well as a result of the thermal effects on the surface layers by the rotating electrode during the spark, a certain amount of it is saturated with the chemical elements of the part material and changes its physical and chemical properties, resulting in the formation of the defect layer having a depth of 0.2 mm. The result is a reduction in processing effectiveness and quality (durability) of the surface being hardened. The technical result of the proposed method is an increase in the productivity of the process and the quality of the processed surface (Figure 3).

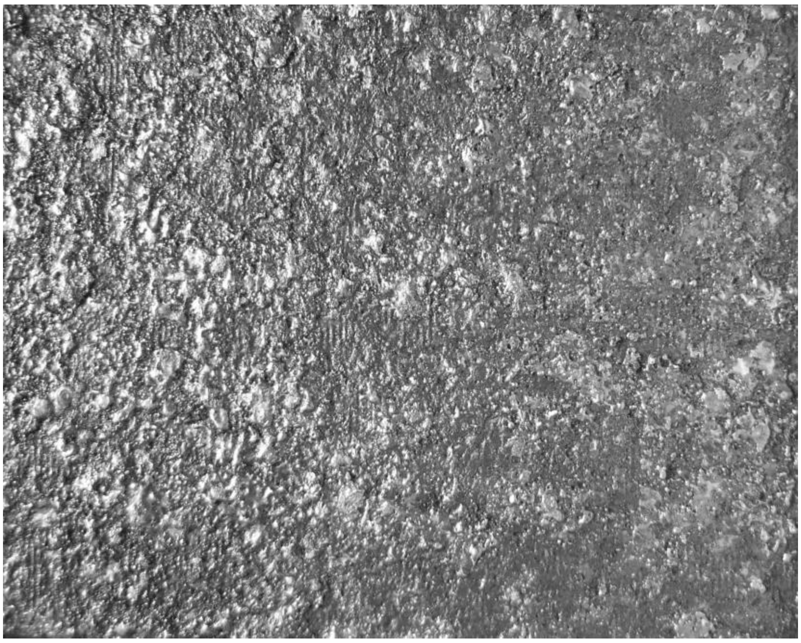

Figure 3 - The functional surface welded by electric spark method

Removing the defective layer (clearance) during the electric spark surfacing of the coating, that is a constant renewal of the operating surface of the electrode in order to preserve the original properties of the material will increase the effectiveness of the process and the quality of the processed surface of the part by maintaining physical and chemical properties of the operating surface of the rotating electrode.

In the process of surfacing cast iron a continuous removal of the defective layer from an operating surface of a rotating electrode is done with a grinding wheel. When surfacing the anti-wear coating with the given method the processing time was reduced by 15-20%. As a result of field tests durability of processed parts has increased on average by 30%.

As a surfacing material we propose to use white unalloyed cast iron with electrodes made from it for anti-wear coatings [2, 3]. Surfacing electrodes are easy to manufacture, are not sensitive to the rate of crystallization, have no expensive alloying elements. The electrodes are the trapeziform cast rods having the length of 250-350 mm.

Arc welding with trapeziform electrodes creates a large layer of welded metal, but there is a great warm-up of the base metal to form an extended heat-affected zone (Figure 4). Electric spark welding does not destruct the structure of the base metal, due to the rapid setting of the metal (Figure 5). But at the same time, there are disadvantages of this method - the small thickness of the welded layer. The thickness of the layer is increased by the use of a rotating electrode with a diameter of 25 mm and as a result, the depth of the welded layer reaches 1 mm. To increase the durability the layer thickness of 4-5 mm is required. This can be achieved through increasing the number of passes.

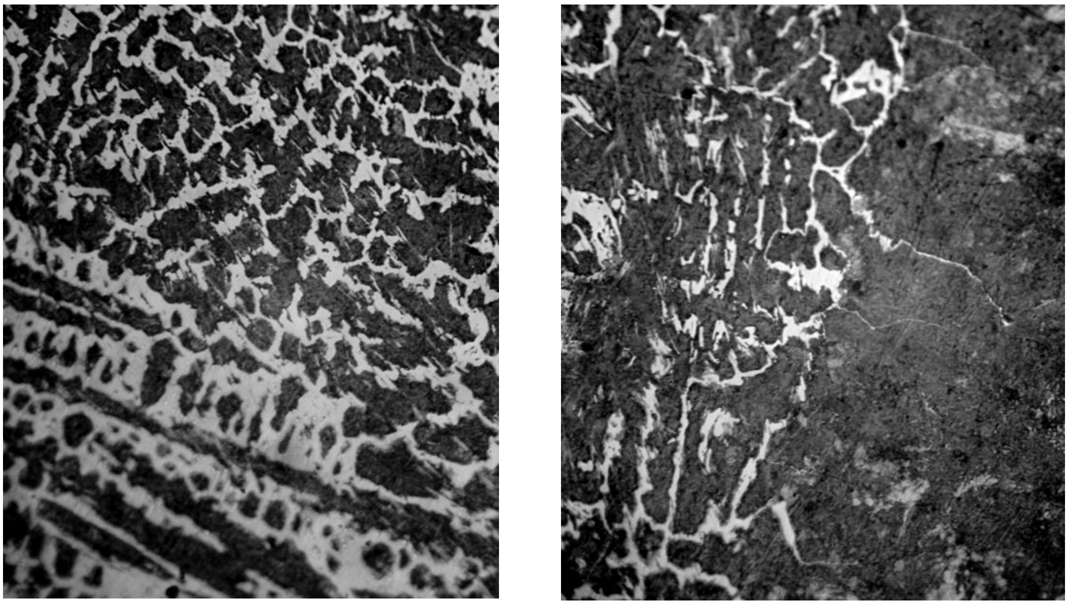

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Figure 4 - The microstructure of the welded layer (a) and the heat affected zone (b) after the arc welding of cast iron to steel 55, × 300.

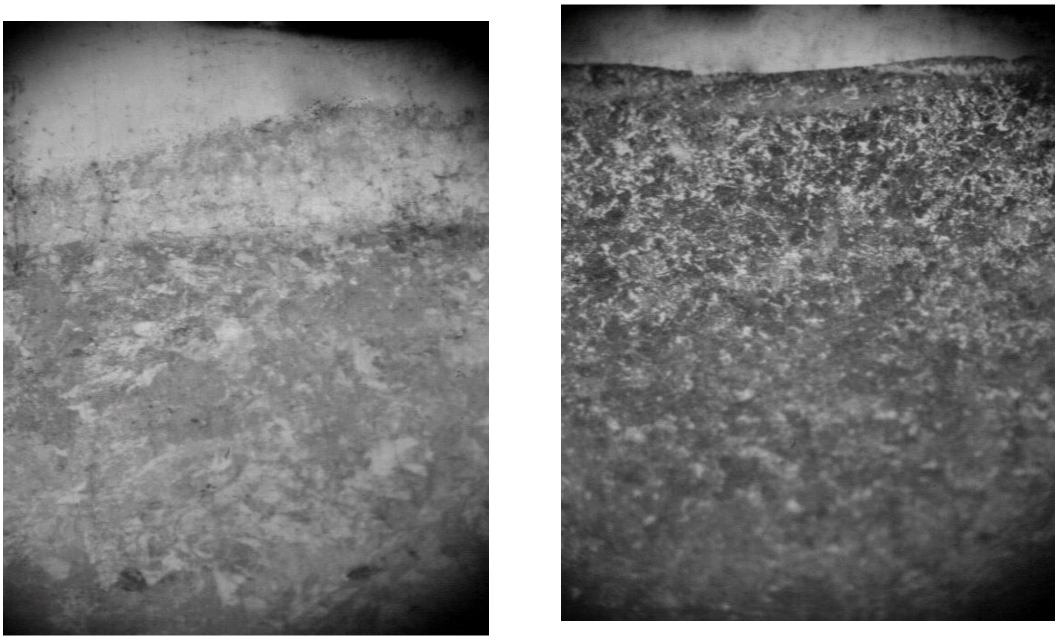

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Figure 5 - The microstructure of samples welded by the electric spark method, × 300: a - annealing at 830^0C, welding mode: U = 20V, I = 45 A, 141 r / min, b - annealing at 830^0C, welding mode: U = 30V, I = 45 A, 890 r / min.

CONCLUSION

The basis for choosing the best method of surfacing anti-wear coatings from low-cost materials was a scientific approach with systematic method of synthesis of technological repair unit for the functional surfaces of the operating parts of agricultural machinery and implements.

As an example of technological repair unit implementation, the designed unit for drilling with an operating part, undergoing high chemical abrasive effects under severe dynamic loading conditions, was adopted.

Research has shown that the process of surfacing the anti-wear layer of white cast iron with electric arc welding and electric spark welding does not lead to the appearance of graphite phase in the structure of the welded layer, i.e. the structural heredity of the material not to form a graphite inclusion in the process of melting of the electrode (metal transfer to the welded detail and cooling to room temperature) is preserved, which led to a reduction in processing time by 15-20% with increased durability of the processed parts on average by 30%.

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