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# Influence of restoration surfacing on service properties of soil pump shafts

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Abstract
The research contains analysis of primary defects of soil pump shafts. Examined is influence of quantity of restoration surfacing on wear resistance of restored parts.

**The Problem and its connection with scientific and practical tasks**

Soil pumps are the most widespread machinery in the sphere of mining industry. Billions of cubic meters of pulp are yearly pumped out with the help of this kind of machinery. That's why they play an important role in the working process of this sphere as far as the development of this industry is impossible without these pumps and they form the basis of almost all production processes. Efficiency of using this expensive machinery depends on reliability and durability rates of soil pumps separate parts. Providing required soil pumps qualitative indexes is an urgent problem. And deffects on the surface of materials emerging in the process of manufacturing and adjustment are among the factors that essencially affect numerous qualitative properties of the produce.

**Researches and publications analysis**

Literature analysis [1, 2] has shown that rolling bearings failures as well as corrosive pockholes, scraches emerging in the result of foreign fine particles ingress result in wear and tear of shaft journals. Shaft journals in rolling bearings are worn out by means of internal holder gnawing through shaft bearings in the result of loosening in the process of bearing seats finding while pumps are in service. Bearing seats renovation (in case of bearing seats wear of more than 0,8 mm) is performed by means of surfacing. It scales up the lifetime of a shaft significantly, provids great economy of spare parts, reduces costs for machinery repair.

**Problem statement**

In connection with the given above information it is necessary to provide a research study concerning the influence of quantity of possible shaft recoveries by means of surfacing on shaft functionality

**Presentation of material and results**

The main external signs of pump failure are: an increased level of vibration, excessive running gear, bearing heating, unwanted sounds, reducing level of pressure being developed (feeding).

The main fault conditions of soil pumps are:

Wear of pump impeller, pulp inner body and plant blocker wheel;

Unbalance of pulp impeller in the result of its uneven wear along the perimeter;

Damage of bearings in the result of lubricant washing out (contamination) or hydraulic impacts being result of an uneven pulp coming, the last factor may result in shaft bending and shaft bearing seats wear.

Shaft is the main component of the rotating part of a pump sending torque moment from engine to pulp impeller. It is one of the most loaded parts operating under hardest conditions. While soil pump is in use its shaft is under significant loads caused by complex interaction of total hydraulic and dynamic forces and moments. That's why high requirements are set as for the process of its restoration.

**Table 1.** Information taken from the leading Mining and Metallurgical Enterprises in the region for 2011

| Enterprise | Quantity of pumps restored | The cause of failure | | |
|---|---|---|---|---|
| | | Because of shaft failure | Because of failure of pump impeller | Because of volute failure |
| OJSC "Yuzhny GOK" | 340 | 249 | 276 | 168 |
| PJSC "ArcellorMittal Kryvyi Rih" | 244 | 192 | 213 | 198 |
| PJSC "Severny GOK" PJSC Central GOK" | 799 | 674 | 738 | 723 |
| NKGOK | 343 | 249 | 321 | 296 |

Statistical data shows that the majority of sludge pumps fail to work before the period having been defined (or the overhaul life period of shaft operation) has expired. Analysis of statistical data gathered from the leading enterprises of Mining and Metallurgical Complex of the region for 2011 shows that approximately 79% of shafts need restoration in the process of soil pumps exploitation (table 1)

Primary defects got by shafts in the course of their exploitation are as follows: surface deterioration (picture 1, c); ripping out of metal (picture 1, b); cracks (picture 1, a), defects, deformations, changes in mutual placement of surfaces [4].

a) b) c)

**Figure1.** Primary defects of soil pumps shafts got in the process of exploitation

In the result of defects analyzing it was established that about 90% of shafts fail to work because of wear they get in the process of exploitation. Wear resistance is a property of materials to offer resistance to wearing. In the course of wearing we deal with the process of surface layers destruction by means of friction. This process leads to gradual change in size, form and surface condition of parts. Wear results in lowering exactitude of conjugation, reliability and efficiency of machinery. Wear of parts leads to increase in machinery exploitation cost because of the necessity of providing their periodic repair.

One of the factors wear resistance depends on is surface hardness of parts. And that's why a decision was made to provide investigation as for hardness distribution on the cross section of parts. The experiment was carried out in working environment as well as under laboratory conditions in accordance with the next plan: two variants of

samples were produced. The first sample was made of a fresh bar which had never been loaded before and didn't have accumulated weariness which also influences durability of work. The second sample was produced of a soil pump shaft, which worked out its resource and was subjected to fatigue wear. Material of both samples was steel 45 GOST 1050-88.

Technology of carrying out experimental investigations is the same as the technology of shaft restoration after wear.

For the first variant of samples a defective layer of 1mm was deleted and then surfacing of 5…6 mm on the diameter was performed. After the first layer of surfacing a sample of 25 mm was cut from the initial sample to be tested on hardness. It was cut from the external side of surfacing in direction to the core of the base metal. The residuary sample was turned up to the base metal; the second layer surfacing was performed then. A sample for tests on hardness was taken again from the given experimental sample. In accordance with the given scheme 7 series of experiment were made. After each surfacing received was a sample to be tested on hardness. Hardness was measured with dynamic hardness-testing machine TDM-1.

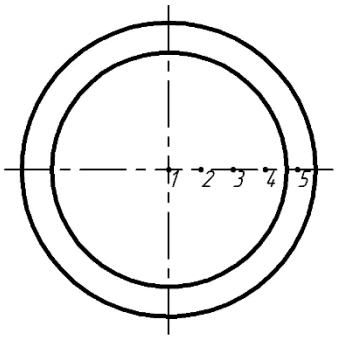


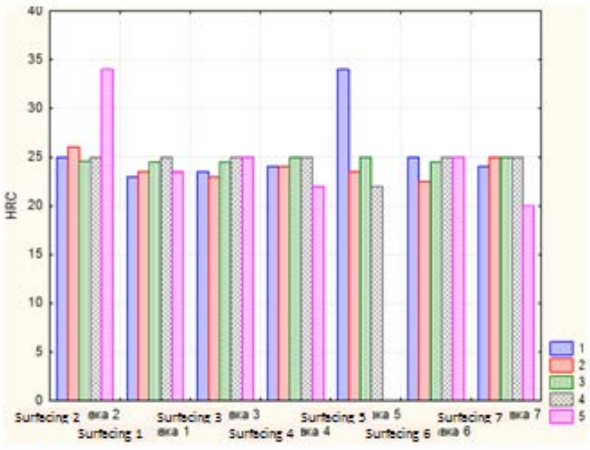

**Figure 2.** Points of testing hardness of samples

The same scheme was implemented in case with the second sample. 7 samples were also received to be tested on hardness.

Electroslag hard-facing was performed on surfacing machine A-384MK with use of flux cored wire 30HGSA GOST 10543-73, ∅2 mm. It was performed under flux AN348FA GOST 9087-81using the following modes [3]: current strength 300A, voltage 28V, speed of surfacing 134 m/h, wire delivery rate 4mm/rev.

Hardness of samples was measured in accordance with the scheme on picture 2 on the diameter of the restored shaft

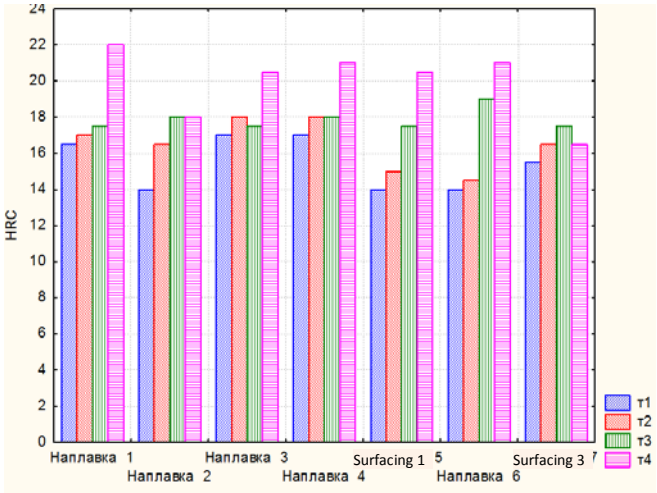
Hardness results for the first set of samples (not subjected to fatigue strength) are shown on the following diagram (picture 3). Having analyzed changes of hardness, we can conclude that hardness rate decreases the more numerous restorations by means of surfacing are.




1,2,3,4,5 – points of measuring hardness of samples

**Figure 3**.Diagram of hardness distribution on the cross-section of parts without influence of fatigue strength

Results for the second set of samples (which had worked out their resource) are shown on the following diagram (picture 4)




1,2,3,4 – points of measuring hardness of samples

**Figure 4**.Diagram of hardness distribution on the cross-section of parts having worked out their resource.

On the diagram we can see that influence of fatigue strength lowers hardness on the total cross-section of the sample. And in case with the seventh surfacing significantly lowered is also hardness of surfacing layer. And in the result of this lowered is wear resistance of the shaft surface layer.

**Conclusions and trends of further investigations**

In the result of physical-mechanical properties investigation of metal of a restored sludge pump shaft defined was the range of hardness distribution from surfacing zone to the base metal. It was found out that greater number of surfacing restorations leads to decrease of shaft operation period between restorations, and that may lead to shaft destruction. This fact appears to be the base for further investigations of surfacing layer microstructure as well as for investigations of heat-affected zone and base metal zone.

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