Prunko I.B.
Ivano-Frankivsk National Technical University of Oil and Gas,
Ivano-Frankivsk, Ukraine
E-mail: trans@nung.edu.ua

INVESTIGATION OF RESTORATION DIMENSIONAL PARAMETERS RODS PUMP GAS TRANSPORT PROCESS BY ELECTRIC-SPARK ALLOYING

UDC 539.234: 539.25

The working surfaces of the made from 40Kh steel push rods for oil-field pumps was treated by electric-spark buildup procedure using electrodes from T15K6 and VK8 alloys. The electric discharge between processed detail and electrode promotes to precipitation of the alloy elements and surface renewal. The high-strength surface layer with thickness 10…35 μm mainly containing the carbides was formed. Investigation of the surface layer structure at high resolution allow to study of surface morphology of treated detail.

Key words: electric-spark, carbides, working surfaces, electrode.

Introduction

The process of oil occurs in complex technological environments and is interrupted by damage to any item of equipment. It causes significant economic losses not only because of interruption of oil, but because of various complications from the accident. One reason for such contingencies may be particularly premature failure of oilfield pumps. Experience of operation shows that their most vulnerable spot is the surface friction between the rod and sleeve, wear seal along which can lead to cardiac pump. In addition to intensive wear during the friction pair " rod - cuff " most stocks are subject to more and hydro- abrasive wear, caused by pumping liquid washing containing weights and particle species, falling to her during drilling.

To improve resource stocks mud pumps use chrome or cementation (to a depth of 1,5 ... 2,0 mm, followed by high frequency quenching [1]) of the surface. By using these types of surface strengthening resource stocks is ~ 150 hours [2], which does not provide a sufficient duration of operation of equipment.

There are also other methods to improve wear resistance rods: surface plastic deformation a rational jet hydro processing [3], covering work surface enamel rod, followed by grinding [4], plasma spraying powders [5]. However, the disadvantage of these methods is the difficulty of drawing materials, low performance and so on. Enamel covers and covers using plasma spraying with cavities and cracks, and during the operation they undergo delamination and chipping [6]. These short comings hinder their widespread practical use in the oil industry. There fore, finding an effective technology to restore and strengthen the surface layer of working under intense waterjet wear and corrosion, remains problematic.

Basic material

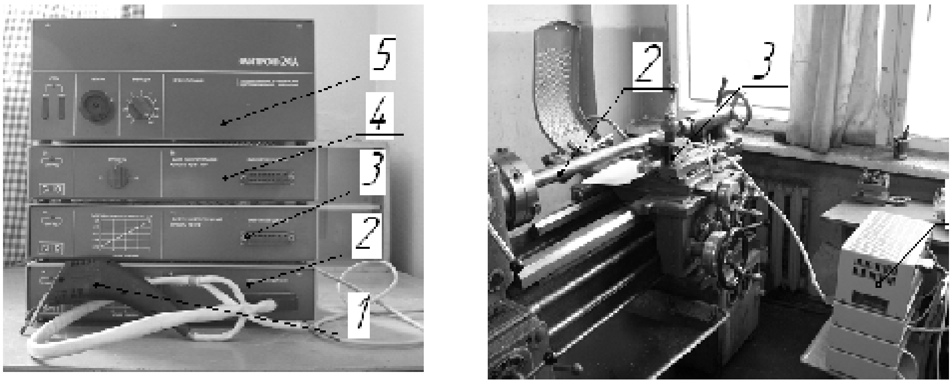
Purpose - to develop a method of restoring worn surfaces of rods oilfield pumps using electric- increasing doping and surface friction.

Description of the process. Spark alloying is to strengthen the surface of the part under the influence of electric- discharge [7]. Spark discharge occurs between two electrodes, which supplied DC voltage 10 - 200 V power adapter for 0,2 - 150 A. In this case, the surface of the cathode (work piece) for achieving energy equivalent electron work function, electrons begin to fly. Walking to the anode, they are accelerated in the between the electrode space and ionize the air. The number of ions and electrons increases and there is a spark discharge cycles. The rate of the spark is 10^{-2} ... 10^{-7} s^{-1}, and the time of burning is minimal. During the bombardment of the anode, electrons are knocked out of him, ions that travel to the cathode and deposited on it. Thus, the surface of the anode is destroyed (electrical erosion), and on the surface of the work piece (cathode) formed cover. For continuous combustion spark electrodes converging the distance required to cause a spark, using a high-frequency vibrator. As the ions fly through the air, while there is a possibility of formation of nitrides and oxides and complex reinforced layer doping ion anode material, nitrogen and oxygen. Also the emergence of local outbreaks temperature under electric- discharge creates conditions for quenched surface layer, which further enhances its durability.

To strengthen accustomed to using electrodes made of graphite, ferrochrome, aluminum, white cast iron, hard alloy T15K6 and iron boron, or other conductive materials to ensure that hardened surface with predetermined properties.

The used equipment. To restore the surface of the rod used industrial equipment “Elytron-24A” for electric- doping [8], which in productivity of 0,3 ... 10 sm^2/hv lets you get hardened layer thickness of 0,25 ... 2 mm. A general view of the equipment shown in Fig. 1. System is equipped with three blocks accumulation of electrical energy, which made it possible to implement different modes of Electrical discharge machine. It is fed by AC at 50 Hz for 220 V ± 10 %. Add consumes 0,6 kW. Average productivity of the formation of the surface hardened layer was 5 mm^2/s, and its thickness - 50 microns. The arithmetic mean deviation of the profile does not exceed

20 microns, ensuring high quality machined surface (5 - 6 students). Parameters measured intensity profile used to strengthen the quality and extension of the surface. Increasing power intensified every single category and as a consequence - the transfer of particles from the electrode to the workpiece surface.



а **б**

Fig. 1 - A general view of the equipment "Elytron - 24A":
1, a – vibration exciter; 2, a – 4, a – storage units, 5, a – PSU,
and stand for the application of electric-cover on the pump shaft
1, b – "Elytron-24A" 2, b and 3, b – rod pump and vibrator mounted, respectively, on the calipers cam lathe

To obtain a uniform rod cover on the pump, it fixed in cam and vibrator - the caliper screw- cutting lathe 1620 (Fig. 1, b). For high performance application cover used in the following modes of the machine: Spindle speed n = 0,75 s^{-1}, giving s = 0,455 mm/rev.

For electrodes for electric capacity and strengthening rod pump is made of steel 40X, used and hard-alloy plates T15K6 BK8. Surface of the rod enlarged in 4 passes using different power level. Mode extensions are given in Table 1.

Table 1

Material and surface modes of extension rod pump

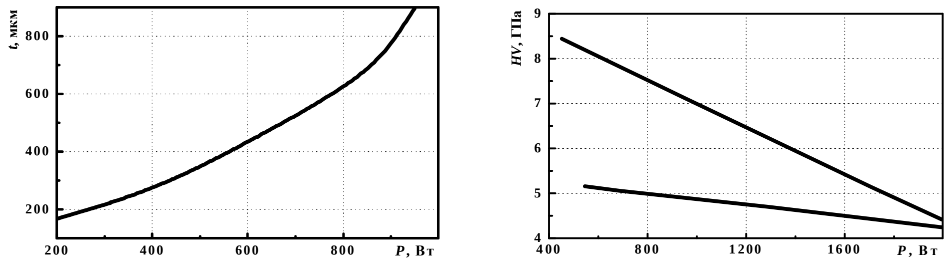
Regime	Electrode	Capacity of power savings, uF	The amplitude of the pulse voltage, V	The frequency of vibration of the instrument, Hz	The energy of a single pulse, J
T1	T15K6 VK8	60 ± 8	75 ± 15	390 ± 70	0,22
T2		150 ± 15	75 ± 16	250 ± 50	0,42
T3		300 ± 30	71 ± 15	125 ± 25	0,75
B1	BK8	60 ± 8	75 ± 15	390 ± 70	0,22
B2		150 ± 15	75 ± 16	250 ± 50	0,42
B3		300 ± 30	71 ± 15	125 ± 25	0,75

After applying the surface layer of hardened rods cut timber and made of them by grinding [9]. For digestion patterns using 3 % alcoholic solution of HNO3. Metallographic analysis of thin sections conducted on an optical microscope Neofot 21. Microhardness (by weight 20 g) measured in the 10 ... 15 points and determine the average.

Determining the length of reinforcement. Rate of formation of the layer and its properties depend on the power of electric- discharge electric- strengthening specific duration (duration of electric- strengthening unit surface s/mm^2) and velocity relative to the electrode surface [10]. With increasing discharge power hardened layer thickness to increases, but the microhardness HV decreases (Fig. 2). The increase in layer thickness to with increasing discharge power P due to the increased mass transfer. While the reduction caused by local overheating HV surface. This increases the diffusion mobility items doping decreases their concentration on the surface, and there is supply of hardened layer [10].

Specific duration strengthening also affects the properties of the hardened surface (Fig. 2). In general, with increasing discharge power and reduce its better to work on a specific length of more than 1,5 s/mm^2 inappropriate. In principle, each share of power there is a critical length of reinforcement, in which strengthening layer collapses and stops.

The frequency of movement of the electrode relative to the treated surface affects the thickness of the hardened layer: it decreasing to increases. But for reaching the critical thickness strain in a reinforced layer growing on the surface appear dark spots and cover collapses.

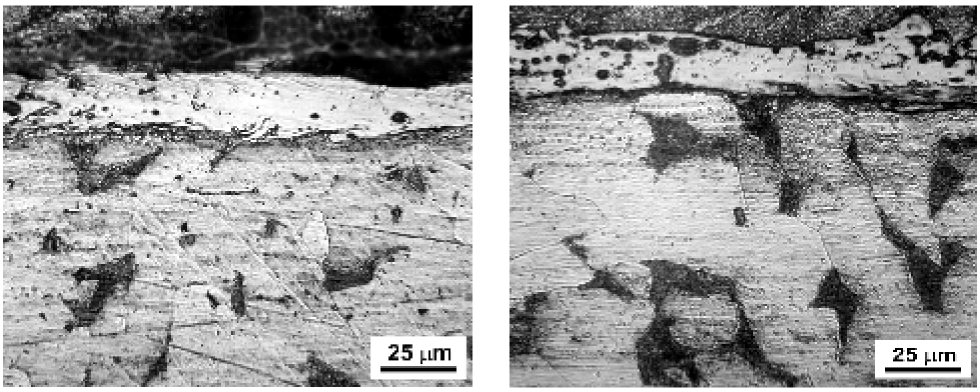


a b

Fig. 2 - Effect of electric-discharge power *P* during surface alloying of the thickness *t* (a) and microhardness HV (b) hardened steel layer 45 by strengthening specific length 1 (1) and 6 (2) s/mm^2

The research results

The typical structure of extension rod to the surface layer obtained by using as an anode carbide VK8 and T15K6 shown in Fig. 3. During implementation are listed in Table. Thickness extension mode 1 layer on the surface of the rod (light strip in Fig. 3) ranged from 8 to 20 microns. This layer is practically not subject to digestion, indicating a significant concentration of alloying elements in it.



a b

Fig. 3 - Effect of electric-discharge power P during surface alloying of the thickness t (a) and microhardness HV (b) hardened steel layer 45 by strengthening specific length 1 (1) and 6 (2) s/mm^2

Microhardness of the resulting layer varied depending on the used mode of treatment from 10 to 22 GPa (Fig. 4). The maximum microhardness (~ 21,5 GPa) recorded for implementing the regime T2 using hard alloy electrode T15K6. Microhardness extension layer by using the same electrode, but other modes of application does not exceed 11 GPa. The average microhardness of extension layer for use in processing BK8 electrode does not exceed 11 ... 14 GPa. Microhardness highest for Using the B3 (Fig. 4).

Microhardness of base metal (steel 40X) directly beneath the deposited layer was 1600 ... 1900 MPa, which is typical for ferrite steels as part of the ferrite-pearlitic structure.

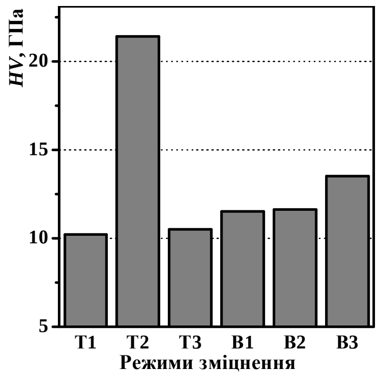


Fig. 4 - Effect Change of microhardness HV depending on the used mode processing, which deciphered in Table 1

The high microhardness extension layer can be explained only by a high concentration of alloying elements in it . Electron microscopy and X-ray microanalysis suggest that the surface layers formed nitrides and carbides of alloying elements that act in the surface layer during the electric-treatment. In particular, accrued layer formed by alloying steel electric- 40X T15K6 hard alloy consisting mainly of titanium and tungsten carbide . This surface layer has high hardness and can predict that it will provide its high abrasion and corrosion resistance.

Conclusion

The use of electric-surface alloying components operating under conditions of friction and abrasion-erosion wear, makes it possible to recover their workability and extend their life. This is achieved by doping the surface layers in the field of electrical discharge. In the surface layers of the metal carbides formed on nitrides, which significantly increases the microhardness.

In the case of an alloy to strengthen steel 40X T15K6 received maximum microhardness of 21.5 GPa, which provide titanium and tungsten carbide.

References

1. Chisel pumps. Basic parameters. [Text]: GOST 6031-81. - [Effective from 1983-01-01]. – M.: Standards Publishing House, 1982. – 2 p.
2. Karaev MA Hydraulic drilling pumps [Text] / MA Karaev - Moscow: Subsoil, 1983. - 208 p.
3. Dyachuk V.V. Technological transport equipment [Text] [Abstract lecture] / V.V. Dyachuk, M.V. Gordiychuk - Ivano-Frankivsk: IFDTUNG , 2000 . – 98 p.
4. Oilfield Equipment [Text] [Reference / Under. Ed. EI Buhalenko] . - Moscow: Subsoil, 1990. - 559 p.
5. Litvinov VM Improving the reliability of oilfield pumps [Text] / VM Litvinov - Moscow: Subsoil, 1978. – 191 p.
6. Kanarchuk V.Є. Bases technological service and repair car [Text] / V.Є. Kanarchuk - K. Higher School, 1994. - 599 p.
7. Nikolic A.S. Piston mud pumps [Text] / A. Nikolic - Moscow: Subsoil, 1973. – 224 p.
8. Kogan Y.D. Technological methods to improve the reliability and durability of machine parts [Text] / J.D. Kogan - Moscow: MADI, 1988. - 52 p.
9. Chertok B.E. Laboratory works on the technology of metals [Text] / B.E. Chertok - M. Mashgiz, 1961. – 183 p.
10. Burumkulov FH Electrical discharge technology recovery and strengthening of machine parts and tools (theory and practice) [Text] / F.H. Burumkulov, P.P. Lezin, P.V. Senin - Saransk edition "Red October" , 2003 – 504 p .

Поступила в редакцію 13.05.2014

Прунько І.Б. **Дослідження процесу відновлення розмірних параметрів штоків насосів нафтогазового технологічного транспорту електроіскровим легуванням.**

Методом електроіскрового нарощування електродами з твердосплавних пластин Т15К6 та ВК8 обробляли робочі поверхні штоків нафтопромислових насосів зі сталі 40Х. Електричний розряд між оброблюваною деталлю і електродом сприяє осадженню елементів легування та відновленню поверхні. При цьому утворюється високоміцний поверхневий шар завтовшки 10…35 мкм, який в основному містить карбіди. Дослідження структури поверхневого шару деталей за високої роздільної здатності дозволило судити про морфологію поверхонь після оброблення.

Ключові слова: електроіскрова, карбіди, робоча поверхня, електрод.