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Influence Of Anodization Technology On Wear Resistance Of D16t Aluminum Alloy

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Abstract
Investigated influence of ozone and ultrasound use when anodizing D16T alloy on wear resistance of a coating. Anodizing executed in 10% water solution of sulfuric acid. Used 4 technologies with separate and joint impact of ozone and ultrasound on a reactionary zone. The size of wear was calculated by a weight method. Coating impregnation by oil increases wear resistance by factor of 1.14 - 3. 33 depending on technology of anodizing. Wear size in comparison with basic technology is decreased by factor of 1.3 - 2.2 in the absence of coating impregnation by oil and by factor of 1.4 - 6.4 at its application. The combined use of ozone and ultrasound in the process of anodizing increases wear resistance of the anodized samples most effectively. It is caused by increase in a share of aluminum oxide crystals in a coating. By means of a scanning electronic microscope of JEOL J5M-6510 LV model, characterizing structure of an oxide coating the microphotos with increase by factor of 3000 are received.
Lamination of an amorphous component of a coating is established, the sizes of channels and pores in it reach 24 microns. Distribution of crystals of aluminum oxide in a coating is shown at various technologies of anodizing, as well as classical dendrites of Al_2O_3 are found.

Keywords: Anodization, Aluminum Alloy, Ozone-Aerial Mixture, Ultrasound, Oxide Coating, Wear

Introduction

In modern constructions and equipment materials with a small density are applied more widely. It allows reducing weight, increasing the loading capacity and travelling speed of transportation vehicles, reducing operational costs. Light materials are applied not only in aircraft, automotive industry, building, but also in oil and gas branch [1 - 3].
Superficial characteristics of aluminum and its alloys can be improved by anodizing in water solution of sulfuric acid. This method is widely applied in the industry. At the same time its improvement proceeds constantly in connection with increase of requirements of consumers to operational parameters of products.

Materials And Technique Of Research

In work influence of use of ozone and ultrasound when anodizing an alloy of D16T for wear resistance of a coating was investigated. Samples in the form of segments of rings with a diameter of 68 mm, 10 mm of width, and a rim of 9 mm thickness were used. Anodizing was carried out in 10 % water solution of sulfuric acid with a density of current 10 A/dm^2 at a temperature of 10 ° C. Thus 4 options of technology of anodizing were used:

1 - bubbling through electrolyte of the cleared and drained air with an expense of 2 l/min;
2 - bubbling through electrolyte of the cleared and drained air with an expense of 2 l/min in an ultrasonic bathtub UZV-13/150-MP-RELTEK with a frequency of 20.35 kHz;
3 - bubbling through electrolyte of the cleared and drained ozonic-air mixture containing 3 mg/l of ozone, with an expense of 2 l/min;
4 - bubbling through electrolyte of the ozonic-air mixture containing 3 mg/l of ozone, with an expense of 2 l/min in an ultrasonic bathtub of UZV-13/150-MP-RELTEK with a frequency of 20.35 kHz.

The part of the anodized patterns was impregnated with TAD-17 oil at a temperature of 100 ° C after warming up in boiling water. Impregnation is possible due to existence of channels and pores in a coating.
Tests for wear executed with machine of friction TM-5-18II 5018 at load of a brake pad 50H and the frequency of rotation of a roller of 444 rpm. The size of wear was calculated with a weight method. The tempered U10 steel was used as a roller with a diameter of 45 mm. The way of friction made 4300 m.
Structure of coatings was studied using scanning electronic microscope of JEOL JSM-6510 LV model with the module add-on unit of the X-ray spectral analysis.

Results And Discussion

Results of tests for wear are given in figure 1. Reduction of size of wear is shown in table 1 depending on option of technology of anodizing in comparison with technology 1 in case of existence and lack of impregnation of a coating with

oil after anodizing. Decrease in size of wear as a result of impregnation by coating with oil is estimated also at separate and combined use of ozone and ultrasound in the process of anodizing (the last column) [4].

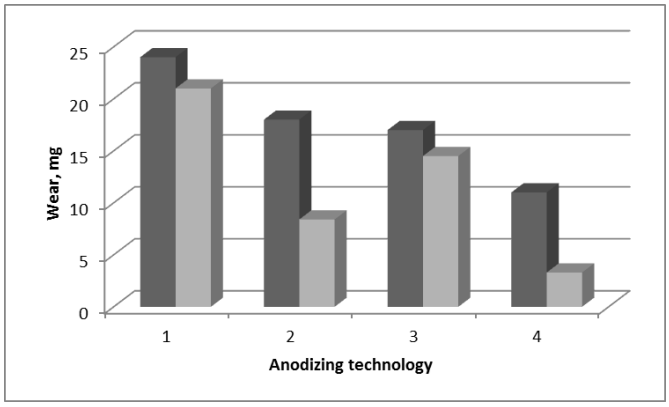


Fig.1. The size of wear of an oxidic coating depending on option of technology of anodizing and existence (□) or absence (■) of impregnation by oil.

Impregnation by oil of the samples anodized by technologies 1, allows reducing wear size by only 14%. Apparently, it is explained by small porosity of a produced coating. Impregnation by oil of samples which anodized with simultaneous use of ozone and ultrasound is most effective (decrease in wear makes 3.33 factors). Diameter of channels in a coating thus turns out to be maximum. So, more oil remains in a sample and in the process of test for its wear it is produced in more volume.

Structural features of the received anode oxidic coatings [1, 5-7] are presented in figures 2-5.

TABLE.1. Efficiency of applied technologies of anodizing

Option of technology of anodizing	Reduction of size of wear, factors		
	in comparison with technology 1		due to impregnation by oil
	without impregnation by oil	with impregnation by oil	
1	1.0	1.0	1.14
2	1.33	2.50	2.14
3	1.41	1.45	1.17
4	2.18	6.36	3.33

Amorphous oxide of aluminum makes a basis of a coating (figure 2). It has a layered structure and is penetrated by a large number of channels and pores which sizes reach 24 microns (figure 3). Surface of interstices is rough.

In figure 4 the dendrite growing, apparently, in the channel is presented. In process of growth it can block the channel similar to the situation given in work [1].

Crystals of aluminum oxide of gamma modification (in figure 5 they are represented by light insertions) are distributed inside the amorphous component. It is established that in the coating received with use of ozone and ultrasound, there are more crystals, and they are distributed more regular, than in the coating received in technology 1. Therefore the size of wear of the samples anodized by technology 4, is less.

On the basis of the obtained data there has been developed a technology of anodizing of real parts of the oil and gas equipment made from aluminum alloys instead of steels [1, 2]. The nozzle and the mixing chamber of the jet pump, the sliding bearing collar, safety shirts, guide vanes and intersection pump packings for maintaining reservoir pressure have been manufactured from alloy D16. Anodized aluminum parts have operated successfully in an aggressive environment without shock loads. The magnitude of wear decreased by more than a factor of seven in comparison with the serial parts.

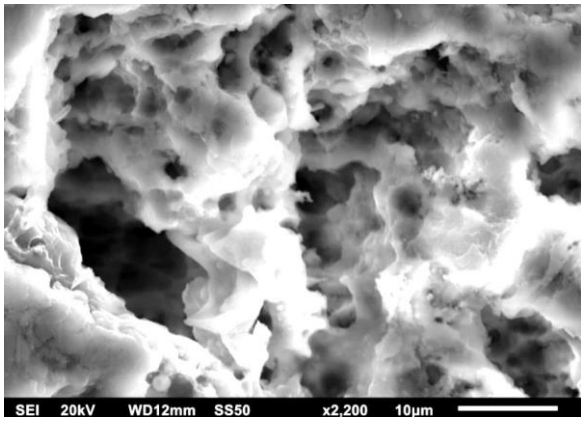


Fig.2. Amorphous component of an anode oxidic coating.

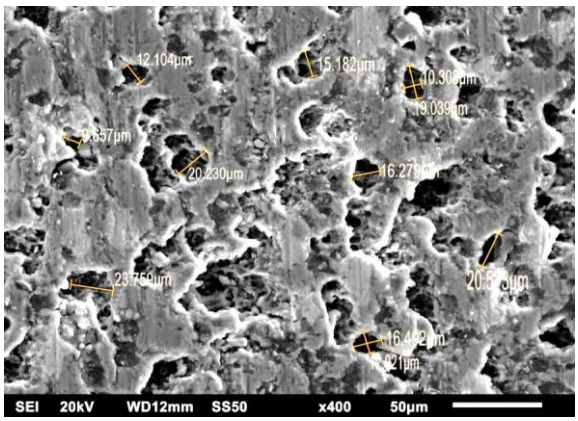


Fig.3. - The sizes of channels and pores in an anode oxidic coating.

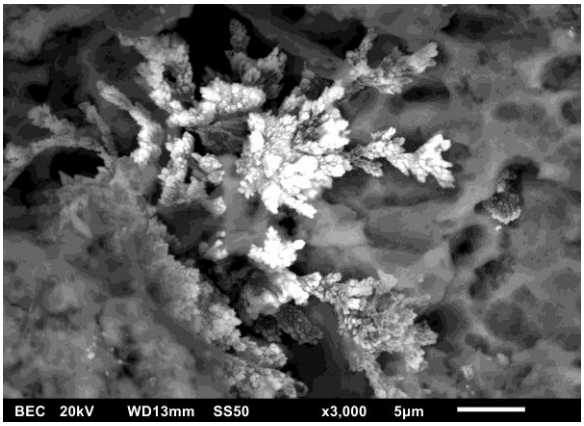
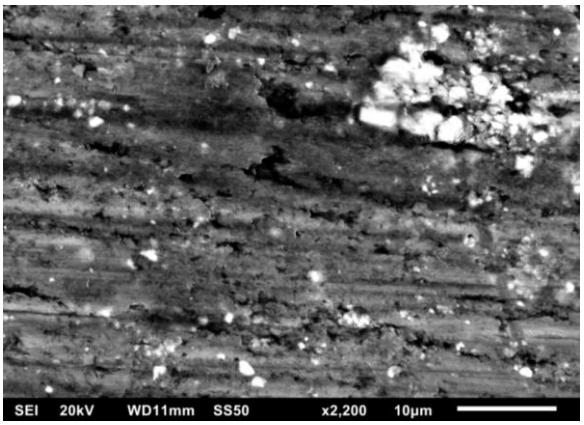
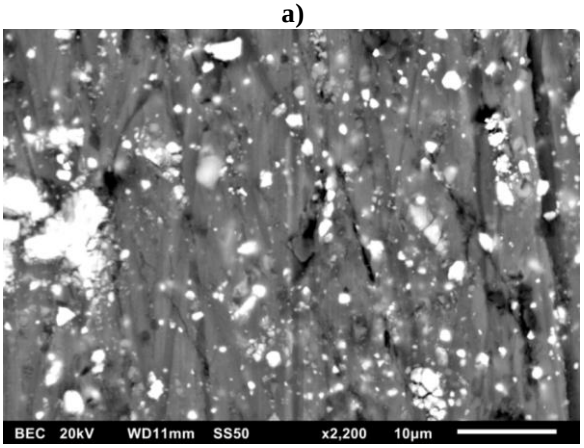


Fig. 4. Crystal of aluminum oxide of a classical treelike form (dendritic form).



a)



b)

Fig. 5. Distribution of crystal particles of aluminum oxide of gamma modification in the coatings received according to technologies 1 (a) and 4 (b).

Conclusion

1. Sizes of wear of the anodized samples (impregnated with oil and without impregnation) are experimentally established. Data allow estimating efficiency of increase of wear resistance at combined and separate use of ozone and ultrasound in the process of anodizing.
2. At impregnation of an anode coating by oil the size of wear decreases in comparison with not impregnated samples by factor of 1.17 when anodizing with use of ozone, by factor of 2.14 when anodizing with ultrasonic influence, by factor of 3.33 at their combined impact on electrolyte, a sample and a reactionary zone.
3. Microphotos with increase to 3000 volumes, characterizing structure of an oxidic coating on an aluminum alloy of D16T are received. On them channels with the indication of their sizes, distribution of crystals of aluminum oxide in a coating and classical dendrites of Al_2O_3 are presented.

A Conflict Of Interest

The authors confirm that the submitted data does not contain conflict of interest

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