IOP Conf. Series: Materials Science and Engineering **412** (2018) 012004 doi:10.1088/1757-899X/412/1/012004

The application of plasma-electrolysis boronizing of parts

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Abstract. The article deals with methods of increasing the working capacity of parts due to the improvement of structural condition of the surface. There were analyzed the characteristic features of the borating method and plasma-electrolysis processing, the necessity for joint use of these methods. On the basis of the review the author suggests the application of plasma-electrolysis boronizing of parts. By increasing the working capacity of parts due to the improvement of structural condition of the surface by means of borating method and plasma-electrolysis processing, it is possible to use more rational application of alloyed materials for manufacturing various parts that have high physical and mechanical, operational characteristics, which is certainly actual for modern machinery production.

The growth of working capacity of machines and mechanisms directly depends on the performance of its components. Therefore, increasing the wear resistance, life cycle of parts such as bearing assemblies, gears, camshafts of internal combustion engines and other parts that often experience large shock loads, strain and work in friction, it is possible to increase the overall mechanism.

It is necessary to have a number of properties such as high strength and hardness of the surface layer combining ductility of the core for life cycle of parts. Such properties can be achieved by applying various methods of surface hardening and surface impregnation. One of less studied methods is the plasma-electrolysis processing of parts and the borating method. The possibility of joint use of the given methods makes it possible to use more rational application of alloyed materials for manufacturing various parts that have high physical and mechanical, operational characteristics, which is certainly actual for modern machinery production.

In modern engineering there used methods for creating various wear-resistant coatings of functional materials (powder coatings, ceramics and heat-resistant polymers, single-component and multicomponent metal and composite galvanized carbide coatings, etc.) for hardening the surface of structural and alloyed steels and components of machines [1].

The surface impregnation is one of the most effective and simple methods of hardening steel parts surface used in final stages of processing and easily combined with component heat treatment.

The saturation of steel surface with boron – boronizing is the most applicable methods of surface impregnation. Boron as well as nitrogen and carbon forms:
– solid solutions for limited solubility;
– intermediate phases: carbides, nitrides, carbonitrides, borides;
– plays the role of reinforcing phases.

Boronizing is the process of surface impregnation consisting in saturation of surface layers of parts with boron, when they are heated in a particular boron-containing medium to increase hardness and resistance.

Solid-phase mixtures of various structures, molten salt, gas environment and pastes or coatings are used as a saturating medium when borating instruments [2].

The required condition for formation of a diffusion layer is the presence of active atomic boron at a saturable surface. In addition, the temperature and duration of soaking in a saturating medium must ensure the diffusion of atomic boron in steel with the formation of chemical compounds - iron borides. The ecologically clean method of plasma-electrolysis processing of metal parts, tools, etc. has been intensively introduced for last 15 years. The analysis showed the presence of boride phases FeB, Fe_2B in electrolyte compositions containing ammonium borofluoride - NH_4BF_3, sodium tetraborate sodium - $Na_2B_4O_7$ and boron carbide - B_4C after boronizing.

The generator is the source of direct current on boronizing, for example, ND 1500/700. By applying it, the current is set to 50-80A. The current increases by approximately 50A for every 100/150 mm, when added to the crucible the level of molten borax also increases. Filling the crucible by borax, the system is resisted for 3-5 hours at a temperature of 950 ° C and current in the electrolysis circuit, depending on the size of the parts 400-600 A [3].

The external characteristics of the beginning of electrolysis are the vigorous release of gas bubbles at the anode and flashes of combusted metallic sodium over the cathode.

On the basis of thermodynamic calculations, it is shown that in the entire range of boron temperature during the electrolysis of borax, the potential of sodium evolution is greater than that of boron, i.e. boron is the primary product.

By operating borax burns out and the part of it is removed with slag and parts. Therefore, portions of fresh borax are added to the bath periodically and refining is carried out after 5-6 hours. After processing a certain number of products, it is necessary to check the chemical composition of the borax, since the iron content in the bath exceeds 0.5%, which greatly impairs boronage.

The voltage on the electrodes is set to 12-20V, the current density is 0.15-0.3 A / cm2. By increasing current density, the depth and surface hardness rise, i.e. the separation of atomic boron on the cathode accelerates. Thus, increasing the current density from 0.1 to 0.3 A / cm2 (bath temperature 950 ° C, processing time 3 h) is accompanied by an increase in layer hardness from 0.13 to 0.16 mm [3].

When surface treatment of steels is processed by an electrolytic-plasma method, the entire surface in the solution is heated. The part is placed on the bracket and immersed in the electrolyte solution. Then the voltage is applied and the solution temperature is maintained within specified limits. In the electrolyte when a current flows through the electrolyte at the cathode (quenched part), a gas jacket of hydrogen is formed (the current strongly increases and the part heats up). After switching off the current, the part can be immediately hardened in the electrolyte. In this case, the heating occurs rapidly and depending on the heating time it is possible to control the depth of the layer processing and hardening [4].

Heating of the parts occurs throughout the product area. There is a 5-10% increase in temperature growth only in places of large protrusions due to the technology peculiarity.

Parameters of equipment for surface hardening by electroplasma method [4]:

– equipment capacity: calculated on the basis of the area of the workpiece. For quenching 1 square approximately 8 kW is needed.

– current density 30 A / sq.dm.

– operating voltage 380 V.

– the quenching time is directly proportional to the depth of the hardened layer: from 3 to 10 seconds.

As a result, the combination of two methods of conducting plasma-electrolysis processing with boron-containing solutions, it is possible to obtain maximum wear resistance and surface hardness of the parts.

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