Abstract

Galvanic plating in engineering. Development of technological process of protective zinc coating on the steel details.

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Diploma project, 2018. The number of pages – 95, tables – 24, pictures – 5, sourses – 8.

The diploma project has developed a technological process of applying protective zinc coating to a steel parts. The steel gear wheel is operated in conditions of light rigidity. A zinc coating with a thickness of 9 microns is applied to provide corrosion resistance. The cyanide electrolyte, which is used, contains:

ZnO	10 g/l
NaCN	30 g/l
NaOH	70 g/l
Na_2S	2 g/l.

Conditions of electrolysis:

1. temperature 18-25 ^oC;
2. density cathode current 4 A/dm^2;
3. pH 10-13;

Cathodic efficiency is 85%.

The advantages of cyanide electrolyte are high dissipating ability and capacity dispersive. The main components of cyanide electrolytes are cyanide complex zinc salts $Na_2Zn(OH)_4$, cyanide NaCN and alkali NaOH. Sodium cyanide and sodium hydroxide increase the electrical conductivity and capacity dispersive of the electrolyte, eliminate the passivation of anodes. Sodium sulfide is injected to improve the quality and gloss of coating.

The coatings obtained from this electrolyte are characterized by high uniformity, strong adhesion to the base, the coating does not contain pores and is smooth.

The technological process involves preliminary processing of parts, which includes: chemical and electrochemical degreasing, chemical etching, chemical brightening and passivation in chosen in the chromatic solution . The passivation improves the protective properties of the coating in an atmosphere with high humidity and variable temperature. Quality control includes visual inspection of parts, thickness control and coupling strength (0.1-1%).

To provide conditions for obtaining quality coverage, preliminary preparation of details is carried out:

1. Degreasing is designed to remove from the surface of the details of the layer of grease contaminants that were formed during the manufacture and storage of details. Conducted at a temperature of 40-60 ^{o}C, for 5-20 min. The solution contains a complex of surfactants and organic amines Gardoclean 30-50 g/l.
2. Degreasing Electrochemical:

   The mode of electrochemical degreasing: t = 18-25 ◦C, and = 2-10 A/dm^2. Reversible current is used to prevent flooding of steel details. Processing time: 5-20 min.

NaOH GOST 2263-79	30-40 g/l
Na_3PO_4 GOST 201-76	15-20 g/l
Sodium silicate GOST 13078-81	20-25 g/l
Additive DHTI-NT (MNT) ТУ 6-36-5800151-506-91	2-3 g/l

3. Since the steel parts have a rust layer, it is necessary to carry out chemical etching of the parts. Conducted within 5-10 sec. In solution containing:

HCl GOST 857-78	500 g/l
Inhibitor	0,5-1 g/l

In the industry, for the application of zinc coatings use sulfate, pyrophosphate, cyanide, chloroammonium and zincate electrolytes. For coating application on the steel gear wheel is used cyanide alkaline electrolyte, because it is suitable for the coating of such part with complex shape. Zinc deposition from cyanide electrolytes occurs at high cathode polarization, especially at high content of free CN-. Coatings of cyanide electrolytes are fine-grained and more uniform in thickness than from acidic electrolytes without special additives. Selected electrolyte contains low quantity of zinc and high alkaline content relative to cyanide. This type of electrolyte is less toxic than others cyanide electrolytes.

Chemical brightening and passivation are selected as the final operations.

Chemical brightening is made in a solution of HNO_3 5 g/l. Processing time 0,5-1 min.

Passivation is the application to the surface of a dense layer of insoluble compounds to enhance corrosion resistance. In this diploma project, passivation is carried out in a chromatic solution of the composition:

CrO_3	10-15 g/l
HNO_3	3-7 g/l
Na_2SO_4	10-15 g/l

For the execution of an annual program of 15,000 m^2 per year, a polypropylene bath with a lining size of 800x700x1000 mm is selected. The bath is equipped with on-board ventilation, drain valve. The details are hung on a suspension. The amperage in the bath is 343 A, the voltage is 3,9 V. The quality of the coating received must meet the requirements of GOST 9.301-86.

Control of the appearance of the coating is made on 100% of the parts by inspection with the naked eye. The coating must be firmly glued to the main metal, without peeling, splitting, blinding and cracking.

It is not considered as a defect if on the surface of the covered part there is following signs: irregularity of light and color; traces of water strokes; absence of coverage in the places of contact of the part with the device that is on the non-

working surface of the part, except for special cases stipulated in the document; change in color intensity after heating.

The methods for measuring the thickness of each layer are coulometric, X-ray spectrometry, microscopic method and scanning method by an electron microscope. Priority is to control the thickness of the coating using a non-destructive method.

The coupling strength is controlled by a heating method of 200 ° C and an elongation for 1 hour followed by a visual inspection of the surface of the coating. On the monitored surface, no swelling or flaking of the coating should be observed.

The thickness control of the coating is carried out by X-ray spectroscopy.

Control of thickness and strength of adhesion is carried out for 0,1-1% of products, but not less than 3.

To optimize the process of applying zinc coatings, reduce manual labor costs, and strictly adhere to the rules of the technological process, the bath is equipped with an automatic control and regulation system.

The main parameters associated with the debugging of the automatic line are:

- acidity of the electrolyte;
- the level of electrolyte in the bath;
- amperage and voltage in the bath.

Scheme of automation involves measurement, automatic control and registration of these parameters.

In the economic-organizational calculations the department was calculated as an object of the economy: the optimal type of movement of labor objects, the number of employees and their schedule, the technical and economic indicators of production were calculated:

- the prime cost of coverage is 105,4 UAH/m^2;
- investment 1 963 731,2 UAH;
- profit is 247 500 UAH/year;
- profitability 16%;
- period of return of investments 5,4 years.

From the galvanic workshop are traditionally allocating separate streams of sewage with acid-alkaline, heavy metals, cyan- and chromium-containings. After oxidation of cyanides and reduction of Cr (VI) to Cr (III), all waste water can be mixed.

Oxidation of simple and complex cyanides is carried out with the help of chlorine-containing reagents (sodium hypochlorite, free chlorine), potassium permanganate, hydrogen peroxide, oxygen, and ozone. The cyanates, formed as a result of oxidation, decompose as a result of hydrolysis on non-toxic products (ammonium and carbonate ions).

From the galvanic workshop, wastewater enters the reactor. Disposed wastewater from the reactor is sent to the expansion vessel, which serves as a function of the preliminary settling tank. From the diluent, neutralized water is fed into sediment bowls (or collections), located on the adjacent to the galvanic workshop area. Water from the first settling tank continuously goes into the sewage system, and the sludge passes into the second one. The sludge from the last settling tank comes by gravity into the tank receiver located in the vacuum compartment. Next, the sludge is fed into a vacuum filter, which provides pumping water or sludge, and a circular pump, which serves to discharge water into the sewer. The thick sludge (in the form of a crude powder) is automatically scrapered by a vacuum filter and is scraped into a sheet, from which it is then removed into a special container and exported from the factory