ABSTRACT

Galvanic plating in instrumentation. The development of technological process for chromium plating on steel parts in stationary electrolyzer.

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The project developed technology of application plastic chromium single-layer plating of telescope 9 microns thick, to provide corrosion resistance.

Plated part – the body of the telescope. The part is used in atmospheric conditions with temperature 15-30° and relative air humidity no more than 75%, doesn`t give in to friction and has to have high corrosion resistance and satisfactory decorative properties.

We choose a single-layer frost chromium covering 9 microns thick, free-pore, having the low hardness for easy polishing.

The chromium plating protects against the corrosion due to the formation of chromium oxide layer on it`s surface.

As electrolyte for plating was chosen tetrachromium electrolyte with main advantages – low temperature regime of electrolysis, relatively high dispersive power and high current yield.

The composition of used elerctrolyte:

1. chromium trioxide 320-400 g/ltr
2. sodium hydroxide 40-60 g/ltr
3. sulphate acid 3-4 g/ltr
4. sugar 1-2 g/ltr

For preparation of tetrachromium electrolyte CrO_3 is dissolved in water heated to 60-80°C. And then, after cooling the solution, enter small doses of sodium hydroxide that was previously dissolved. Solution strongly heats up and therefore it is cooled, as sodium tetrachromate, formed by mixing, decomposes at temperature 22°C. After that sulfuric acids and then sugar (for reduction of a small amount of 6 valance chrome to 3 valance state (concentration of Cr^{3+} ions need to be within the confines of 8-12 g/l) are entered at the rate of 1-2 g/l.

Mostly chromic acid formed during the dissolution of chromium trioxide reacts with sodium hydroxide and forms sodium tetrachromate. Small amount of acid remains in free state, so the electrolyte has properties of light concentrated electrolyte, which allows deposit chromium directly on the steel parts.

Were chosen preparatory operations and measures of the quality control for getting high quality covering.

As anodes insoluble antimony-lead plate are used. Their surface is passivite by passive oxide of lead.

The shape of the anods affects on the plating prosses. We apply flat anodes with a width of 50 mm, a thickness of 5 mm and a length of 600 mm. Thin and wide anodes are unwished because on their opposite side it is difficult to obtain the current density required to maintain the anode in a passive state. 18 anodes are placed on the anod rod.

The part has a cylindrical shape and is covered from the outside and inside, therefore, it is necessary to use additional anodes - wires 21,5 cm in length and 1 cm in diameter. They are placed inside the cylindrical part.

The quality control of plating contains following parameters: adhesion of the coating with the metal substrate, corrosion resistance tests and external visual inspection.

The part is placed in the salt spray, which is a closed space with walls, a bottom and a lid made of corrosion-resistant material. Inside it, solution of sodium chloride is spraying for 15 minutes every 45 minutes. Concentration of salt in the fog 2-3 g/ltr.

The qualitative coating doesn`t change their appearance after the test.

Tests are carried out within 2 days. Corrosion resistance is determined visually. For testing corrosion resistance use the ASTM B117 salt spray.

Visual control of a covering is carried out for 100% of parts with lighting not less than 300 lx.

It is necessary to check:

- lack of covering in places of contact of the part with adaptation which is on a non-working surface of a detail, except the special cases caused in the design document;

- changing of color intensity after heating.

It was decided to remove poor-quality coatings using a part like an anode in a solution of 80% sulfuric acid with current density – 50 A/dm^2.

As a result, a technological scheme for chromium plating was developed. It includes the following processes:

1. Degreasing in an organic solvent - gasoline, for cleaning the surface of the part from preserving oils.

2. Mounting the parts on the hanger.

3. The following operation is chemical degreasing within 5 min at a temperature of 80-90 °C, for the purpose of removal of the main part of fatty films from the surface of metal in solution of the following structure:

- hydroxide to sodium - 25 g/ltr;
- a sodium carbonate - 50 g/ltr;
- sodium phosphate - 15 g/ltr;
- sodium silicate - 2-3g/ltr

Chemical degreasing is using reaction of alkaline saponification in solution with the main component - sodium hydroxide.

4. Subsequent hot rinse, used for cleaning the part from surface contamination.

5. Electrochemical degreasing, provided in the same solution as chemical degreasing, to remove residual lipid layers from the metallic surface.

6. Hot rinse of the part, which is provided for cleaning the surface from the dirt and gradual cooling of the part.

7. Cold rinse for cooling the part.

8. Chemical etching. It is carried out after removal of pollution and fatty deposits from the surface of metal for removal of oxide layers, rust and other chemical compounds which appear on a surface as a result of interaction with the environment.

Parts are immersed into the concentrated hydrochloric acid. This process happens in solution which contains:

- 1. hydrochloric acid 200 − 250 g/ltr;
- 2. hexamethylenetetramine 3-5 g/ltr

9. Rinse in cold running water for cleaning the surface from the solution used in chemical etching.

10. Process of chromium plating.

Plating conditions:

- Current density – 50 A/dm^2
- Temperature – 18-20°C
- Time – 4 min
- Current yield – 32%

11. Rinse in a bath with still water. This is done to reduce electrolyte losses and to discharge the rinse bath. Since the main component of the electrolyte is chromium, the use of still water is an obligatory factor.

12. Cold rinse for additional cleaning of the surface from electrolyte residues.

13. Hot rinse, used for heating the part before drying.

14. Drying the surface of the part until complete removing the moisture.

15. Dismantling of plated parts from the hanger.

Based on the technological assignment, technological calculations were carried out.

The real operating time of the enterprise and equipment is calculated, as well as the time required to fulfill the task of production productivity.

Given the overall dimensions of the parts and the task of productivity, a suspension device was designed.

Based on the design of the suspension device, which provides a reliable attachment of the part during electrolysis, an electrolytic bath has been selected. As a bath material, the modern material resistant to aggressive media – polypropylene was chosen.

The current voltage and voltage on the bath are calculated to select the appropriate power source.

The amount of heat that is released during electrolysis is determined. The electrolyte heats up. To cool it to the electrolysis temperature, side coils are designed.

The cost of materials for the launch of technology and the annual output of products are calculated.

In order to protect against harmful chrome vapor, the bath was equipped with onboard suction. The electrolyte is drained from the bathtub by means of a ball valve.

For getting information about the value of the basic parameters of the technological process of plastic chromium and automatic control of these parameters automatization system was projected.

Wastewater of galvanic department containes toxic chemical products. Pouring out them into the rivers is unacceptable. That`s why recycle water purification scheme was developed.

Firstly acid-alkaline rinse waters are mixed. Chrome-containing waters enter the reactor where 6 valence chromium reduct into the 3 valance state. Both types of wastewater are mixed by bubbling in a cumulative tank.

In the second reactor insoluble hydroxides are sedimentated. After that water goes to electroflotation apparatus. Electroflotation hose passing through filter press. The filtrate returns to the water purification cycle, and the solid residues - to the chromium processing plant. Further, water is passing by mechanical and adsorption filtres with subsequent submission to the reverse osmosis apparatus.

Also the economic base of the enterprise is developed. The annual expenses for raw materials, wages, taxes, depreciation on fixed assets of the enterprise are calculated.

The optimal working schedule of the enterprise is developed. The average estimated price of coverage and the period of return of capital investments is determined. The cost of quality control is calculated.

In realization of this project, during the process of chromium coating, which takes place in the workshop for application of galvanic coatings, harmful, chemically aggressive, fire and explosive substances and materials are used; The use of mechanical, electrical, thermal and compressed air energy is foreseen.

The project is implemented taking into account the requirements of protection. In this section, on the basis of detection and analysis of harmful and hazardous production factors of galvanic production, measures aimed at creating healthy and safe working conditions and ensuring fire safety at the projected facility have been developed.

The calculated amount of air removed by airborne suction pumps.

Normal conditions in the projected workshop are carried out at the expense of mechanization and automation of heavy and labor-intensive works, rational placement and thermal insulation of equipment, aggregates, communications and other sources, radiating in the workplace heat.

Projected labor protection optimization is reached by methods and means of engineering labor protection. Two groups of methods and means of ensuring of safety of work are used:

− an exception of contact of the person with dangerous production factors by production process automation;

− the compliance of characteristics of the working environment and personality characteristics that provide adaptation, natural protective properties of the organism to the environment.

Keywords: electroplating, chromium, galvanic baths, stationary electroliser, voltagebalance, electrolysis, wastewater.