Abstract

Galvanic Coatings for Instrumentation. Development the Technological Process for Wear Resistant Chromium Plating on Steel Parts in Automatic Line

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Depending on the requirements for the performance of the parts, there are three types of coatings: protective, used to protect against corrosion of parts in various aggressive environments, protective and decorative, which are used for decorative processing of parts with the simultaneous protection against corrosion, and special ones that are used for providing the surface of details of special properties (wear-resistant, solid, electrical, magnetic, etc.) or providing protection of the base metal from special environments.

Protective properties of coatings depend not only on the nature of the metal, but also on the composition of the corrosive environment.

When choosing coatings, it is necessary to consider the purpose and material of the parts, the conditions of operation of the parts, the purpose and properties of the coating, the method of coating and the economic justification of the application of this coating. The corrosive action of the environment, which is determined by the conditions of operation of products, is one of the important factors that determine the choice of coverage.

The industrial use of chrome coatings determines their high decorative properties (mirror luster), chemical resistance, low friction, high hardness and wear resistance.

The purpose of this diploma project is to develop a technology for wear-resistant chrome coating on steel parts and the choice of equipment for the implementation of the specified process with a productivity of 600 m^2 / year.

The process of applying galvanic coating consists of a series of successive operations, which can be divided into the following main groups: preparatory, electroplating, finishing, quality control and thickness of the coating layer.

In this project work, the coating is applied to the inner part of the pipe, in which will located the movable piston, so the coating must be corrosion resistant, wear-resistant and have a low friction coefficient. The only cover for these purposes is a wear-resistant chromium coating. This is due to the fact that the special structure is responsible for the very high surface strength. The hardest layers achieve practically the properties of corundum. They are twice as hard as other metals, such as iron, cobalt and nickel.

Proceeding from the fact that only the inside of the pipe should be covered, a special hanging frame will be used for the location of the part in the plating bath.

The thickness of the chrome coating is 50 microns. The chromium coating is applied to the steel part.

This coating will increase the corrosion resistance and resistance to mechanical wear of the component, which is operated under constant friction. The steel base under wear-resistant chrome must be necessarily firm and hardened.

The advantages of the chosen chromium coating - resistance to corrosion and chemical influences, dynamic strength, low coefficient of friction.

Features of the process of chromium:

1) necessity for particularly accurate compliance with the temperature of the electrolyte, current density, method of hanging. In case of violations of the technological process, inevitable defect;

2) bad coverage of in-depth parts of the product due to poor electrolyte dissipation capacity;

3) a large concentration of current on protruding parts of products, causing the deposition of a thicker layer of chromium on them;

4) the use of insoluble anodes of lead or alloy of lead and antimony, which only help oxidation-reducing processes in the transition of chromium from the electrolyte to the part.

Choice of operations for preparing the surface of products before applying galvanic coating. Preparation of the surface of the base metal is an integral and very important operation of the entire technological process of applying metal coatings. The main requirement - the strength of the grip between the base and the metal coating - can be made only if there is no foreign pollution between them, most often in the form of fats and oxides.

Control. Surface control is carried out for 2-5% of the parts. They are not allowed: the originality of the layer of lubricant, emulsions, metal shavings, burrs, dust and products of corrosion, the penetration of particles of another material. The surface of cast and forged parts should be without gas shells, sludges, adhesives, imperfections, cracks.

Assembling. Conduct on the mounting table. Mount the parts for fitting with a copper wire or load into a brass grid.

Electrochemical Degreasing. Conduct in a stationary plating bath equipped with local exhaust ventilation with anodic polarization.

Composition of electrolyte for degreasing, g / l:

$NaOH$ 10-20

Na_2CO_3 20-30

Na_3PO_4 30-50

Na_2SiO_3 3-5

The mode of electrochemical degreasing: t = 70-90 ◦C, and = 2-10 A / dm^2, the process time - 15-20 minutes.

Rinse the parts in the bath with stationary cold running water. Water temperature 18-25 ◦C, washing time - 0,25-0,5 min.

Chemical Etching. Conducted in a stationary bathtub equipped with local exhaust ventilation.

Composition of electrolyte:

HCl 200-250 g / l

The temperature is 18-25 ◦C, the time is 5-10 minutes.

Then rinse the parts in the bath with stationary cold running water. Water temperature 18-25 ◦C, washing time - 0,25-0,5 min.

Choice of electrolyte composition for electroplating.

The main components of the chromium electrolyte are chromic acids H_2CrO_4 and $H_2Cr_2O_7$, anions SO_4^{2-}, F^-, SiF_6^{2-} and trivalent chromium compounds. The electrolyte is prepared by dissolving in a pure water (condensate) chromium anhydride CrO_3, free from impurities NO_3^-. The concentration of chromic acid can be measured in a wide range from 50 to 500 g / dm^3. The higher the concentration of chromic acid, the greater the electrical conductivity of the solution, but the more significant losses due to the sputtering of the electrolyte with hydrogen, and the removal of chromic acid by the covered parts. With the increase in the concentration of chromic acid in a solution containing sulfate ions, the output of chromium by the current decreases, in the presence of the same fluoride and silicon fluoride acids, it reaches a maximum at higher concentrations of CrO3 and then again decreases. The main components of the chromium electrolyte are chromic acids H2CrO4 and H2Cr2O7 , anions SO4 ², F^-, SiF6 ² and trivalent chromium compounds. The electrolyte is prepared by dissolving in a pure water (condensate) chromium anhydride CrO3, free from impurities $NO3^-$. The concentration of chromic acid can be measured in a wide range from 50 to 500 g / dm^3. The higher the concentration of chromic acid, the greater the electrical conductivity of the solution, but the more significant losses due to the sputtering of the electrolyte with hydrogen, and the removal of chromic acid by the covered parts. With the increase in the concentration of chromic acid in a solution containing sulfate ions, the output of chromium by current decreases, in the presence of the same fluoride and silicon fluoride acids, it reaches a maximum at higher concentrations of CrO_3 and then again decreases.

The decrease in the output of chromium by current with increasing temperature is due to the removal from the surface of the cathode products of the reduction of chromate ions and the dissolution of the film, and an increase in the yield of chromium with an increase in the density of current - the accumulation of products of the reaction $Cr^{6+} \rightarrow Cr^{3+}$ and seal film. The latter complicates the course of adverse reactions and increases the rate of precipitation of metallic chromium. For each temperature at other equal conditions there is a certain minimum current density, below which chrome does not precipitate on the cathode.

With an increase in the current density, when chromium is released, the cathode potential changes little, and the output of the metal by current increases, so the electrolyte has a very low scattering power. In addition, the cessation of metal release at low current densities makes it impossible at all to obtain a solid coating on a relief surface. Therefore, the chromium electrolyte (especially hot) is often evaluated not by scattering power, which varies relatively little with the change in the composition of the electrolyte and the conditions of electrolysis, but by its ability to give a continuous coating of at least a small thickness, that is, its coating capability. In the case of chromium-plating of relief components (especially when applied to a relatively thick coating), profiled anodes are used or additional anodes are brought to the deep places.

In practice, the so-called standard or universal electrolyte containing 250 g / dm^3 CrO_3 and 2.5 g / dm^3 H_2SO_4, with electrolysis mode t = 45 ... 55˚ C and I_k = (20 ... 60) · 10^2 A / m^2., is most commonly used for protective and decorative treatment and increase of resistance to mechanical wear of the product surface.

Shiny hard coatings of chromium, obtained from a universal electrolyte are porous and have a grid of cracks. The cracking of the coating occurs due to the large internal stresses that arise as a result of volume reduction when converting the unstable hexagonal crystal lattice of a metal into a more stable cubic bulk center.

In order to obtain shiny coatings of chromium with a lot of microcracks, it is recommended to use so-called self-regulating electrolyte containing simultaneously ions SO_4^{2-} and SiF_6^{2-}, in the ratio ≈ 1: 2. The temperature of the electrolyte is 40 ... 45°C, the cathode current density is about 15 · 10^2 A / m^2.

In this project, for the chromium plating of the aforementioned part, we used electrolyte that contains, g/l:

CrO_3 250-300

H_2SO_4 2,5-2,7

The addition of "Hromin" 1-3

From this electrolyte, chromium coatings are obtained at a temperature of 40-60 ° C and ic = 20-30 A / dm2 with an output of chromium by current of an average of 16%.

Use insoluble lead anodes with admixture of stibium and tin.

Perform the following operations after chrome plating: rinse in the bathtub trapping, washing, hot flush, drying, dismantling, dehydration and final control.

In this diploma project we developed the scheme of process automation. Automated lines provide higher performance of equipment, allow you to reduce labor costs, which is a very important factor in a toxic and aggressive environment. Allow to adhere to the strict rules of the technological process necessary for obtaining a qualitative electroplating coating. Electricity, non-ferrous and precious metals are reduced.

The next step we have calculated the calculation of current balance, voltage, energy, designed autocoper line.

The ecological safety of the developed technological process has been analyzed, the principal scheme of sewage treatment is given and described, which is chosen depending on the composition of wastewater and its quantity. The chosen scheme of purification is based on the ratio between the interests of the production economy and the protection of the environment from pollution.

Purification of sewage from chromium compounds by combined reagent method with purification by means of reverse osmosis.

In the Building part we performed the layout of the shop taking into account the continuity of production, the maximum possible reduction of transport of parts and materials, as well as the convergence of interconnected production and ancillary facilities.

In the economic part we calculated the economic feasibility of our factory.

Based on the technological part of the project, harmful substances and materials, as well as electric, thermal, mechanical energy are used in the production. Inland transport is represented by hand-carts for the movement of chemical reagents and processing parts.

All design decisions are made taking into account the requirements of occupational safety.

KEY WORDS: CHROMIUM, SULFATE ELECTROLYTE, PLATING BATH, INNER ANODES, HANGING FRAME, BALANCE VOLTAGE, COMBINED METHOD FOR SEWAGE TREATMENT.