Abstract

«Galvanic plating in engineering. Coating process technology development of alloy copper and zinc on steel component parts»

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Diploma project, 2018. The number of pages – 106, tables–20, pictures–10, bibliography –18.

Galvanic coating process technology development of alloy copper and zinc in galvanizing lines with effectiveness of 16000 m^2/year was developed. Technological process calculation was done.

Brass plating are coated on current-sourcing cable clamp rail which are made of 08KP steel with an overall size of 70*80*60. The fabrication after brass coating, must be rubberized by vulcanization. The thickness of the coating required for reliable adhesion to the rubber is 3 mm.

The fabrication are covered with rubber plating take properties such as anticorrosion protection and dialectical characteristics. However, coating process of vulcanized rubber directly on the surface of the metal fabric is impossible, because of high containing of sulfur in such rubber. It can contributes the corrosion of the metal base. Therefore, to prevent it, as well as to secure the grip of rubber and metal base, an intermediate layer of yellow brass is applied to the part, which not only protects the metal base from corrosion, but also makes it possible to obtain a strong temperature-resistant adhesion of rubber to the surface of the fabric.

The choice of such a coating is necessary for the parts that will be used in conditions that accelerate steel corrosion, which is the main material for manufacturing parts in industry. For example, in factories and industries of chemicals, electroplating workshops, etc., as well as parts that may be subjected to voltage during certain electrical equipment failures, which may lead to a violation of the technological process and endanger the life of the workers.

Cyanide electrolyte plating is chosen for coating:

C(CuCN) = 40 kg/m^3

C(ZnO) = 12 kg/m^3

C(NaCN) = 9kg/m^3

C(Na2CO3)= 20kg/m^3

C(Na2SO3) = 7 kg/m^3

C(25% ammonia-watermixture)= 1 kg/m^3

Electrolysis conditions:

Temperature:15 – 30 °C

Charge densityi_kA/дм^2 : 0,3 -1,0

pH : 10,3 – 11

Output electrodes: Л70

Current output70 %

A co-precipitation of copper and zinc whose potentials differ by more than 1 B, usually occurs from solutions of complex salts where the copper and zinc potentials are approaching. The main group of complex electrolytes for brass deposition is nitrile. For example, in a 0.1 M solution of $K_2Cu(CN)_3$at 18 ˚C, the equilibrium copper potential is 0.9 V, and in 0.1 M solution $K_2Zn(CN)_4$, the zinc potential is equal to 1.1 V. In addition, there is a small effect of depolarization. Thus, it is possible to deposit a Cu-Zn alloy of cyanide plating solution.

Basic preparatory operations are:

1) Chemical degreasing carried out to remove the bulk of oily films in a solution containing 30-50 g/l of Gardoclean (a mixture for degreasing with the organic amines and the complex of surfactants).Depending on the parts contamination, the processing time will be 5-20 minutes, when heated to a temperature of 40-60 ◦C.
2) Electrochemical degreasing performed for the final removal of the finest oily films from the surface of the parts, and contamination from the pores, holes

and parts of the complex profile configuration. Electrochemical degreasing is carried out in the resulting solution:

NaOHtech. GOST 2263-79	30-40 g/l
Na_3PO_4 tech. GOST 201-76	15-20 g/l
SodiummetasilicateGOST 13078-81	20-25 g/l
AdditiveDHTI-NT(MNT) TU 6-36-5800151-506-91	2-3 g/l

Operation pattern t =40-60˚C, i =2-10 A/dm^2

Processing time: 5 to 20 min

Preparation and adjustment of the electrolyte are carried out according to GOST 9.305-84

3) Etching is carried out in order to remove metal corrosion products from the surface of the part. At the core of the process there is the chemical dissolution of rust and metal oxides in solutions of acids and alkalis. For the etching of steel parts, the following solution of the composition is used:
   HClGOST 857-78 200-250 g /dm^3
   The inhibitor: 0.5-1 g / dm3
   The temperature of the solution: t = 18-25 ˚C.
   Processing time: 5 to 20 min
   In order to prevent the dissolution of the metal-base during etching, an inhibitor is introduced into the solution.
4) Activation of the part in the solution:
   KCN 30-50 g/l
   Temperature: t = 15-30 ˚C
   Activation time: 0,15 to 0,25 min

Fortheexecutionofanannualprogramof 16,000 m^2, a steelbathwith a liningsizeof 1250x710x1000 mm isselected. Thebathisequippedwithon-boardventilation, electricheater, drainvalve. Thedetailsarehungon a frame-typesuspension.Theamperageinthebathis 100,5 A, thevoltageis 2,2 V.

The following method is used to prepare quickly electrolyte. The bath is filled to half the working volume with water and cyanide, alkali (or sodium carbonate) and sodium sulfite is dissolved according to the formulation of the electrolyte. In a separate portion of warm water, copper sulfate and zinc sulfate are dissolved. After cooling, the second solution is infused slowly into the bath containing cyanide and other components, intensively stirring.Originally formed precipitate gradually dissolves in cyanide. After complete dissolution, the bath is filled with water to the required level.

Electrolyte brass after its preparation requires a long current process to obtain qualitative coatings.

Changing the composition of the bathing batch in the process of work ismade primarily due to the binding of cyanide dissolved by metals, decomposition of cyanide and its transition to carbonate. The concentration of copper varies faster than the concentration of zinc.

The adjustment of the electrolyte is usually reduced to the addition of cyanide and less often to salts of copper or zinc. Increasing the pH of the solution is achieved by adding dilute alkali to the bath, and lowering is achieved by adding sodium bicarbonate solution. Ammonia is also regularly added.

Controlling of parts and received galvanic coating quality.

All the details are controlled by the naked eye and their appearance are visually evaluated. Coatings without exfoliation, bloating, splinters, cracks, firmly tied to the metal base are allowed.

The following features are not considered to be defective: the unequal luminosity and color, water flow marks, the absence of coverage in the contact areas of the parts with the suspended device, which is on the non-working flank of the parts and the color change after the heat treatment of the part are found on the surface of the coating.

In our case we use the method of X-ray spectrometry. The method is based on the analysis of the spectrum obtained by influencing the material under investigation by X-ray radiation. When the atom of each chemical element of the sample was irradiated by X-rays, the one emits energy or secondary radiation, the spectrum of which can be uniquely determined. The X-ray fluorescence detector registers the secondary radiation secondary emission determines its energy and intensity, and represents it in the form of a spectrum. The estimation of the spectrum by means of special algorithms makes it possible to determine from which elements a sample is formed, their distant content, and also the thickness of the material. The percentage of error of such method is 10%.

Coupling point control is carried out by heating up to 200C and extract for 1 hour with subsequent inspection of the surface of the cover with the naked eye. On the surface, there should be no dampening or flaking off of the coating need to be checked. We control the thickness and strength of the clutch for 0.1-1% of the products, but not less than 3.

The parameters of the technological process are calculated; the balance of voltages, current, and the thermal balance of the brass bath are constructed. The water consumption, anodes and reagents for the process of given performance are determined

Foroptimizationofalloy copper-zinc applying coating process, reducemanuallaborcosts, andstrictlyadheretotherulesofthetechnologicalprocess, thebathisequippedwithanautomaticcontrolandregulationsystem.

Themainparametersassociatedwiththedebuggingoftheautomaticlineare:

- temperature;
- acidityoftheelectrolyte;
- thelevelofelectrolyteinthebath;
- amperageandvoltageinthebath.

Schemeofautomationinvolvesmeasurement, automaticcontrolandregistrationoftheseparameters.

Intheeconomic-organizationalcalculationsthedepartmentwascalculatedasanobjectoftheeconomy: theoptimaltypeofmovementoflaborobjects, thenumberofemployeesandtheirschedule, thetechnicalandeconomicindicatorsofproductionwerecalculated:

- theprimecostofcoverageis95 UAH/m^2;
- investment1264930 UAH;
- profitis233865 UAH/year;
- profitability17,8%;
- periodofreturnofinvestments5,2years.
- the coefficient of economic efficiency 0,19
- return of fixed assets 1,31 UAH/UAH
- return of floating assets 4,91 UAH/UAH
- capitalinesity of fixed assets 0,75 UAH/UAH
- capitalinesity of floating assets 0,2 UAH/UAH

According to the technological part of the project work, harmful substances and materials, as well as electric, thermal and mechanical energy are used in the production. Handcart is represented as indoors cargo transport for the transportation of chemical reagents and mechanical portions. All design choices are taking subject to conditions the requirements of labor protection. In the following part, which is based on the analysis of harmful and dangerous factors of production, the security arrangements to create healthy and safe working conditions and fire security have been drafted.

This project work represents measures for workers' protection, and definition of hazardous production factors. In addition troubleshooting methods are represented.

Working zone air. Accordant with Health and Safety Regulations of environment 3.3.6.042-99, works in the shop floor are among the IIa and IIbmiddle class.For these categories of works, the project work shows the values of the climate of the industrial premises for two periods of the year.

On the galvanic coatingmanufacturing technology divisiona system monitoring of the environment is provided by the following devices:spirit thermometers (for the temperature measuring), dry-and-wet-bulb thermometers (for the humiditymeasuring), wind-speed indicators (for the speed of air determining) (every three months). For the effective working zone airnormalization, the project work provides the use of natural and artificial ventilation systems. The shop floor area is equipped with air conditioning, exhaust hoods. The project work provides that in the shop floor area equipped with general mechanical, inflow ventilation, as well as control of the maximum permissible concentration (MPC) of hazardous substances in the air. Natural ventilation is also provided.

Local mechanical ventilation systems are calculated. Bilateral side suction,as local exhaust ventilation, for the capture of harmful emissions from the surface of solutions, is taken.Based on the air flow and pressure losses, a fan Ts4-70 No. 4 A4095 2a was selected.Power on a shaft is 0.5 kW, with a speed of 1400 rpm.

The engine A02-11-6 is completed with the fan.

Workplace illumination. The use systems of artificial working, emergency, evacuation, repair and security is introduced. The natural lighting system is a combination of upper and side lighting.Luminescent lamps LB-40 (G13) and LB-60 (G13) types are used for lighting of the workplace illumination.«Alpha» direct-type lamps which are used for emergency and evacuation lighting are also provided. To measure and control the illumination of the premises using lux-meters U-117 with a frequency of 1 time / year and after the repair of lighting installations and replacement of lamps.

Workplace noise and vibration protection. The main factors and sources of production noise in the galvanic shop floor were revealed.The noise level in the shop floor depends on the simultaneous operation of all types of equipment and reaches 70-76 dBA according to the laboratory measurements. It is compliant with the norms for work in permanent workplaces and working areas of the manufacturing enterprise. It is accepted value accordant with Health and Safety Regulations of environment 3.3.6.042-99, and it should not exceed 80 dBA.The ways and means of reducing the level of industrial noise are proposed.

Electrosafety. The premises of galvanic sections are classified as dangerous to the degree of electric shock for a person, according to GOST 12.1.013-18 and Occupational safety standards system. The main factors of electrical safety at work are revealed and the means and methods of protection from them are offered. The research of fire protection technological processes safety has been carried out, the main dangerous production factors have been identified and methods of their prevention have been proposed.

Ecological safety of galvanic production. Galvanic production is one of the most dangerous sources of environmental pollution, due to the formation of large amounts of sewage containing harmful impurities of heavy metals, inorganic acids and alkalis, surfactants and other highly toxic compounds, as well as a large amount of solid waste.

The compounds of metals that are deposited by sewage of galvanic production have a fairly harmful effect on the biosphere, especially on groundwater and superficial water. Many chemical substances entering the environment, in addition to toxic effects, have carcinogenic (can cause malignant formations), mutagenic (can cause changes in heredity) and teratogenic effects (can cause injury to children born). Arsenic, selenium, zinc, palladium, chromium, beryllium, lead, mercury, cobalt, nickel, silver, platinum caused carcinogenic effect on endothermic animals when it enters the body. And cadmium, lead, arsenic, cobalt, aluminum and lithium caused teratogenic effects on animals under experimental conditions.

In the body, cyanides penetrate through the organs of digestion, respiratory organs, and rarely through the skin.Poisonous action of cyanides is guaranteed because they bind with enzymes of tissues responsible for cellular respiration, inhibiting their activity, and cause oxygen starvation of body tissues.Anions of cyanides form complexes with ions of divalent iron, which leads to blockade of oxygen transfer in the tissue and causes tissue hypoxia (oxygen starvation). As a result, the functions of the brain and the respiratory center are disturbed.

When inhaling a pair of synthetic acid, death occurs within one minute. Breathing in cyanide of sodium or calcium in your mouth can also cause death in within a few minutes. The systemic action of potassium and sodium cyanide on the skin can cause crack formation, and the eczema development.

GDK of CN^--surface waters intended for drinking needs - 50 mkg / dm 3, GDK CN^--surface waters for cultural and recreational purposes 100 mkg / dm2, GDK CN^--waters of reservoirs for fishing purposes - 50 mkg / dm2.

Sewage water cyanides purification. Oxidation of simple and complex cyanides is carried out using chlorine-containing reagents (sodium hypochlorite, free chlorine, bleach), and other oxidizing agents. Adsorption of activated carbon; removal of iron sulfate, which consists in the formation of the cyanide iron that precipitates; iron sulfate together with quicklime are also known as methods for treating sewage from cyanides. The most effective methods are oxidation of cyanides with "active chlorine", ozone, ion-exchange purification, electrochemical anodic oxidation to obtain cathode metal. When applied to the waste water of "active chlorine", the oxidation of simple cyanides occurs according to the reactions:

$$CN^- + OCl^- > CNO^- + Cl^-;$$

$$CN^- + Cl_2 + 2OH^- + CNO^- + 2Cl^- + H_2O.$$

Also, for the removal of cyanide from wastewater, the electrolysis method is used. Graphite is used as anodes according to GOST 11256 - 73. Anode current density is 0.5 -2 A / dm2. Cathodes are made of alloyed steels.

Electrolysis of an anode in an alkaline medium results in the electrochemical oxidation of CN^- ions and complex cyanide anions:

$$CN^- + 2OH^- \rightarrow CNO^- + H_2O + 2e$$

$$[Cu(CN)_3]^{2-} + 6OH^- \rightarrow Cu^{2+} + 3CNO^- + 3H_2O + 6e$$

$$2CNO^- + 2H_2O \rightarrow NH_4^+ + CO_3^{2-}$$

$$4OH^- \rightarrow 2H_2O + O_2 + 4e$$

At the cathode there is an emission of hydrogen and deposition of metals from complexes.

To increase the electrical conductivity of the treated wastewater, reduce the cost of electricity, intensify the process of oxidation of cyanides, we add NaCl 5-10 g / l to the solution, with the electrolysis of which free chlorine (sodium hypochlorite), which oxidizes cyanides, is formed:

$$2Cl^- \rightarrow Cl_2 + 2e$$

$$Cl_2 + CN^- + 2\ OH^- \rightarrow CNO^- + 2Cl^- + H_2O$$

pHoperating environment11-12, temperaturenothigher than 40 degrees, volumecurrentdensity 1-2 A / l, processingtime 20 - 30 minutes.

The advantages of this method are almost one hundred percent degree cyanides purification, facility of execution, and design traceability.

Taking into account the purification of sewage from cyanides by electrolysis, and the subsequent purification of copper and zinc ions, a scheme for wastewater treatment with the subsequent return of water to production has been developed.