ABSTRACT

«Electroplating in light-technical industry. The development of copper coating technology on a steel parts with complex configuration»

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In this project was developed a technology of protective and decorative copper coating on the particle of folding-structual lamp, which is used light-technical industry for room lighting. This particle is made of steel brand number 20, by stamping and rolling.

The particle has complex configuration, the overall dimensions are: length - 0,2 m, width - 0,2 m, height - 0,1 m. The particle has the following parameters: the weight of the particle is 2,462 kg, the square is 0.314 $м^2$.

The year program of the project is 21 000 $м^2$/year.

In this diploma-project, the technological scheme of copper-coating deposition was proposed and it consist next technological operations:

1. Chemical degreasing
2. Rinsing in warm water
3. Rinsing in cold water
4. Chemical etching
5. Rinsing in cold water
6. Electrochemical deposition of copper-coating
7. Rinsing in recovery-bath
8. Rinsing in cold water
9. Toning
10. Rinsing in recovery-bath

11. Rinsing in cold water
12. Drying

Preparation of the surface of the metal is an integral part of the technological process of metal coatings. The main requirement is the strength of the bond between the base-metal and the coating can be satisfied only if there is no foreign pollution between them, for example in the form of fats and oxides.

Therefore, all particles before deposition of electrochemical coatings are degreased.

For chemical degreasing, dilute alkaline solutions should be used, since the concentrated alkaline solutions have the ability to form oxide films on the surface of the particles, which are made of steel, copper and copper alloys. High levels of alkali may cause passivation and corrosion of products or surfactants may be destroyed.

The composition:

NaOH GOST 2263-79	10–20 g/L
Na_2CO_3 GOST 5100-73	20–30 g/L
Na_3PO_4 GOST 201-76	30–50 g/L
$Na_2O(SiO_2)_n$ GOST 13078-81	3–5 g/L

The regime:

t = 70–90 ^oC,

Time of process 15–20 minutes.

The particles are hanged on anode without a current.

The etching can be done in chemical or electrochemical way. The choice of the method of etching depends on the state of the metal surface and depends on the following technological operation. The etching solution should quickly dissolve oxide films from the metal surface and not dissolve the metal. Also, the etching solution must have a minimum aggressive effect on the equipment and be suitable for using in baths with pendant devices. In view of this, the process of etching was selected for the following conditions.

The etching is used in stationary-bath, which is equipped with local ventilation. (air speed is 1–1,2 m/s).

The composition:

HCl GOST 857-78 200–250 g/dm^3

Inhibitor PB-8 3–5 g/dm^3

The regime:

t =18–25 ^{o}C,

Time of process 20–20 minutes

The warm rinsing with following cold rinsing in ea-water is made after electrochemical degreasing. After the etching-stage cold rinsing in ea-water is made. The goal of rinsing are removal the solutions from the surface of the particles from previous operations and providing of their minimal entry into wastewaters. Pollution can cause deterioration of coating-adhesion with the metal-base and the appearance of coating-defects.

Ethylenediamine electrolytes of copper-coating are also found use in industry. One of the main advantages is a possibility of coating copper-coat directly on steel. For copper-coating on steel an ethylenediamine electrolyte was selected.

The composition of electrolyte:

*$CuSO_4$ * 5H_2O 125 g/L*

*$ZnSO_4$ * 7H_2O 25 g/L*

Ethylenediamine 60 g/L

Na_2SO_4 10H_2O 60 g/L*

$(NH_4)_2SO_4$ 60 g/L

This electrolyte provides bright copper-coating at room temperature.

It is recommended to prepare the electrolyte on distilled water or condensate. In case of using the hard water, ethylenediamine is wasted for precipitation of calcium, magnesium, etc., the result of it is in deterioration of the coating-quality.

First of all, a solution of ethylenediamine copper-complex are prepared, in the way of adding 20-25% solution of ethylenediamine in solution of copper sulfate at 40-45 °C by mixing. Ethylenediamine complex is formed during 10-15 minutes. Aqueous solutions of sodium and ammonium sulfate are prepared separately. First of all,

introduce a solution of sodium sulfate, and then solution of ammonium sulfate are added, which are cooled to 30-35 ° C. After that the solution is added to the working volume, then the pH is determined and adjusted to the desired value.

Ethylenediamine zinc complex for deactivation of anodes is prepared by adding zinc sulfate solution into ammonium, then sodium and then ethylenediamine (20%), while stirring aqueous solutions of sulfates. The ethylenediamine zinc, which is cooled to room temperature, is added into the ethylene diamine-cooled electrolyte to room temperature. The required amount of ethylenediamine complex of zinc is determined from the calculation of 100-150 ml per liter of the main solution. The electrolyte must be worked with current ati_k = $0{,}5\,{}^{\text{А}}/_{\text{дм}^2}$.

The feature of ethylenediamine electrolytes is the fact that the particles are loaded into the bath under the current density, which in 3-5 times higher than the working one. The duration of the "current jump" is 30-60 seconds.

To remove copper coating from the surface of the particles it is recommended to load them into solutions containing organic (nitroaromatic compounds and inorganic oxidizing agents) compounds.

Nitrobenzene and nitrobenzenesulfonic acids, nitrochlorobenzene, nitroaniline, etc. can be used as nitroaromatic compounds in solutions.

In order to increase the surface square of the anodes and reduce the overall dimensions of the anodes, copper bulk anodes were selected in the titanium baskets of the MF brand.

The final operations include catching, rinsing and drying parts.

To reduce the consumption of the electrolyte, it is necessary, after removal from the bath, to rinse the particle in a bath with non-running water, a bath is called - a recovery-bath. Water from the recovery- bath is used later for adding electrolyte to other bathes, and thus, the rinsed and washed solution returns to the main bath. The process is carried out during 10 minutes at temperature 18 ... 25°C.

Rinsing by running water is in a stationary bath during 5 minutes at a water with temperature18 ... 25°C.

The parts are dried at a temperature of 70-90°C for several minutes.

Control of coating-outward is carried out on 100% of the particles by inspection with the naked eye. The coating must be firmly adhesived to the base metal, without peeling, splitting, bloating and cracking.

On the surface of the covered part there is no reject of the following features:

- Unevenness of bright 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 constructed document;
- Change in the intensity of the color after heating to remove hydrogen and check the strength of the grip.

The thickness control of the coating is determined by ultrasonic thickness gauges - devices intended to measure the thickness of the coating without their destruction.

The principle of ultrasonic thickness gauges is based on the ability of ultrasonic waves to be reflected from the boundary of two mediums, which differ in acoustic resistance, equal to the product of the density of the medium on the rate of propagation in it of ultrasound. The method is to measure the time of running ultrasonic impulses between the surfaces of the measured product.

The copper coating process will be carried out in a standard galvanic bath, which is made of polyvinyl chloride, which has high chemical resistance, heat

resistance, wear resistance, high resistance to shock loads and satisfactory mechanical strength.

Overall dimensions of the bath are: length - 2000 mm; width - 1000 mm; depth - 1000 mm.

During the coating of copper-coat, the volume of the electrolyte may vary during spraying, when particles are unloaded. That is why it should automatically maintain a constant level of electrolyte.

Thus, based on the analysis of the technological scheme, the norms of the technological regime, we determine the necessary volume of automation of the process of copper coating deposition.

To control the level, a transmission transducer with a pneumatic output signal is used which is designed to continuously convert the fluid level into a proportional signal of the remote transmission - pneumatic. Also, a secondary device with remote control and a control unit, as an actuator, used a membrane pneumatic cable, a pneumoelectric converter and an electropneumatic converter.

Devices were used to control the level of liquid in acid and alkaline tanks.

To regulate the pH, a sensitive element of the pH meter of submersible performance, a high-level transducer, an automatic indicating and recording device is provided.

To monitor the current strength in the bath of copper-coating, a circuit is provided, consisting of such devices, as rectifier unit, and a remote control for controlling the current strength.

For the organization of the galvanic department, in accordance with the current "Sectoral Instruction on Planning, Production Accounting and Cost Estimation at Chemical Industry Companies", it is necessary to calculate the technical and economic performance of the electro deposition of metal and the full cost of production.

Based on the calculations, an analysis of technical and economic indicators, on the basis of which draw conclusions about the feasibility of establishing a department’s production for the enterprise.

Classification features of the enterprise:

1. in the form of ownership - private;
2. according to the registration form - a legal entity;
3. in the specialization of production - highly specialized;
4. By scale of production - mass;
5. Resources - material resources;
6. with power - average;
7. by the number of staff - small;
8. at the cost of own property - average;
9. for influence on the subject of work - processing;
10. according to the working regime during the year - off-season;
11. for the purpose of products - industrial products

Purpose: to meet the needs of the lighting industry in decorative steel particles.

The main tasks that the company solves:

1. provision of consumers with quality products within the time limits set;
2. prevention of failures in the work of the enterprise (disruption of supply, release of defective products, a sharp decrease in production volumes and decrease in profitability);
3. receipt of income at the expense of sales to consumers of manufactured products.

To complete the full program, a rhythm of 30 minutes is used, the following number of baths is required: chemical degreasing 1, warm rinsing 1, electrochemical degreasing 1, cold rinsing 3, chemical etching 1, electrochemical copper-coating 1, recovery-bath 2, toning 1. Thus, the total number of equipment is 11 units.

To complete the full scope of work in an enterprise, there are enough 3 employees per shift: 1 galvanic-worker and 2 laboratory assistant.

Galvanic production is one of the most dangerous sources of environmental pollution. Metal compounds, which are applied by sewage of galvanic production, have a very harmful effect on the ecosystem of the reservoirs - soil - plants - animals - people. Many chemical substances entering the environment, including in the reservoir, and through drinking water in the human body, in addition to toxic effects, are carcinogenic (can cause malignant formations), mutagenic (can cause changes in heredity) and terrigenous effects (can cause injuries in born children).

In the projected production, low-toxic metals are copper and zinc.

In addition to heavy metals, electrodeposotion uses such environmentally hazardous substances as sulfate ions, ammonium and ethylenediamine.

Waterwastes from the baths enters the copper electroextraction bath from which copper powder is obtained, and the remaining solution is sent to the zinc electroextraction. From this bath get zinc powder, and the solution is sent to the collector-reactor. Lime milk is added to it and adjusted to pH> 10. The separated ammonia is sent to the production, and the solution is sent to the settling tank, from which the sludge is removed, which is a low soluble ethylenediamine and calcium compound. Further water is sent to the tank of deposition of calcium compounds and introduced into it alkaline wastewater and Na_2HPO_4.

The solution passes into a sediment bowl, which deposits calcium salts and is sent to production. Further water is sent to the neutralization tank, to which acidic effluents enter. After neutralization of water enter the mechanical filter. The alkaline solutions of the tinting solution are separately neutralized to pH 7 and passed through a filter press. The resulting slurry, which consists of low soluble compounds, consumes waste of copper and production, and water along with the water after the mechanical filter passes to the carbon filter to completely remove the residual of organic compounds. At the final stage, the solution is fed to electrodialysis, after which the desalinated water and concentrates from the anode and cathode chambers are directed back to production.

In the diploma project the process of deposition copper coating on steel parts is given.

The process takes place in the shop for deposition of galvanic coatings, used harmful, chemically aggressive, fire and explosive materials and materials; The use of mechanical, electrical, thermal energy and compressed air energy is foreseen.

The work performed in this galvanic workshop is related to the maintenance of the autoportal and technological line and in accordance with DSN 3.3.6.042 - 99 can be classified as a category of physical work of medium gravity.

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.

Workers are provided with personal protective equipment - respirators such as "Petals", overalls and footwear. Twice a month with the help of a sawmill will be monitored the content of air in the working area of harmful substances and their parameters.

In order to remove harmful substances from the air, and to provide clean air, a mechanical exhaust manifold, local exhaust ventilation, as well as a mechanical local exhaust ventilation system, which serves grinding and polishing machines, is provided in the galvanic department.

Tidal ventilation serves to supply clean ventilation air instead of sewage. The tidal air is specially treated as needed (cleaning, heating, dampening, etc.). Exhaust ventilation removes dirty or heated exhaust air from the workshop. Their productivity is balanced taking into account the possibility of receiving air to or from adjacent premises. The air balance for the electroplating mill is negative by 10 - 15%. Also, the production provides for emergency ventilation in the event of sudden allocation of toxic steam, which is activated only in the event of an accident and is carried out by exhaust ventilation to create a dilution inside the premises thereby preventing harmful substances from spreading to neighboring premises. Emergency ventilation is included both from sensors of gas detectors

adjusted to the magnitude of the MPC controlled substances, and manually. Baths with harmful emissions are equipped with on-board suction cups (baths for chemical degreasing, etching for coating). In the shop installation is installed with drinking water.

To prevent overcooling and colds of workers, at the entrance to the shop, there are heat air curtains.

The projected facility provides natural, artificial and combined lighting. The system of natural lighting is combined. It is a combination of top and side lighting. The project provides for the use of systems of artificial work, emergency, evacuation, repair and security lighting.

For the provision of electrical safety, the following technical methods and means are provided: electric equipment shutoff, protective shutdown of installations, equalization of potentials, small voltage supply of manual power tools, isolation of current-carrying parts, electrical separation of networks, enclosures, locking, signaling, safety signs, warning posters. The safety of operation in the normal mode of electrical installation will be followed by the following factors: isolation of current-carrying parts, inaccessibility of current-carrying parts, small voltages (on portable fixtures).

The project adopted the following protective devices: dielectric rubber gloves, tool with insulating grips and current detectors, rubber insulating supports. Mandatory regular training on safety rules with current. It is also provided for naked wires, devices that are not protected and accessible for touching current-carrying parts, placement in special boxes, closed by solid or mesh fences.

Key words: galvanic coatings, copper, galvanic bath, toning, current balance, electrolysis, wastewaters.