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ENVIRONMENTAL PROBLEMS OF ZINC-BASED ELECTROPLATING

Annotation. *The environmental problem of electroplating is the pollution of the environment with heavy metals. Since most metals containing electroplating coatings are found in tap water, there is a high probability of the presence of heavy metal ions, inorganic acids and alkalis, surfactants and highly toxic waste in it. Environmental protection consists in the application of modern high-tech technologies with local purification at various stages of technological processes, physico-chemical methods for controlling the composition of the reagents used. Production of zinc-based electroplating by electrolytic, physico-chemical methods, production in a special experimental sequence. The solution of electroplating production is possible only by an integrated approach, including legislative acts and their execution. The thickness of the resulting zinc coating of the metal surface was obtained electrochemically and is 40 microns.*

Keywords: *electrolyte, electroplating, electrochemical treatment, galvanizing, environmental problem, physico –chemical method.*

Introduction

One of the main environmental problems of galvanic coatings is environmental pollution by heavy metals such as lead, zinc, cadmium and chromium. Improper use of these galvanic solutions and waste can result in the release of metals into the soil, water, and air. In addition, zinc-based galvanic coatings can emit toxic fumes when heated, which is also a threat to the environment. To solve these problems, it is necessary to take measures to prevent the spread of galvanic solutions, as well as use environmentally safe methods for the disposal of galvanic waste.

Galvanic production is one of the most environmentally hazardous industries. Large volumes of wastewater contain all heavy metal ions, inorganic acids and alkalis, surfactant reagents, solid toxic waste. As a result, heavy metal ions enter the environment and accumulate in plants, negatively affecting living organisms, including humans [1].

Zinc plating is the process of applying a layer of zinc to the surface of a metal to protect it from corrosion. The importance of this process is due to the corrosion resistance and wear resistance of zinc, which makes it possible to significantly extend the service life of metal products. In addition, the zinc coating gives the metal an aesthetic appearance and facilitates its processing [2].

Environmental protection from pollution by waste from galvanic industries consists primarily in the use of modern knowledge-intensive technologies with local purification at various stages of technological processes, physico-chemical methods for controlling the composition of the reagents used. Of great importance is the design of automatic networks with software control and waste-free technologies.

After use by reuse and recovery of solutions, galvanic solutions can be cleaned and reused or subjected to recovery processes to remove heavy metals

The main environmental protection strategy is to redirect galvanic industries from waste disposal to their recovery. The main direction is the creation of closed industries and cycles, as well as the use of natural sources of raw materials. For example, rainwater treated by reverse osmosis can be used in phosphating plants. There are technologies for the treatment and use of groundwater containing chlorinated hydrocarbons by filtration through filters.

Methodology

Electrochemical processing is based on the laws of anodic dissolution of metals during electrolysis. When an electric current passes through the electrolyte, chemical reactions occur on the surface of the workpiece, and the surface of the metal is transformed into a chemical compound. Electrolysis products enter the solution or are removed mechanically. The performance of this method depends on the electrochemical properties of the electrolyte, the material being processed and the current density [3].

During the experiment, the surface of the coating part was cleaned in accordance with Gost 2789-73, electrochemical degreasing was carried out in table 1.

Procedure for conducting the experiment:

1. Object mass measurement;
2. Mechanical processing of the object; measurement of the mass of the object after mechanical processing;
3. Degreasing of the object; measurement of the mass of the object after degreasing;
4. Object chrome plating;
5. Measurement of the mass of a galvanized object.

Steel grade 12X18N10T plate were used as objects in the experiment. The resulting tape was first mechanically processed with rat paper, as it was simple in structure. Rat paper was chosen for its affordability and simplicity of use. Then it was thoroughly washed with distilled water in order to get rid of scratches. Then it was degreased with a solution of sodium hydroxide at a temperature of 65°C and purified with sulfuric acid. Then the tape was dried and wrapped in white paper.

Solution components	Composition of the solution for degreasing, g/l		
	For steel parts for continuous baths	For steel wires and pipes	For non-ferrous metals
Caustic sodium	20-40	50-150	-
Trin sodium phosphate	20-40	-	20-40
Soda	20-40	-	20-40
Liquid glass	3-5	30-80	3-5
Temperature, °C	60-70	60-80	60-80
Current density, A/dm^2	2-10	40 (biopolar current)	2-10

***Table 1**-solution for Electrochemical degreasing*

The degreasing process was carried out in a NaOH solution at a temperature of 60°C for 20 minutes with a current of 0,36 A/dm^2.

Deposition of oxides in the surface layer of parts, purification from salts depending on the reason for reducing the adhesion strength of the coating, electrochemical cleaning is carried out, the amount of which is shown in table 2. Electrochemical purification was carried out with sulfuric acid with a current of 0,36 A/dm^2 in the amount of 10 minutes.

Solvent	Total (% loss)			
	Solvent	Solvent	Wash and drying	With used mortar
	Steel	lock		
H_2SO_4 (ml)	60-62	5-3	20	15

Table 2 *- Solution for Electrochemical cleaning*

Results

Table 3 indicates the final nature of the experiment. it is necessary to make sure that the pH degree does not exceed or be less than 3,5 – 4,5. In order to improve the quality of packaging, a surfactant was added – dextrin.

Order of experience	Visualization	t°	t, min	Current, kV	m, g
Object mass	-	-	-	-	16,3214
Mechanical processing	Sandpaper	-	-	-	16,3196
Degreasing	H_2SO_4 solution	18	10	0,60	16,3192
Galvanizing	$m(ZnSO_4 \cdot 7H_2O)$ = 30 g $m(Na_2SO_4 \cdot 10H_2O)$ = 7,5 g $m(KAl(SO_4)_2 \cdot 15H_2O)$ = 7,5 g Surfactant (dextrin) = 1,5 g	20	50	0,66	17,0335

Table 3 *- The nature of the work during the experiment.*

The thickness of the coating is determined by the following Fomula:

$h = (n-0,5) \cdot hk$

where, n is the number of drops of solution, hk is the layer thickness to be removed by one drop in the assigned time interval [4].

$h = (12 – 0,5)*1,40 = 16,10$ mcm

The experiment was conducted at a temperature of 24°C. Then 25 drops of the solution are dripped according to the surface layer of the package and kept on the surface for up to 60 second intervals. The calculated thickness of the zinc coating was 16,10 microns.

$P = CIt\mu/100$ [5,6]

Here, P is the mass of the metal collected at the cathode, g; I is the current strength, a; t is the time during which electrolysis takes place in hours; μ is the yield by current; the mass and thickness of the deposited zinc were determined by the following formula (electrochemical equivalent of zinc C=1,22 g/sm^3):

$P = (1,22 \times 0,66 \times 1 \times 97\%)/100 = 0,781$ g

The surface of the product is calculated using the formula:

$S = 20P(a+b)/ab\gamma = 20 \times 17,03(40+18)/40 \times 18 \times 1 = 27,03$ sm^2

The volume of the deposited metal was found by dividing the mass of the deposited metal by the specific weight of chromium (7,13 g/cm^3):

$V = \frac{P}{\gamma} = \frac{0,781}{7,13}$= 0,109 sm^3

If the thickness of the deposited metal, the surface area of the metal object to be coated and the volume of the deposited metal are known [7], the volume of the deposited metal is calculated by dividing the area of the deposited metal object by the area of the deposited metal object:

h= V/F

h = 0,109 / 27,03 = 0,0040 sm^3 = 40 mcm

Discussion

The calculations based on the results of the work indicate, it was possible to determine the optimal, more plating thickness. The packaging had a matte finish with a thickness of 40 microns.

Conclusion

In conclusion, it should be noted that many problems of protecting the environment from pollution of galvanic industries can only be solved with an integrated approach, including legislative acts and their implementation. Zinc-based galvanic coatings have their own characteristics that must be taken into account when using them. In particular, it was found that the galvanizing process requires certain conditions and parameters, such as temperature, electrolyte concentration, current density, etc., to achieve optimal results. Adopting and complying with international green standards and certificates, such as ISO 14001, can help companies improve their environmental performance.

However, there are a number of problems that require additional research and development of new technologies. One such problem is the insufficient corrosion resistance of the coatings due to the presence of defects and impurities. In addition, the economic aspects of the galvanizing process require optimization and reduction of production costs.

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МЫРЫШ НЕГІЗІНДЕГІ ГАЛЬВАНИКАЛЫҚ ҚАПТАМАЛАРДЫҢ ЭКОЛОГИЯЛЫҚ МӘСЕЛЕЛЕРІ

Аңдатпа. *Гальваникалық қаптамалардың экологиялық мәселесі ауыр металдардың қоршаған ортаны ластауда. Гальваникалық қаптамалар бар металлдардың көбісі ағын суларда кездескендіктен, ондағы ауыр металл иондары, бейорганикалық қышқылдар мен сілтілер, беттік белсенді реагенттер мен улылығы жоғары қалдықтардың болу ықтималдылығы жоғары. Қоршаған ортаны қорғау технологиялық процестердің әртүрлі кезеңдерінде жергілікті тазартумен заманауи ғылымды қажет ететін технологияларды, қолданылатын реагенттердің құрамын бақылаудың физика-химиялық әдістерін қолданудан тұрады. Мырыш негізіндегі гальваникалық қаптаманы электролиттік, физикалық - химиялық әдістер арқылы дайындау, арнайы тәжірибелік реттілікпен жасау. Гальваникалық өндірістерді тек кешенді тәсілмен, оның ішінде заңнамалық актілермен және оларды орындаумен ғана шешуге болады. Металл бетіне қапталған мырыш қаптамасының 40 мкм қалыңдығын электрохимиялық тәсілмен алып, есептеулер жүргізу арқылы есептелінді.*

Кілт сөздер: *электролит; гальваникалық қаптама; электрохимиялық өңдеу; мырыштау; экологиялық мәселе; физика – химиялық әдіс.*

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ЭКОЛОГИЧЕСКИЕ ПРОБЛЕМЫ ГАЛЬВАНИЧЕСКИХ ПОКРЫТИЙ НА ОСНОВЕ ЦИНКА

Аннотация*. Экологическая проблема гальванических покрытий заключается в загрязнении окружающей среды тяжелыми металлами. Поскольку большинство металлов, содержащих гальванические покрытия, обнаруживаются в водопроводной воде, высока вероятность наличия в ней ионов тяжелых металлов, неорганических кислот и щелочей, поверхностно-активных реагентов и высокотоксичных отходов. Охрана окружающей среды заключается в применении современных наукоемких технологий с местной очисткой на различных этапах технологических процессов, физико-химических методов контроля состава применяемых реагентов. Изготовление гальванического покрытия на основе цинка электролитическими, физико-химическими методами, изготовление в специальной экспериментальной последовательности. Решение гальванических производств можно только комплексным подходом, в том числе законодательными актами и их исполнением. Толщина полученного цинкового покрытия металлической поверхности была получена электрохимическим путем и составляет 40 мкм.*

Ключевые слова: *электролит; гальваническое покрытие; электрохимическая обработка; цинкование; экологическая проблема; физико – химический метод.*