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Environmental problem in organization of works related to electroplating of parts

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Abstract

Problem statement: Ecological problem in the application of galvanic coatings during the manufacture of electronic equipment for the Navy. The aim of the work is to analyze the applied galvanic coatings in the manufacture of radio-electronic equipment (CEA) and a description of the environmental problem in the organization of work related to the application of galvanic coatings to parts within the city of St. Petersburg. **Novelty:** consists in a description of the conflict of legislative requirements regarding licensing of hazardous industries and proposals to rectify the situation. **The result:** it is necessary to allow enterprises located within the city limits to re-equip galvanic production to improve the ecological condition of the city. **Practical significance:** improving the environmental situation in the city of St. Petersburg.

Keywords: Electronic equipment, galvanic production, ecology, polypropylene, harmful substances;

1. Relevance

The problem of ecology in the application of galvanic coatings in the manufacture of radio-electronic equipment for the Navy is relevant because galvanic production is one of the most dangerous sources of environmental pollution, mainly surface and underground water bodies, due to the formation of a large volume of waste water [8]. Air pollution is generated by emissions from stationary sources (industrial enterprises) and vehicles. Total harmful emissions of 513 thousand tons. Figure 1 shows a diagram of the amount of harmful substances (in thousands of tons) in emissions from transport and stationary sources in St. Petersburg.

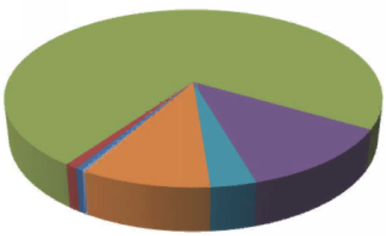

Fig. 1. Diagram of the amount of harmful substances (in thousands of tons) in emissions from transport and stationary sources

1.1. *Problem definition*

Protective metal coatings are used in the production of electronic equipment (REA), including the production of communication complexes for the benefit of the Navy. This is due to the need to protect the metal from corrosion when exposed to moisture contained in the air. In accordance with GOST RV 20.39.309-98, in addition to corrosion protection, REA parts shall have low transient resistance between metallized elements to obtain a reliable grounding loop, including to provide an electromagnetic screen [1]. Metal coatings in the production of REA are usually produced by galvanic method. The advantage of such coatings is that a wide selection of coating metals is possible, and in the electrolysis process, the production of thin and relatively thick films is possible. According to the requirements of GOST RV 20.39.304-98 [2], the group of equipment execution is selected, in accordance with the requirements of the technical assignment (TA). This standard establishes classification, nomenclature, characteristics and values of technical requirements for equipment, in accordance with the conditions of its application, including for maritime groups of equipment production 2.1-2.7.

The article is devoted to the issues of galvanic coating during the production of equipment of execution groups 2.1.1 and 2.3.1. The versions are located on objects with sea climate (OM), in accordance with the classification of climatic situation on the Globe, which is reflected in GOST 15150-69 [3]. In addition to the corrosion from the effects of wet air, electrochemical corrosion of metal contact compounds is of particular importance in humid climates. Permissible and non-permissible contacts between metals and coatings in different operating conditions are specified in GOST 9.303-84 [4]. GOST 9.306-85 [5] standard contains coating designations, production methods and recording examples. GOST 9.305-84 [6] sets parameters of operations included in the coating production process.

The main production characteristic of the REA design is processability, so the systematization of works related to the selection and application of galvanic coatings, taking into account the system of standards according to the ESZKZ, allows to use spent standard technological processes.

1.2. *Materials*

Consider the main characteristics of coatings and ecological characteristics of metals and coatings [2-7]. The material parameters are shown in Table 1.

Table 1. Material parameters at 18 ° C

Name of material	Specific resistance, Om·m
Zinc	$5{,}75 \cdot 10^{-8}$
Cadmium	$10{,}98 \cdot 10^{-8}$
Nickel	$7{,}23 \cdot 10^{-8}$
Chrome	$1{,}68 \cdot 10^{-8}$
Polypropylene	$10 \cdot 10^{-8}$
Copper	$1{,}68 \cdot 10^{-8}$
Tin	$11{,}5 \cdot 10^{-8}$
Palladium	$10{,}8 \cdot 10^{-8}$

Rhodium	$4{,}5\cdot 10^{-8}$
Lead	$20{,}8\cdot 10^{-8}$

1. Zinc coatings are anode, have average hardness, withstand various bends, are poorly welded and welded, the color of the coating is blue-steel. Coating prevents contact corrosion of steels at connection with parts made of aluminium and its alloys, provides screwing of threaded parts. Zinc coatings are chromated to increase corrosion resistance, thereby improving the appearance of the coating and its strength. Zinc coatings have a strong bond with the base metal. It is slightly toxic to humans compared to the various metals that are used for electroplating.
2. Cadmium coating is anodic and protects steel from corrosion in the atmosphere and seawater, electrochemical and mechanical in fresh water. If necessary, increase corrosion resistance - chromium. It is not recommended to use it in an industrial atmosphere containing sulfur compounds and volatile aggressive compounds because the organic matter is released upon aging. It has strong adhesion to the base metal, good antifriction properties, withstands drawing, pressing and cracking. Oxides of cadmium are toxic. Cadmium is one of the most dangerous of all metal pollutants. Prolonged introduction of cadmium into the body causes severe kidney as well as bone diseases. Prolonged exposure to cadmium causes anemia and hypertension. Cadmium toxicity decreases and other metals enter the body. The mitigating effect is cobalt, selenium, and zinc and its chelates.
3. Cathode nickel plating. Not a toxic substance to humans. Increased nickel consumption occurs when gutters are contaminated with industrial waste, including galvanic runoff. The covering is used for protective, protective and decorative finishing of details, increase in hardness of a surface, wear resistance and conductivity. It provides good solder fluidity and serves as a barrier layer under a coating of gold, silver, tin-lead alloy and other metals, preventing diffusion of copper, zinc, iron and other metals.
4. The chromeplated covering cathode. The solid coating has high wear resistance and works effectively for friction. The toxic effect of chromium on the human body depends on the degree of oxidation. The high content of hexavalent chromium salts in wastewater has toxic effects on the microflora of water bodies.
5. Polypropylene (PP) coating is characterized by high chemical resistance, mechanical strength, low cost, soft, elastic, heat resistance. The relatively low permeability of polyolefins allows them to be used to protect products that work in contact with aggressive media. PP coatings protect metal from corrosion in water, in solutions of various acids and alkalis. PP is also used in combination with globular carbon concentrate; It is extruded into profile articles using single- and twin-screw extrusion techniques. The use of this product is possible in piping systems for the transport of bulk materials, liquids and gases, as protection of power cables and in other structures. Use of a polypropylene covering will allow to lower labor costs at installation, installation time, design weight.
6. Copper covering cathode. It has high electrical thermal conductivity, is well opposed to deep drawing, cracking, is well soldered and has low corrosion resistance. Toxic to aquatic organisms. At 0.001 mg/cm3, copper salts inhibit the development of many aquatic organisms, and at 0.004 mg/cm3 they have toxic effects. Toxic doses of copper salts lead to acute but curable human poisoning. This coating has high electrical and thermal conductivity, plasticity, withstands deep drawing, cracking, well polished, facilitates rolling, tacking and screwing; In a freshly deposited state, it is well soldered. When low temperature solders are used, it forms intermetallic compounds that dramatically impair the soldering ability and strength of the solder joint. Polypropylene (PP) coating is characterized by high chemical resistance, mechanical strength, low

cost, soft, elastic, heat resistance. The relatively low permeability of polyolefins allows them to be used to protect products that work in contact with aggressive media. PP coatings protect metal from corrosion in water, in solutions of various acids and alkalis. PP is also used in combination with globular carbon concentrate; It is extruded into profile articles using single- and twin-screw extrusion techniques. The use of this product is possible in piping systems for the transport of bulk materials, liquids and gases, as protection of power cables and in other structures. Use of a polypropylene covering will allow to lower labor costs at installation, installation time, design weight.

7. Copper covering cathode. It has high electrical thermal conductivity, is well opposed to deep drawing, cracking, is well soldered and has low corrosion resistance. Toxic to aquatic organisms. At 0.001 mg/cm3, copper salts inhibit the development of many aquatic organisms, and at 0.004 mg/cm3 they have toxic effects. Toxic doses of copper salts lead to acute but curable human poisoning. This coating has high electrical and thermal conductivity, plasticity, withstands deep drawing, cracking, well polished, facilitates rolling, tacking and screwing; In a freshly deposited state, it is well soldered. When low temperature solders are used, it forms intermetallic compounds that dramatically impair the soldering ability and strength of the solder joint.

8. The tin coating is cathodic under atmospheric conditions. The coating is recommended for soldering. It is resistant to sulfur-containing compounds and is recommended for parts contacting all types of plastics and rubbers. Good adhesion to the base metal, elastic, resistant to bending, drawing, rolling, stamping, press fitting, well preserved when applied, Sweg applied coating well soldered, brilliant retains the ability to solder longer than matte. Tin entering the human body with food and drinking water is quickly removed from the body. In the body, tin is deposited in the kidneys, liver, bones and, to a small extent, in soft tissues, the largest amount is deposited in the skeleton.

9. Palladic covering cathode. It has high resistance to atmospheric conditions and effects of sulphur compounds. It is recommended to reduce the transient resistance of the contacting surfaces, increase their surface hardness and wear resistance, if necessary, to maintain a constant electrical resistance. It has high wear resistance and good electrical conductivity, stable contact resistance over time; coefficient of reflection of 60-70%. Electrical conductivity is stable over time up to 300 ° C. It is not recommended to be used in contact with organic materials and rubbers, as well as in a closed space in the presence of these materials. Coating is not allowed to be applied in hydrogen medium.

10. Rhodium plating cathode. It is recommended to use for stable electrical parameters of the contact parts of the device. It has high wear resistance, electric conductivity, reflectivity, is not subject to welding, is stable in most aggressive media, including hydrogen sulphide, is not oxidized to the temperature of 600 ° C. At a thickness of 1.0 mcm it practically has no pores with thickness of more than 3 mcm.

11. Lead refers to trace elements leading to human organ and blood pathology; During life, lead accumulates in bones. Increased uptake of lead from water and food is observed in children. By analysing the harmful effects on the human body and the surrounding nature of galvanic production, it can be concluded that it is necessary to comply with safety requirements in any case, wherever the production is located. There is no equivalent replacement of the above-mentioned ESZKS system during the process of REA creation, including for the Navy at present. The present solutions for these galvanic coatings contain metal salts, weak acids, alkali, and in some cases potassium and sodium cyanides. All chemicals are toxic. Meteorological conditions and content of harmful substances in the working area of the premises shall not exceed the standards established

by GOST 12.1.005.88. In order to prevent exposure to general toxic and irritant substances, it is necessary to provide plenum-exhaust ventilation in rooms and at workplaces.

1.3. Production

Pollution of the atmosphere by harmful emissions from stationary sources in the areas of St. Petersburg city is presented in Table 2.

Table 1. Pollution of the atmosphere by harmful emissions from stationary sources

Area	The most polluted	The least polluted
Vyborg	+	
Kirovski	+	
Seaside	+	
Nevsky	+	
Kronstadt		+
Admiralty		+
Frunze		+
Petrodvorets		+

Take the example of a production that is located in the Nevsky district with high pollution of the atmosphere with harmful emissions. The enterprise has the right to leave already existing equipment for galvanic coating, but does not give the right to re-equip galvanic production with new lines, requiring the use of only existing equipment. As a consequence, the use of old equipment is the most dangerous and harmful to the ecology of the city of St. Petersburg.

It is necessary to create a modern electroplating complex that fully meets the needs of enterprises in the necessary range, quality and volume of products, which would include high-efficiency treatment facilities that meet modern environmental protection requirements.

1.4. Section headings

Section headings should be left justified, with the first letter capitalized and numbered consecutively, starting with the Introduction. Sub-section headings should be in capital and lower-case italic letters, numbered 1.1, 1.2, etc, and left justified, with second and subsequent lines indented. You may need to insert a page break to keep a heading with its text [9].

2. Equipment

When creating a modern complex of electroplating at the enterprise it is necessary to optimize (expand) electroplating production by systematic replacement of physically and morally obsolete equipment with modern automatic lines in complex with treatment facilities and systems of automated development of technological processes of electroplating production on personal computers and control, as well as elimination of individual electroplating areas with transfer of parts for coating to new equipment.

In order to reduce the load on the treatment facilities and reduce the discharge of petroleum products into the sewerage system, as well as the rational use of degreasing solutions, it is proposed to purchase the microfiltration plant shown in Figure 2 in all workshops. Such installations will reduce the discharge of degreasing solutions by three times and extract up to 90% of oil products.

Fig. 2 Microfiltration installation

In order to reduce the consumption of firewater, it is proposed to purchase plants for the production of dionized water, the operation of which is coordinated with the supply of water to washing baths.

In the new equipment of Ts 93 and МСЦ-3 there are systems of three-stage washing of parts, which allows to reduce the amount of water used for washing. Figure 3 shows the system of three-stage washing of parts.

Fig. 3 System of three-stage washing of parts

Ingress of harmful substances into the environment with aerosols and vapors from the removed air from the exhaust ventilation baths.

This problem is most relevant for nickel and chrome baths, as well as acid baths (for etching and activation baths). At the moment, the issue is solved thanks to the frame filter installed in the exhaust ventilation at the bath with special material absorbing vapors and aerosols. Periodically this material is washed with water and forming washing waters are discharged to treatment facilities.

In order to eliminate the discharge of aerosols and vapours from etching baths and activation in the new equipment C 93, install the foam absorber shown in Figure 4.

Fig. 4 Foam absorber

Washing water forming during operation of this absorber is discharged to treatment facilities. It is necessary to install frame filters with special absorbent material in the operating equipment for all workshops. New equipment during delivery shall have both frame filters in ventilation and foam absorbers.

3. Conclusion

There is an environmental problem in the organization of galvanic production. At the moment, the legislation prohibits the placement of galvanic industries in the city. At the same time, even in the historical center of the city it was allowed to leave already existing galvanic production. That is, the ban applies to the galvanic production being created, but does not apply to existing ones. At the same time, it is forbidden not only to create, but also to reconstruct existing systems. This decision is even more environmentally dangerous for the city than the ban on new production.

At the same time, on the territory of St. Petersburg, enterprises within the city are not given the opportunity to re-equip galvanic production with new lines, requiring the use of existing equipment, or to close or transfer galvanic production, which in turn is not economically profitable for enterprises. There is a lack of legislation, which can be eliminated either by closing galvanic production in the city or by recommending to the Government of St. Petersburg to develop a regional law allowing the modernization of existing production by modern means of water purification and galvanic waste.

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