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THE IMPACT OF GALVANIC PRODUCTION ON THE ENVIRONMENT

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Анотація

Розглянуто вплив гальванічного виробництва на навколишнє середовище в Україні. Підкреслюються екологічні небезпеки гальванічного виробництва як найбільш небезпечних джерел антропогенного забруднення. Запропоновано нові методи нейтралізації металу нікелю.

Ключові слова: гальванічне покриття, ціаніди, органічні розчинники, шлам, шлак, фториди вищого потоку, доменна піч.

Abstract

The article considers the impact of galvanic production on the environment in Ukraine. The environmental hazards of galvanic production as the most dangerous sources of antropogenic pollution are emphasised. New methods of metal neutralization Nickel in particular are suggested.

Key words: Galvanic plating, cyanides, organic solvents, sludge, slag, high-flow fluorides, blast, furnace.

Introduction

Galvanic plating is electrolytic deposition of a thin layer of metal on the surface of any metal object to protect it from corrosion, to increase resistance, to prevent from cementation. Galvanic metal coating is a great way to avoid many problems and increase the service life of equipment, machines and other devices. The application of galvanic coatings is an electrochemical process in which the metal layer is deposited on the surface of the product.

Galvanic production is used in many traditional and innovative industries: in instrumentation and engineering, electronics, electrical engineering, energy, space, and construction industries. The development of electroplating has led to the use of electrochemical technologies for the creation of nanomaterials, elements of nanoelectronics, new energy sources, antibacterial nanoparticles.

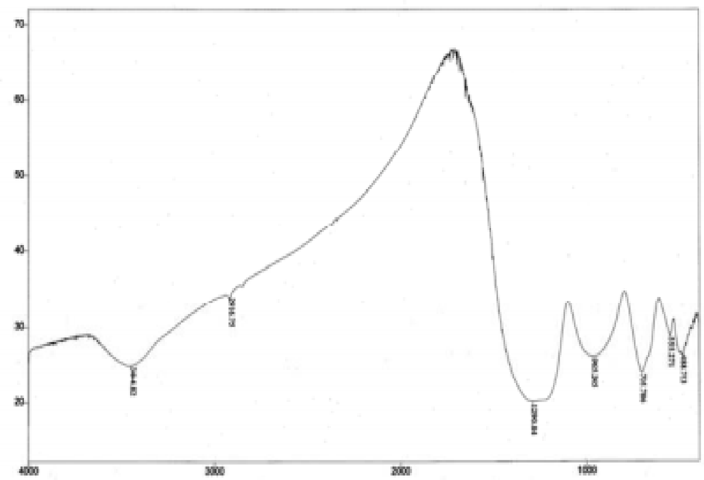
The advantages of electrochemical technologies for the treatment of metallic and nonmetallic materials, and the simplicity of automation and the economic efficiency of electrochemical technologies make electroplating production competitive in comparison with other methods of surface treatment of materials.

At the same time an important aspect of galvanic production is its environmental hazard. The use of a variety of chemicals, including toxic, such as heavy metals, cyanides, organic solvents causes the formation of solid, gaseous and liquid wastes. The problem of utilization of galvanic wastes in the modern machine-building industry is topical, despite the significant reduction in volumes of galvanic production.

The essence of the current problem is that galvanic production is one of the most dangerous sources of anthropogenic pollution of the environment. Waste water from harmful electroplating industries is contaminated by salts of heavy metals with acids and alkalis. The results formed in chemical and electrochemical processing of metals and their alloys and the application of galvanic coatings belong to one of the most common types of industrial sewage in Ukraine. The sewage of galvanic production contains heavy metal ions, a significant amount of nickel being among that is not completely discharged in the city sewage network or the nearest rivers and water facilities. Nickel compounds are carcinogen. They can cause allergic reactions and neoplasms, hazarday effect on DNA and RNA. The primary material used in the eco-technological process is galvanic sludge. Qualitatively, galvanic sludge consists of toxic metal hydroxides $Cu(OH)_2$, $Cr(OH)_3$, $Zn(OH)_2$, $Pb(OH)_2$, $Cd(OH)_2$, $Ni(OH)_2$, and others).

The second material is waste aluminium slag, which contains certain amounts of aluminium, metal oxides (Al_2O_3, BeO, TiO_2, CuO, Cr_2O_3, and others), and predominantly Al_2O_3 and solidified refinement salts, which mostly contain KCl, NaCl, Na_3AlF_6, $MgCl_2$, CaF_2, MgF_2, etc.

Since aluminium slag contains high-flow fluorides which could destroy glass-ceramics phase, it is rinsed with water in order to remove the fluorides. The slag is sunk in the water and left like that for 24 hours, during which the fluorides dissolve. The insoluble part of the slag is separated by filtration and fluorides are regenerated by evaporation and crystallization. The residue thus obtained is then processed further. To obtain dehydration, it is necessary to dry the galvanic sludge. A low-temperature dry kiln can be used for this purpose. After these operations all the elements (sludge, slag, glass, and borax) are ground in a coloid mill to facilitate melting. When the ingredients are ground, they are mixed until the mixture is homogenized and then the same mixture is poured into the melting mould. The mould with the mixture is put into a blast furnace where it is heated at 1200-1400 ℃. The melting temperature of the mixture depends on the quantity of several components included in the mixture. An increased quantity of glass will lower the melting temperature and reduce the solidity of the obtained ceramics. With the increase in the quantity of aluminium slag the solidity of the ceramic structure will also increase, but this requires a higher melting temperature, which sometimes presents a difficulty. In order to get to phase transformations, the mixture has to be absolutely liquid, which is why the mould is kept in the blast furnace for about 40 minutes. After melting, the melted content is poured into a preheated graphite mould. The preheated graphite mould is preheated at 250-300 ℃ so that glass-ceramics would not crack due to sudden cooling in a cold mould The efficiency of the eco-technological procedure of transforming galvanic sludge and aluminium slag into a sTab. glass-ceramic structure was confirmed with Fourier Transform Infrared Spectroscopy (FT-IR) and X-ray diffraction (XRD). Infrared spectra of glass-ceramics were obtained with a BOMEM (Hartman & Braun) FT-IR spectrophotometer, model MB-Series, in a spectral range 4000 to 400cm-1, with a resolution of 2cm-1, by method of pressed pellets. The Potassium Bromide (KBr) Technique for sample preparation was used to record spectra. A quantity of 1-2 mg of tested sample is mixed with 150 mg of spectroscopically pure KBr. The mixture is then vacuumed and pressed at 200 Mpa, which forms thin permeable pellets. A reference pellet for background recording was prepared from pure KBr.



IR spectrum of glass ceramics

Thus, through application of standard procedures U.S. EPA 1997/222, designation of low and high-flow metal fractions, we identified the ecological risk of the disposal of galvanic sludge and aluminium slag, which are classified as hazardous waste. If they are not processed or properly disposed of, high-flow metal fraction is easily eluated with atmospheric precipitation, thus infiltrating and polluting the environment. The low-flow fraction is conditionally mobile and represents the reservoir of the high-flow fraction. Accordingly, waste galvanic sludge and aluminium slag were inactivated by sintering into a useful product – glass-ceramics. The FT-IR and XRD spectra confirmed chemical-phase transformations with the bonding of toxic metals (Zn, Pb, Cr, Cu, Cd, Ti, etc.) to the aluminosilicate phase in the form of solid solutions.

To conclude the theoretical and practical experience of the prominent European and American companies can be successfully applied to the elimination of hazard affect of galvanic production in Ukraine.

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