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Development of a technological process for electrodeposition of zinc-nickel alloy from an alkaline electrolyte

Abstract

Relevance of the research

Galvanic zinc coatings are widely used to protect steel products from corrosion. They have a high protective capability in relation to steel and provide electrochemical protection in a humid atmosphere. However, due to the high negative potential, zinc coatings are characterized by low corrosion resistance and are quickly destroyed in corrosive environments. It is known that alloying zinc coatings with iron subgroup metals (such as Ni, Co) significantly increases their corrosion resistance by shifting the potential to a more positive region.

Coatings containing from 12 to 14% nickel by weight have the highest corrosion resistance and protective capability in relation to steel. With a lower nickel content, the corrosion resistance of the coating is not much higher than that of zinc, and with a higher nickel content, the electrochemical nature of the protection of the steel base by the coating is lost.

Numerous simple acidic electrolytes for depositing zinc-nickel coatings have not found practical application due to the strong dependence of the alloy composition on the cathode current density. Alkaline electrolytes are characterized by high throwing power and constancy of alloy composition over a wide range of cathodic current densities, which is especially important when applied to complexly profiled surfaces.

At present, industrial enterprises in the Russian Federation use foreign technologies, since domestic technologies for depositing zinc-nickel coatings that meet modern requirements for the processability and functional characteristics of the deposited coatings do not exist. In this regard, the development of an import-substituting technology for the electrodeposition of protective and decorative zinc-nickel coatings containing 12-14% by weight of nickel is relevant.

The degree of development of the research. An analysis of the literature, including patents, showed an almost complete lack of information on Russian developments in the field of technology for the electrodeposition of zinc-nickel alloy containing 12-14% nickel from an alkaline electrolyte, as well as on the patterns of co-precipitation of these metals from solutions in the presence of amino compounds.

The purpose of the work

Development of technology for electrodeposition of protective and decorative coatings with zinc-nickel alloy containing 12-14% by weight of nickel from an alkaline electrolyte.

The research tasks

1. Study of the influence of the ratio of component contents in the electrolyte, the nature of organic ligands and brightening additives, as well as process parameters on the alloy composition.

2. Study of electrolyte stability, development of corrective concentrates and electrolyte correction mode during operation.

3. Development of a process for chromate-free passivation of the developed zinc-nickel coatings.

4. Conducting corrosion tests of coatings.

5. Conducting tests of the developed technology in production conditions.

Scientific novelty of the research

1. It has been established that the introduction of a compound from the class of nitrogen-containing polyalkylene glycols (AC2) into an alkaline aminocomplex zinc electrolyte for the deposition of zinc-nickel alloy leads to an increase in the nickel content in the alloy (from 6 to 13%) due to the polarization of the zinc deposition process in the alloy.

2. It has been shown that the introduction of a compound containing a metalloid in a non-maximum oxidation state (B3) into an aminocomplex zinc electrolyte for electrodeposition of a zinc-nickel alloy expands the working range of current densities in which zinc-nickel alloy coatings with a nickel content of 12-14% are deposited.

Theoretical and practical significance of the research

1. The theoretical significance of the work lies in establishing the patterns of the process of electrodeposition of zinc-nickel alloy coatings from an alkaline electrolyte in the presence of amino compounds.

2. An import-substituting technology for the electrodeposition of zinc-nickel alloy has been developed that meets modern requirements for the uniformity of the chemical composition and coating thickness on a complex-profile surface, the appearance of the coatings, corrosion resistance and protective capability, as well as the service life and stability of the electrolyte.

3. A process for chromate-free passivation of electrolytic zinc-nickel coatings deposited from an alkaline aminocomplex zinc electrolyte has been developed.

Methodology and research methods

The methodology of the work includes generally accepted theoretical and practical methods of scientific activity, including analysis of literature on the research topic, generalization, comparison and systematization of data, setting work objectives, determining a promising direction of research for their solution, conducting experiments in order to obtain new knowledge in the area under study, analysis of the results obtained and their use to solve the problems of the dissertation work.

Provisions for defense

The results are submitted for defense:

– studies of the dependence of the alloy composition on the content of components in the electrolyte, the nature of organic ligands and brightening additives, as well as process parameters;

– studies of the patterns of co-precipitation of zinc and nickel from an alkaline amino zincate electrolyte;

– studies of electrolyte stability and service life;

– corrosion tests;

– electroplating solution testing at existing production facilities.