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**Improving the efficiency of the electroflotation process for the extraction of copper, nickel and zinc ions as part of multicomponent systems**

**Abstract**

**Relevance of the research topic**

Improving the environmental situation at enterprises using galvanochemical surface treatment processes for metals and plastics, which are widely represented in the Republic of the Union of Myanmar, is a serious urgent problem. To achieve minimization of harmful effects on the environment and society as a whole, it is necessary to improve and implement the electroflotation method of wastewater treatment from toxic components of non-ferrous metals as part of a multicomponent mixture in the presence of complexing agents and organic pollutants.

Electroflotation method is one of the promising areas for wastewater treatment from impurities of heavy metals, suspended solids and some organic pollutants. The advantage of this method is the high efficiency of purification, the ability to automate the process, the creation of local systems of the required volume and the absence of secondary water pollution.

For the development of an effective, environmentally friendly and resource-saving technology for the treatment of water effluents, which contain ions of heavy metals and non-ferrous metals, surfactants of various nature. It is necessary to determine the most optimal solutions based on an individual approach, using previously obtained laboratory data on pilot plants.

**The purpose of the work:** Establishment of basic patterns (intensity and efficiency) on the influence of the nature of the dispersed phase and  $\text{NH}_3 \cdot \text{H}_2\text{O}$  on the process of electroflotation extraction of sparingly soluble compounds of copper, zinc and nickel as part of multicomponent systems to search for ways to improve the efficiency of electroflotation processes for treating wastewater of complex composition.

**The purpose of the work determines the following tasks:**

1. Investigation of the electroflotation process of joint extraction of copper, nickel and zinc ions as part of two- and three-component systems. Determination of optimal pH values, current density, processing time.

2. Establishment of regularities in the process of electroflotation extraction of sparingly soluble compounds of copper, nickel and zinc in the composition of two-component systems in the presence of background electrolytes  $\text{Na}_2\text{SO}_4$  and  $\text{NH}_3 \cdot \text{H}_2\text{O}$ .

3. Search for ways to improve the efficiency of the process of electroflotation extraction of copper, nickel and zinc hydroxides from two-component systems contaminated with organic compositions (penetrant LZ-6A, varnish FL-5111, cleaning liquid OZH-1 and solvent R-5).

4. Study of the effect of background electrolytes  $\text{Na}_2\text{SO}_4$ ,  $\text{NH}_3 \cdot \text{H}_2\text{O}$ ,  $\text{NaNO}_3$ ,  $\text{Na}_3\text{PO}_4$  on the process of extracting three-component mixtures of copper, nickel and zinc ions from wastewater.

5. Development of a schematic diagram for the treatment of wastewater of complex composition generated at machine-building enterprises of the Republic of the Union of Myanmar.

In the course of the research, new data were obtained that are of wide scientific and practical interest for the development of methods and technologies for wastewater treatment from impurities of heavy and non-ferrous metal ions in the presence of surfactants of various nature.

#### **Scientific novelty of the research:**

1. It has been established that for the two-component Cu-Zn system, the highest degree of extraction is observed in the sulfate background electrolyte in the presence of a cationic surfactant at  $\text{pH} = 9$  and is 98%, which is due to the effect of cationic surfactants on the surface charge of the particles of the extracted hydroxides and a shift to a more positive region.

2. It was found that for the two-component Cu-Zn and Ni-Zn systems, the highest degree of extraction is achieved under the conditions of the background electrolyte  $\text{NH}_3 \cdot \text{H}_2\text{O}$  and is 95% and 94%, respectively, which is probably due to the formation of larger hydroxide particles of the extracted metal ions.

3. For the first time, the effect of organic compositions, such as: cleaning liquid OZH-1, penetrant LZ-6A, lacquer FL-5111 and solvent R-5, used in metal surface treatment, on the process of electroflotation extraction of two-component mixtures of sparingly soluble compounds of copper, nickel and zinc at  $\text{pH}=9$ .

4. The role of cationic surfactants (Katasurfactant, Septasurfactant) and a flocculant based on polyacrylamide (Zetag-8160) in intensifying by 20–40% and increasing the efficiency of the process of electroflotation extraction of a multicomponent mixture of sparingly soluble compounds of copper, nickel and zinc at  $\text{pH}=9$  for background electrolytes was determined.  $\text{Na}_2\text{SO}_4$ ,  $\text{NH}_3 \cdot \text{H}_2\text{O}$ ,

$\text{NaNO}_3$ ,  $\text{Na}_3\text{PO}_4$ , which consists in changing both the sign of the charge and the size of the floated metal hydroxides.

**Theoretical and practical significance of the work:**

1. New regularities of the electroflotation process of extraction of various sparingly soluble compounds of copper, nickel, zinc in the background electrolyte  $\text{NH}_3 \cdot \text{H}_2\text{O}$  have been established.

2. The role of background electrolytes ( $\text{Na}_2\text{SO}_4$ ,  $\text{NaNO}_3$  and  $\text{Na}_3\text{PO}_4$ ) in the process of electroflotation extraction of sparingly soluble non-ferrous metal compounds in the composition of multicomponent effluents has been determined. Approaches to increase the efficiency are proposed, which consist in shifting the pH of the process to the range of existence of hydroxides of all extracted metals and influencing their dispersed phase by introducing surfactants or flocculants to enlarge or change the electro kinetic potential.

3. The influence of organic compositions (cleaning liquid OZH-1, penetrant LZ-6A, lacquer FL-5111 and solvent R-5) used in metal surface treatment at enterprises in the Republic of the Union of Myanmar on the process of electroflotation extraction is shown. In the presence of P-5 solvent, the highest degree of extraction for the two-component Cu-Ni system reaches 94%; lacquer FL-5111, the highest degree of extraction in Cu-Zn and Ni-Zn pairs reaches 98% and 90%, respectively; cleaning liquid OZH-1, the highest degree of extraction in a pair of Cu-Zn reaches 98%.

4. The optimal conditions for the process of electroflotation extraction of sparingly soluble compounds of copper, nickel, and zinc in the composition of multicomponent effluents are determined. A schematic diagram for the treatment of wastewater from a mixture of heavy metals in the presence of organic compositions for machine-building enterprises of the Republic of the Union of Myanmar has been developed.