DEVELOPMENT OF ENVIRONMENTALLY SOUND TECHNOLOGY FOR NICKEL-CONTANING WASTEWATER TREATMENT

G. KOCHETOV, *doctor of technical sciences*; **A. TUGAY**, *doctor of technical sciences*; **D. SAMCHENKO**

National University of Construction and Architecture
Povitroflotsky Pr. 31, 03680, Kiev, Ukraine
e-mail: gkochetov@knuba.edu.ua

Wastewater of electroplating facilities contains substantial levels of different pollutants including heavy metals as the most toxic components. Requirements to industrial wastewater treatment need development of technologies that would allow on-site recycle and reuse of both treated water and the heavy metals extracted. The most prospective option for introduction of low-waste wastewater treatment processes is associated with application of local wastewater treatment installation at specific technologic electroplating lines, as separation of wastewater flows by key pollutants ensures tailored recuperation of valuable metals and substantially simplifies design of closed-circuit water supply systems.

Electroplating facilities generate substantial amount of nickel-containing wastewater and sludge, since nickel coatings are on the second place of application after zinc ones. Nickel is an important resource, as its natural deposits are rather limited. Wastewater neutralisation technologies, that are usually applied by electroplating facilities, do not allow to use more than 25% of primary nickel efficiently in electroplating processes.

This research study is dedicated to development of the new resource-saving technology for wastewater treatment of nickel electroplating facilities with re-use of heavy metals and purified water. Rinsing wastewater of nickel electroplating lines contains the following pollutants: suspended solids - up to 50 g/m^3, heavy metals ions (mainly Fe^{2+} and Ni^{2+}) - up to 4 g-eq/m^3, COD - up to 50 g/m^3 at pH of 3 to 4. All analyses were done by photometric and potentiometric methods.

We proposed local wastewater treatment of rinsing wastewater flows instead of traditional reagent-based one. Our technology is based on ion-exchange method, which allows to concentrate pollutants and thus effectively utilise of copper compounds. The ion-exchange method could be applied only in case of rational utilisation of the eluate (solutions after regeneration of ionite filter). This problem has been solved in current research. The eluate contains Ni^{2+} and Fe^{2+} ions (in almost equal concentrations) and their overall level may reach up to 20 g/l. The traditional method of eluate neutralisation and sedimentation by alkaline reagents generates large amounts of highy wet sludge. The sludge is not environmentally acceptable and results in irreversible loss of valuable components. We propose to apply the ferritisation method for formation of dispersed particles with magnetic properties in water contaminated by nickel and other heavy metals. The method allows easy separation of almost insoluble and chemically inert sediments.

We developed low-temperature wastewater treatment with production of ferrite sediment and determine optimal parameters of it obtaining: pH value of ≈ 9,0; air bubbling for oxidation of Fe (II) at rate of about 1 cm^3/s; duration of the ferritisation process is up to 5 min at temperature of 20°C. The process of ferrite formation is accelerated by electromagnetic pulse wastewater treatment with the magnetic induction amplitude in working area up to 0,45 T. Using X-ray diffraction and electron microscopy we have studied structures of materials produced. Most of the obtained compounds are insoluble in water, has compact ferrite structure with ferromagnetic properties, and therefore might be easy separated from solutions with usage of special magnetic filters. We also studied magnetic properties of obtained samples.

In the course of formation of the crystalline ferrite structure it incorporates traces of other heavy metals and organic substances present in the reaction solution. In terms of quality, the treated water of the proposed technological process meets all requirements to its secondary industrial use: suspended solids – up to 3 g/m^3, concentration of heavy metals (Ni^{2+} and Fe^{2+}) ~ 0.02 g-eq/m^3, COD up to 3 g/m^3, and pH ~ 7.

Besides that, we have developed several treatment technologies for toxic nickel-containing exhausted solutions and solid waste (sludge). The technologies allow to obtain valuable marketable products: nickel salts, pigments for ceramic tile manufacture, ingredients for ground enamel coatings for steel wares. We also proposed a technology for regeneration of exhausted nickel electrolyte solutions by extraction of detrimental components.

Thus the research results are used for development of the new environmentally sound technology for utilisation of toxic industrial waste with production of nickel ferrite and other ferromagnetic substances. Depending on amounts, quality and properties of the product, we may propose other appropriate utilisation option:

- the technology for processing of nickel-containing sludge to replace expensive nickel and cobalt oxides in enamel coatings;
- production of glazing enamels for ceramic tile instead of costly pigments;
- ferromagnetic sorbents' production; tests have confirmed good efficiency of the sorbents for removing heavy metal ions from wastewater.

Results of our experiments showed that the main working characteristics, physical-chemical properties of ground enamels and smooth glaze coatings obtained from ferrit sediments meet standard requirements. Our experiments on HM leaching from these products are shown that obtained compounds are chemically and thermodynamically stable. This means a substantially enhancement of environmental safety of the products in terms of compliance with MACs for migration of heavy metals to environmental media.

Our technologies have been successfully tested at industrial sites. As a result, introduction of the proposed technologies would facilitate addressing both economic and environmental problems of industrial facilities of Ukraine.