ХІМІЧНІ НАУКИ

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SOLVENT SUBLATION OF NICKEL IONS FROM WASTEWATER

Summary. *To investigate the process of the solvent sublation of nickel, to make the choice of extractant, surfactant, pH, molar ratio of metal: surfactant.*

Key words: *solvent sublation, extractant, isoamil alcohol, nickel.*

Development of industry is accompanied by the emergence of number new environmental problems. So, one of them is the pollution of water bodies with industrial wastewater that contain toxic metals. One of the main sources of pollution of surface waters by heavy metals is wastewater from galvanic production, as well as wastewater from enrichment plants. Heavy metals are belonged to the most biologically unsafe environmental pollutants. The rate of heavy metal in drinking water, namely nickel, is not more than 0.1 mg / dm^3. Heavy metals when released into the water with sewage disrupt the course of natural processes and reduce the quality of natural waters.

Another problem is the loss of valuable components as a result of wastewater treatment. To remove heavy metal ions from the wastewater of galvanic production, reagent purification methods are used mainly, the main disadvantage of which is the irrevocable loss of valuable components and the need to dispose of a large amount of wet sludge. A promising method is solvent sublation, as a method of separation and concentration, finds its application in the purification of wastewater from organic and inorganic impurities in dissolved form and in the form of insoluble in water compounds, and in analytical chemistry as a method of quantitative determination of metal traces and surface-active substances [1, p. 3–23]. By solvent sublation is intended such a flotation process in which the floated substance (sublat) is concentrated in a thin layer of organic water-immiscible liquid on the surface of the aqueous phase. The following advantages of solvent sublation should be noted:

- the ability to work with large volumes of water, the concentration of which can easily exceed the ratio of 100:1;
- the active substance is carried away by gas bubbles and enters the upper layer of the hydrophobic liquid without mixing the phases. Thus, the separation process provides a selectivity potentially greater than other flotation processes;
- an equilibrium process of substance transfer that is typical for extraction, in solvent sublation is possible only at the interface, and not in volume, i.e. the solvent sublation is non-equilibrium and is not limited by the distribution constant. Therefore, the extraction of small quantities of elements can theoretically reach 100%;
- in many cases, the fact that the extracted substance is concentrated in the organic phase greatly facilitates it's further treatment.

The process of solvent sublation was carried out in a glass column. It had a length of 50 cm with an initial diameter of 3.5 cm and had 2 access ports. Gas bubbles were generated in Schott filters with porosities of 40 and 100 µm. Compressed air was supplied by the compressor and moved through the filter from the bottom of the flotation unit column. The gas velocity was measured by a flow meter. Isoamyl alcohol was used as an organic solvent; an alcoholic solution of sodium stearate was used as a surfactant. Sodium stearate is a salt of sodium and stearic acid with formula $NaC_{18}H_{35}O_2$ (on Fig.1 is shown structure). The surfactant was chosen because it met the following criteria: it forms a poorly soluble hydrophobic compound sublat with the metal; dissolves in the organic phase; anion-active nature (the metal under study is in solution in cationic form); has hydrophobic properties. In this process, an alcohol solution of sodium stearate was used, since it is known that surfactants form true solutions in alcohols (critical micelle concentration 0.025–0.03 mol/dm³).

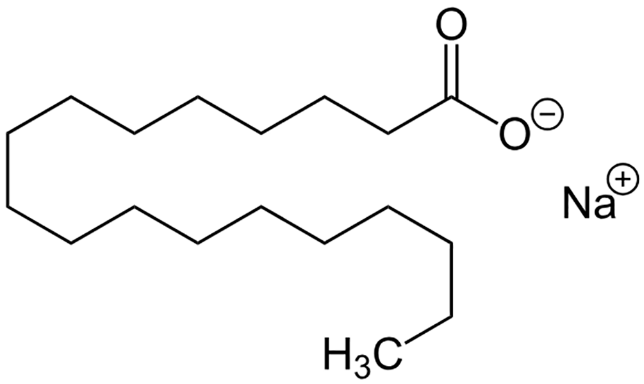

Fig. 1. Structure of sodium stearate [2]

The process was conducted in a such way: a surfactant was added to the model nickel solution with a volume of 200 cm³ to form a metal-surfactant complex; the solution contained 10 mg/dm³ of nickel and placed in a flotation column; 10 cm³ of isoamyl alcohol was added directly to the column; then a timer was started and samples of the aqueous solution were taken for analysis at certain points in time. The pH of the solution was measured by using a Portlab 102 pH meter. The UV-visible spectra of sample solutions were measured using a Portlab 501 scanning spectrophotometer.

Research has established the existence of several major factors affecting the intensity of the process [3, p. 48]. Some of them are due to the characteristics of the water (pH, ionic strength) and organic (type of organic solvent and it's volume) phases, others are the operational factors of the process (temperature, process duration, air flow).

The experiment was conducted under the conditions of the maximum permissible gas flow rate (50 cm³/min).

The concentration of nickel in the aqueous phase was measured every 5 minutes for 30 minutes. As the graph shows (Fig. 2), the optimal duration of the process for Schott filter pores with a diameter of 40 and 100 µm was 15 minutes at 81% and 75.6% nickel removal, respectively.

Another factor affecting the degree of extraction is the pH of the nickel initial solution. As can be seen from the graph (Fig. 3), the highest degree of metal removal for both pore diameters is achieved at pH 10.1.

An important parameter for the process under study is the molar ratio of metal-surfactant. The graph (Fig. 4) shows the results of experiments with the following metal-surfactant ratios: 1:1; 1:1.5; 1:2; 1:2.5; 1:3. The highest degree of removal was 81% with a metal-surfactant ratio of 1: 2 and porosity of 40µm.

In this report was analyzed the problem of water pollution with heavy metals, in particular nickel. Solvent sublation method was proposed, using isoamyl alcohol as an organic solvent and an alcohol solution of sodium stearate as a collector. The following parameters affecting the degree of nickel removal from wastewater were studied in detail: the pH of the initial solution, the porosity of the Schott filters, the time of the flotation, the molar ratio of metal to surfactant. The initial concentration of the nickel model solution is 10 mg/dm³. It was found that the process is best carried out under the following conditions: pH 10.1; the molar ratio of metal-surfactant 1:2; process duration — 15 min; Schott filters porosity — 40, 100 microns; process efficiency is 81%.

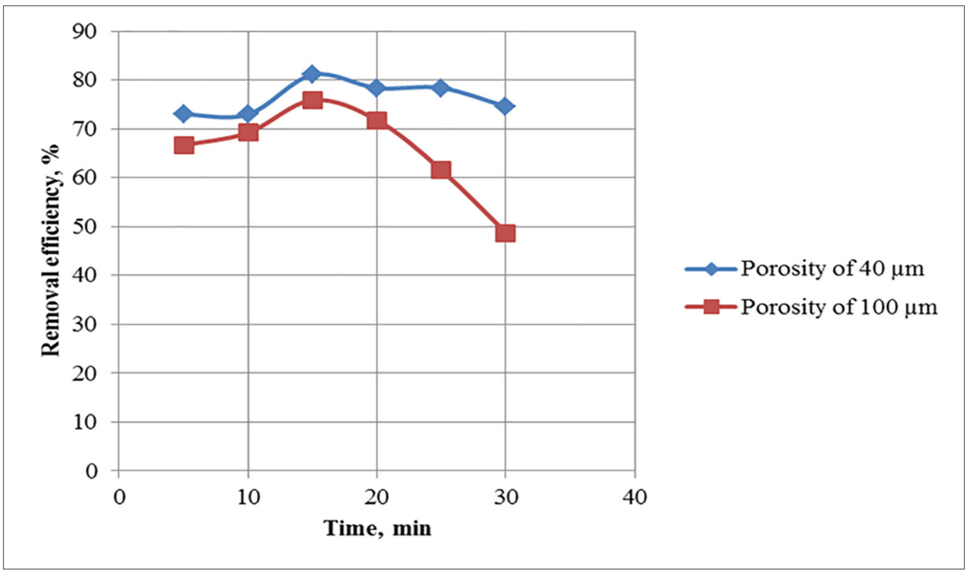

Fig. 2. Dependence of removal efficiency from the time

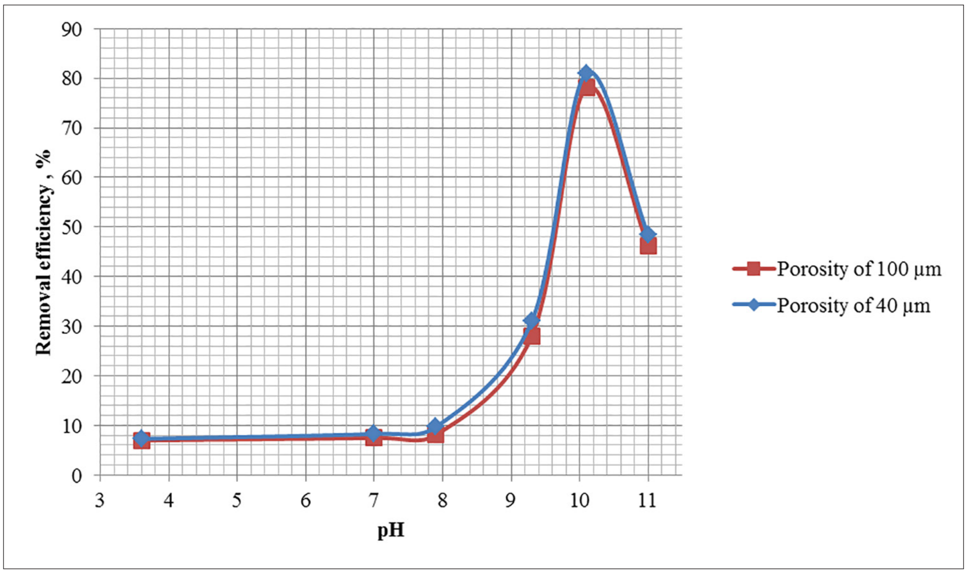

Fig. 3. Dependence of removal efficiency from pH

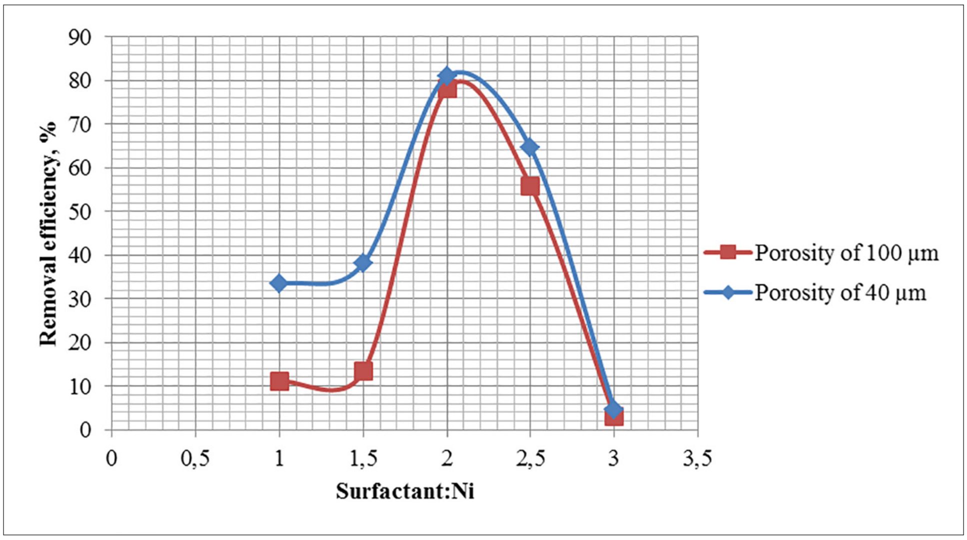

Fig. 4. Dependence of removal efficiency from ratio Surfactant: Ni

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