Chemistry

UDC 622.765:542.61:546.571

Pankratenko Kseniia
Student of the
National Technical University of Ukraine
«Igor Sikorsky Kyiv Polytechnic Institute»

Obushenko Tatiana
Senior Lecturer
National Technical University of Ukraine
«Igor Sikorsky Kyiv Polytechnic Institute»

Tolstopalova Natali
Candidate of Technical Science
Technology National Technical University of Ukraine
«Igor Sikorsky Kyiv Polytechnic Institute»

THE REMOVAL OF NICKEL IONS FROM WASTE WATERS

Summary. *Solvent sublation of Ni^{2+} ions depending on the parameters (extractant, surfactant, pH, molar ratio of metal:surfactant, time, initial concentration) was researched.*

Key words: *solvent sublation, nickel, sulfanol, isoamyl alcohol.*

Galvanic production is an integral part of almost every enterprise of mechanical engineering, metalworking, metallurgy, electronics, etc. In this case, galvanic production is one of the most dangerous sources of environmental pollution by impurities of heavy metals, inorganic acids and alkalis, surfactants and other highly toxic compounds.

Wastewater of galvanic production includes diluted drains (washing waters) and concentrated solutions (washing, degreasing, pickling, electrolytes). As a rule, they are subject to mixing and subsequent joint processing.

When choose a scheme and method of purification of galvanoscopes is taken into account [1, p. 134]:

- the initial composition of wastewater and spent working solutions, which are sent for recycling;
- regulatory requirements for the quality of purified water;
- the level of reconstruction of existing treatment facilities or the construction of new cleaning systems;
- operating mode of treatment facilities (continuous or periodic);
- financial condition of the enterprise.

Due to the large variety of heavy metals that are toxic and stringent in terms of their MPC in purified water, there is a need to improve existing methods of wastewater treatment of galvanic plants (as they have a number of disadvantages).

It is necessary to search methods, which would allow to clear drains to the norms of MPC, and at the same time, to carry out regeneration of valuable components. Such method is solvent sublation, which is a combination of ion flotation and extraction technologies. Therefore scientists are actively engaged in the study and research of this process, as evidenced by numerous articles and scientific papers.

The technology of solvent sublation was first proposed by F. Siebba in 1961. The process of ion extraction was proposed to be carried out in the presence of collectors (surfactants). In order to carry out the solvent sublation, bubbles of gas, extractor and collector were introduced into the initial solution. The latter were selected in such a way that the charge was opposite to the charge of the ion that is being removed. The parameters (pH, extractant, surfactant, air flow rate, temperature, etc.) were selected in such a way that the process of

transferring the ion-surfactant complex to the extraction phase took place as efficiently as possible. The separation of the concentrated ion is carried out by different methods depending on the collector [2].

In this work, the possibility of removing nickel ions (II) by solvent sublation was investigated. Sulfanol was used, as a collector, which is a mixture of sodium salts of alkylbenzene sulfonic acids with an alkyl residue. Concentration of the model solution of nickel - 10 mg/dm^3. The optimal conditions of the process, such as the choice of the extractant, the pH of the aqueous phase, the molar ratio of the metal:sulfonate, the time of the process, were determined.

The solvent sublation process was carried out in a glass cylindrical column (at the bottom is the Schott filter) with a diameter of the holes for passing bubbles was 40 μm. The air in the column was compressed by the compressor. Nickel ions were transferred from the aqueous phase with bubbles of gas in the form of a sublate and remained in the organic layer. The process was carried out to a constant residual concentration of nickel ions, which was determined according to the standard methodology [3].

During the experiment, it was found that the best extractant is isoamilic alcohol, which may be explained by the fact that branched alcohols have a better ability to hold the sublates [4]. The comparative characteristic of extractants by degree of exclusion is illustrated in Figure 1. According to the results, the highest degree of extraction in isoamyl alcohol is 69.9%.

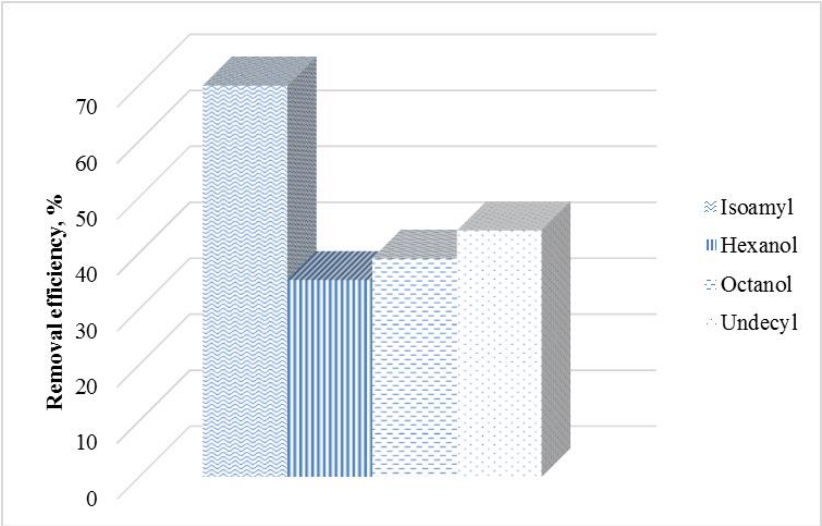

Fig. 1. Comparative characteristic of extractants according to removal efficiency

The influence of the molar ratio of metal: sulfonate on the removal efficiency of nickel (II) ions from the aqueous phase has been studied. Experiments with the following ratios (Me: surfactant) were carried out: 1: 0.5; 1: 1; 1: 1.5; 1: 2; 1: 2.5. Taking into account the results shown in Figure 2, can be concluded that the ratio of Me: surfactant = 1: 2 is optimal, which may be explained by the fact that nickel is a doubly charged cation and needs a doubly charged anionic pair [4].

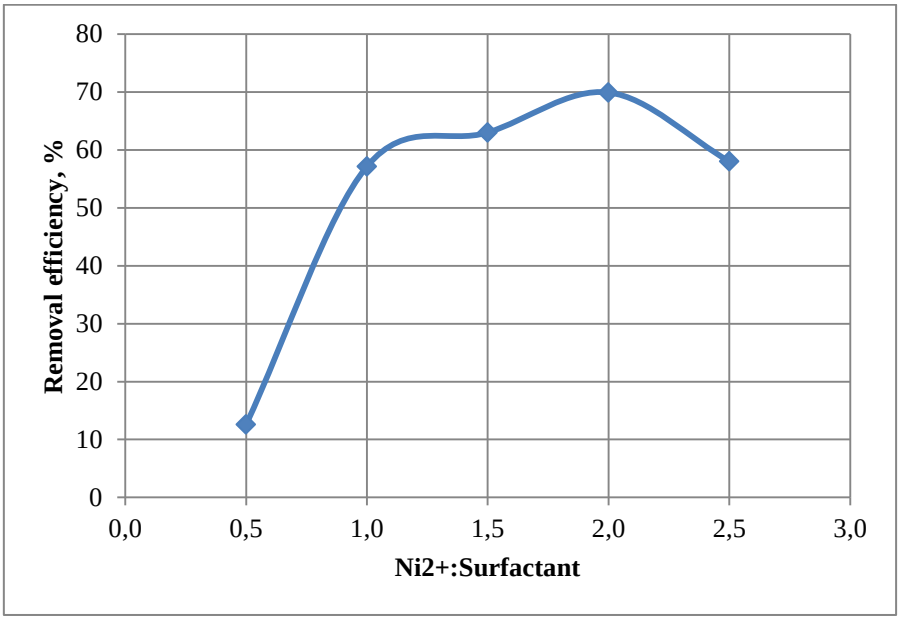

Fig. 2. Dependence of removal efficiency from the molar ratio

An important factor affects the degree of extraction is the pH of the water phase. The hydrogen index was corrected by solutions of sodium hydroxide (0,1 M) and nitric acid (concentrated). The influence of pH on the removal efficiency with the molar ratio of metal: Surfactant = 1: 2 and 1: 1 were studied (Fig.3, Fig.4). For both cases, the highest removal efficiency is at pH 9.5.

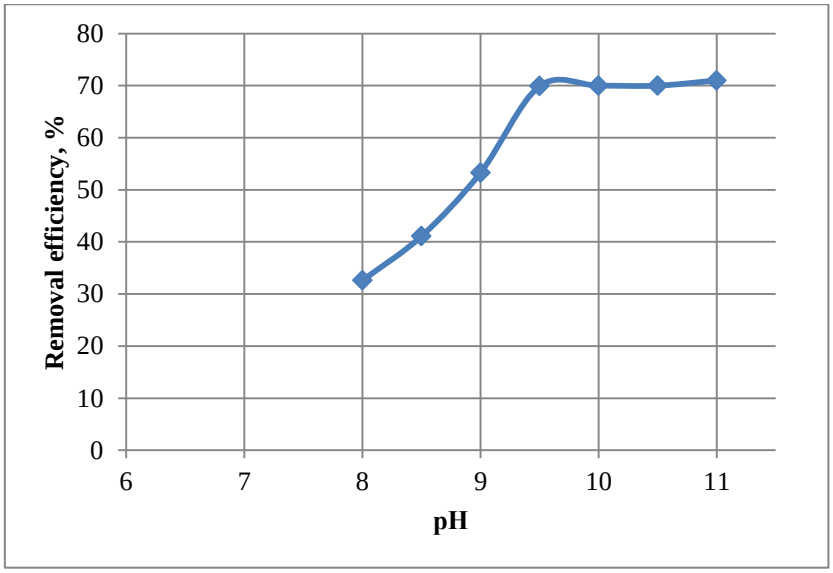

Fig. 3. Dependence of removal efficiency from molar ratio Surfactant:Ni^{2+}=2:1

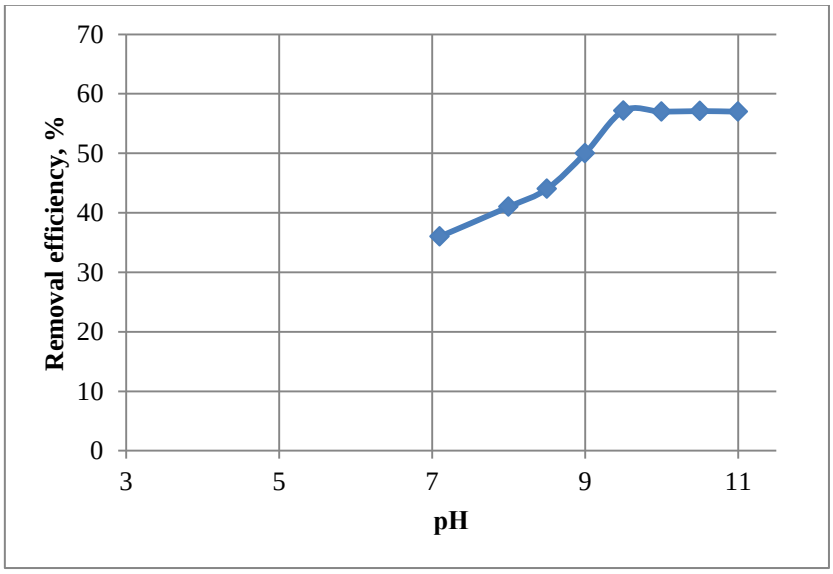

Fig. 4. Dependence of removal efficiency from molar ratio Surfactant: Ni^{2+}=1:1

During the study, the optimal duration of the solvent sublation process was determined. Dependence of removal efficiency from the duration of the

process is illustrated in Figure 5. The highest degree of extraction is achieved at 30 minutes.

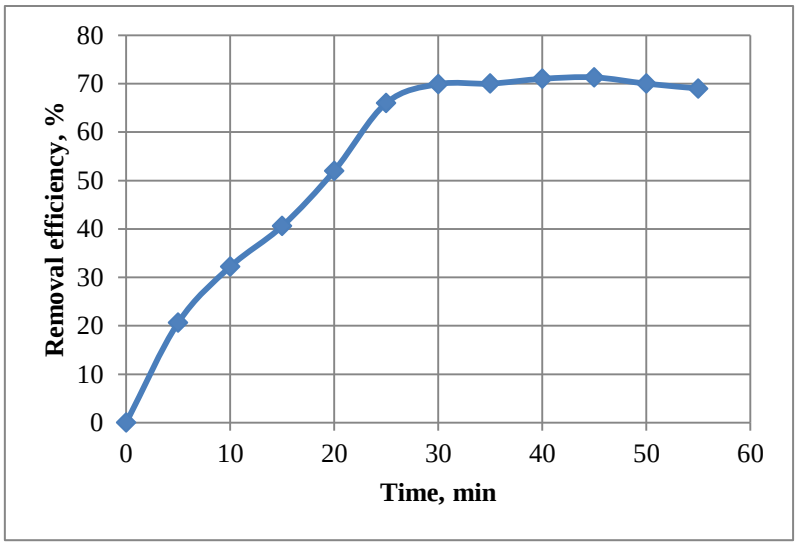

Fig. 5. Dependence of removal efficiency from the time

During the study, the influence of concentration of metal has been studied. As can be seen from Fig. 6, an increase of concentration of the ions of Ni^{2+} provides an increase of removal degree. Thus, with an initial concentration of the ions of Ni^{2+} 10 mg/dm^3, purification is achieved up to 69,9 %, and at a concentration of 150 mg/dm^3 is increased to 88,9 %.

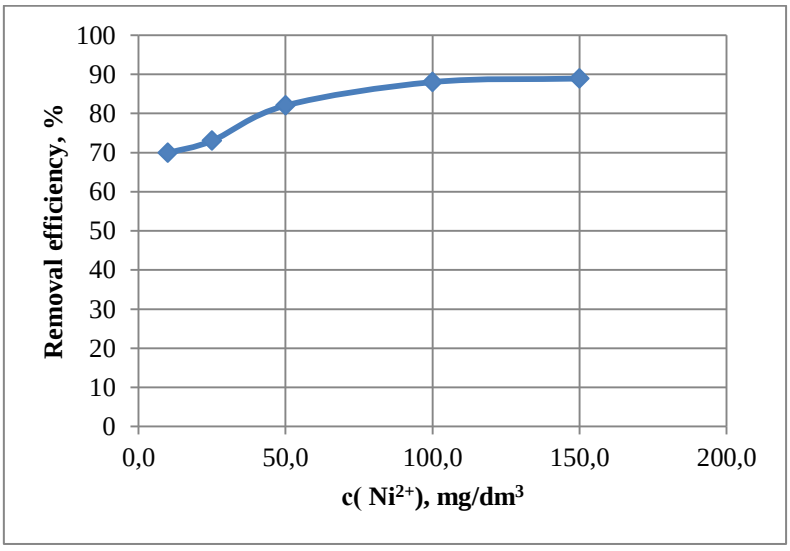

Fig. 6. Dependence of removal efficiency from the concentration

To summarize the results of experimental studies and theoretical substantiation, it can be assumed that optimal conditions for the process of solvent sublation of removal of nickel (II) ions from aqueous solutions at a concentration of 10 mg/dm^3 are the molar ratio of Me:surfactant = 1:2, pH 9.5 and duration process - 30 minutes. As an extractant, isoamyl alcohol is selected. Collector – water solution of sulfanol. Under such conditions, the removal efficiency of nickel ions is 69.9%.

References

1. Запольский А. К., Образцов В. В. Комплексная переработка сточных вод гальванического производства. – К.: Техника, 1989. - 199 с.
2. Себба Ф. Ионная флотация, пер. с англ., М., 1965; Гольман А. М., Ионная флотация, М., 1982.
3. Набиванець, Б. Й. Аналітична хімія природного середовища: Підручник./ Б. Й. Набиванець, В. В. Сухан, Л. В. Калабіна.– К.: Либідь, 1996. – 304 с.
4. Kim, Young-Sang, Yoon-seok Choi, and Won Lee. "Studies on solvent sublation of trace heavy metals by continuous flow system as ternary complexes of 1, 10-phenanthroline and thiocyanate ion." Bulletin of the Korean Chemical Society 24.12 (2003): 1775-1780.
5. Очистка сточных вод от токсических металлов флотоэкстракцией / Т.И. Обушенко, И.М. Астрелин, Н.М. Толстопалова, М.А. Варбанец, Т.А. Кондратенко // Химия и технология воды. – 2008. – Т. 30, № 4. – С. 429-436.