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Development of Technology for Extraction of Noble Metals from Discharge Solutions of Hydrometallurgy

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ABSTRACT: This article analyzes a new method for extracting precious metals from waste solutions of hydrometallurgy. The factors influencing the process to increase the efficiency of the process are investigated, and schemes of a modernized sorption column are developed. As well as created and justified effective sorption leaching regimes.

KEY WORDS: noble metals, gold, silver, acid, thiourea, radionuclide, tailings, iodide, hydrate, hydrogen bromide.

I. INTRODUCTION

Due to the low content of gold and platinum metals in processed products and the high expenditures of energy and materials during their extraction, a comprehensive reduction in the losses of these valuable metals is required. Due to the favorable nuclear-physical characteristics of platinum metals, gold, silver and interfering elements, it is possible to conduct studies in sorption and extraction processes.

Using the radionuclides of platinum metals, gold, silver and other elements, it is relatively easy to develop methods for the separation and extraction of small quantities of noble metals from complex technological solutions. In addition, nuclear physical methods, combined with radiochemistry, allow the separation of submicroconcentrations of inorganic elements, including platinum metals, in geological and technological samples.

II. METHODOLOGY

Thus, the problem of developing methods for concentrating small amounts of platinum group metals, gold and silver from complex technological solutions has not yet been completely solved. In this regard, the relevance of the formulation and solution of these issues is obvious. The aim of the study was to develop simple, selective and reliable methods for the extraction of platinum metals, gold and silver (using their radionuclides) from waste technological solutions with anion exchangers: AM-2B, ChFO, AN-82-14G, VP14KR, conducting integrated tests in hydrometallurgy and implementation of the results, as well as the development of neutron activation methods for the determination of platinum, palladium in waste technological solutions of MMC.

For the first time, the foundations of sorption and extraction methods for the extraction of precious metals from multicomponent technological solutions have been developed. The work includes a number of new basic technological schemes, including: - adsorption extraction of platinum metals, gold and silver by anion exchangers AM-2B and ChFO in iodide forms; - for the first time it was shown using labeled iodine (^{131}I) that the counterion of iodine is not exchanged for metal anions, but forms complex compounds with them in the ionite phase; - a new method has been developed for the extraction of thiourea complex compounds of gold and silver from acid thiourea effluent solutions of hydrometallurgy with anion exchange resin AM-2B in iodide form; - a new technique for sorption and desorption of gold from solutions of the tailings of hydrometallurgy with changing the pH of the initial solution with anion exchange resin AM-2B in hydrate form has been developed; - the possibility of sorption extraction of precious metals and from alkaline solutions with anion exchange resin AM-2B in hydrate form and its desorption is shown.

Using the developed schemes for the separation and extraction of small amounts (0.1 mg / L) of noble metals from a mixture of solutions: thiourea, acid, and base metals with anion exchange resins AM-2B in iodide forms, the following series of selectivity of ion exchangers for noble metals was obtained: $\text{Au} > \text{Pt} > \text{Pd} > \text{Os} > \text{Ru} > \text{Ag} > \text{Ir}$ and, accordingly, the series of anion exchange capacities for these metals was, mg / g: $8 > 7 > 6 > 5 > 4 > 3 > 2$. Using the radionuclide technique, all the most important technological chains (more than 20 points) of gold hydrometallurgy were studied to



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detect the accumulation of platinum metals. It was found that palladium accumulates in the electrolyte, where gold is precipitated. Palladium is currently mined from this point.

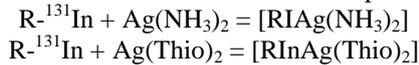
Developed by nuclear-physical method to extract gold and silver by the anion exchanger AM-2B iodides in the form of acidic waste solutions verified (tested) at MMC. The method recommended for implementation. Development of methods for extraction of ions of platinum metals with the use of radio-nuclides anion exchange resin of AM-2B IN a phase of almost all ion-exchange resins under certain conditions there can be different types of interactions: ion exchange, formation of complexes with functional groups of ion exchangers, sludge with counter-ions, redox processes and molecular sorption. For example, in the study of sorption of platinum metals macroporous anion exchange resin of AM-2B iodides in the form we have seen that ions of platinum metals (PM) are not exchanged in the phase of anion exchanger by electrostatic attraction. This process can be monitored using radionuclide iodine ^{131}I , even visually (if the amount of PM more than 1 mg/l) for the coloration in the ion exchanger phase. Given the high stability of the complexes Yudenich (PM), staged a series of experiments to study the effect of concentration of acids (HCl, HNO_3 , H_2SO_4), thiourea and ferrous metals (Cu, Ni, Fe) on the sorption of PM. Thus the highest degree of sorption of platinum metals is observed at about 0.1-0.3 molar concentration of acids. Above this concentration the degree of sorption of platinum metals sharply reduced. The introduction of thiourea (1 mg/l) in acid solutions also reduces the degree of sorption of platinum metals. The suppression of sorption of platinum metals in non-ferrous metals is in the following range $\text{Cu} < \text{Ni} < \text{Fe}$. You defined a static exchange capacity of the anion exchanger in the chloride form at ions of platinum metals and it was determined that the anion exchanger AM-2B in chloride, sulfide and iodide forms can be successfully used for the concentration of small (0.2-0.5 mg/l) quantities of PM from complex technological solutions. One of the most important and responsible stages of technology of the platinum metals is their desorption from the resin, the restoration of the sorption properties of the anion exchanger and returning it into circulation. For this purpose tiomochevina used acidic solutions. The results of desorption of PM tiomochevina acidic solutions can be judged not only on the completeness of desorption, but also about the capacity of the ion exchanger on the platinum metals.

Radioactivation determination of platinum and palladium in the solid and liquid process samples with pre-concentration Using radionuclides of platinum and palladium is relatively easy and quick to develop a methodology for the separation and recovery of small quantities of precious metals from complex technological solutions. This paper describes methods of concentrating trace quantities of platinum and palladium from ores and their radioactivation definition. The weight of ore in the amount of 5.0 g was dissolved in a mixture of $3\text{HCl} + \text{HNO}_3$ at heating, fresh portions of "Aqua Regia". The dissolution continues for two to three days. After dissolving, the solution was separated from indissoluble residue and was evaporated to wet salts. Then added 10 mg of tellurium are converted into chlorides, creating a 0.5 M HCl environment and reduced tellurium to the elemental state 50 % -s ' solution of hydrochloric acid hydrazine. The precipitate (tellurium) was filtered and dissolved in Aqua Regia, converted into chlorides, tellurium and gold was removed by treatment of a solution of sodium nitrite (NaNO_2). The filtrate was first passed through a KU-2, then microcolony with the anion exchanger AM-2B in nitrite form at a rate of 10 drops per minute. Similarly prepared samples from liquid samples. Microcolony were irradiated together with standards of Pt and Pd in a flow of $1.8 \cdot 10^{13}$ on natural hair./ cm^2 sec. thermal neutrons and measured the activity in 10-12 hours after exposure. The whole analysis was tested using radionuclides of platinum-197, palladium-109. Radioactivation by the developed method was studied all important technological chain (20 points) the hydrometallurgy of gold. It should be noted that a significant amount of palladium accumulated in spent gold electrolyte.

The extraction of gold and silver from waste solutions by the use of AM-2B IN hydrometallurgy gold, in the process of regeneration of saturated ion exchanger from zinc, Nickel, and cyanide and also in the process of washing the resin from thiourea, lost a noticeable amount of gold, more than 1 mg/l of silver and more than 5 mg/L. the Extraction of these valuable metals from waste solutions still remains one of the most urgent tasks. The experiments to determine the optimum conditions sorption of Au and Ag from acidic solutions (HCl, HBr, H_2SO_4 , HClO_4). Concentrations from 0.1 to 10 M salt, bromatological and sulphuric acids does not affect the sorption of gold. Nitric, perchloric acid in the range of 0.1-0.5 M does not reduce the degree of sorption of gold (not below 50-60 %), and the degree of sorption of silver does not change significantly. This indicates that silver with the functional group of the resin forms a coordination compound, and therefore the anions of perchloric acid does not affect the capacity of the ion exchanger by silver. As already mentioned, waste solutions, along with the remains contain acids and thiourea, so without studying the influence of thiourea on the sorption of gold and silver it is impossible to determine or to chart the recovery of precious metals from waste acidic tiomochevina solutions. It is known that the counterions of the resin play an important role in the extraction of metal ions from solutions. In this regard, with the aim of increasing the selectivity of the ion exchanger AM-2B against ions of gold and silver, the ion exchanger was transferred into various forms: chlorine,



iodine, sulfate and hydrate forms. It's been experimentally proven that the capacity of the ion exchanger in the form of iodides in relation to ions of gold and silver, as sour and acidic ammonium thiochevina solutions three times higher than other forms of the ion exchanger. This is due to the formation of complexes of the tees as follows:



where R-131 In - n - the number of radioactive iodine - 131 in the anion exchanger phase. Therefore, despite the cationic forms, nitrate, ammonium and thiochevina silver compound quantitatively adsorbed by anion exchange resin in iodide form. The ion exchanger AM-2B in an amount of 2 g dissolved in iodide form containing iodine-131 was placed in a column and missed thiochevina the solutions of different concentrations (g/l): 50, 60, 70, 80, 90, measured the activity of iodine. In all cases, radioactive iodine in the solution was detected. Then passed solution of sulfuric acid in different concentrations g/l: 5; 10; 20; 30. In this case, also the invisible influence of the concentration of the acid strength of iodine sitting on the anion exchange resin. However, the transmission through the ion exchanger mixture of thiourea and sulfuric acid having a concentration of 80 g/l and 20 g/l, respectively, affects the bond strength of iodine. If this solution be heated to 600 C and flowing through the ion exchanger, the loss of iodine reach 60-70 %. The same solution was passed through an ion exchanger containing a non-radioactive iodine labeled with silver-110, in this case silver fully desorbitados. Similar experiments were performed with gold ions. On the basis of experimental data compiled technological scheme to extract gold and silver from waste acidic thiochevina solutions. Under this scheme, carried out semi-industrial tests. In a production environment, we have managed to contact in static conditions 250 m³ of waste thiochevina acidic solution with 2.5 m³ of ion exchanger in iodide form. The capacity of the anion exchange resin in the silver and gold was 3 mg/l and 0.65 mg/l, respectively. After desorption, the total volume of the eluate was 6 m³ with an average silver content 200 mg/l of gold, 45 mg/l. Of eluate the gold and the silver is precipitated by sodium hydroxide. The total number of hydrates amounted to 36 kg. the analysis of the hydrate gave the following results (dry residue) in mg/g: silver-25; gold-6,9; iron-67,5; Nickel-14,12; cu-0,2; cobalt and 0.12; zinc-4. The technological scheme to extract gold and silver from waste thiochevina acidic solutions by the use of the anion exchanger AM-2B in iodides the form recommended for implementation. Sorption recovery of gold and precious metals and precipitation from waste solutions hydrometallurgy, anion exchange resin of AM-2B Main sources of obtaining of noble metals and are the waste sulfuric acid production and the precipitate (sludge) generated in the purification of copper by electrolysis. In some gold ores containing precious metals appear in the process of cyanidation of ores, noble metals goes into solution in the form SeO₃, which together with the gold is sorbed by the anion exchanger AM-2B, and in the process of desorption of gold thiochevina acidic solution of precious metals is desorbed and restored to the basic state and held on the surface of the anion exchanger:

H₂SO₄



In the course of washing the resin from thiourea and alkaline treatment of the anion exchanger in the tails emitted a significant amount of solution containing precious metals and precious metals . Leaching of precious metals and gold from sediment carried in the iron Pachuca volume of 20 l with steam heat. In this set-up leaching of precious metals and gold spent depending on the time of heating of the pulp, the content of sodium sulfite, the influence of air mixing. Based on these data, we can say that with increasing concentration of sodium sulfite up to 80-100 g/l videochiamate gold and precious metals and increases above this concentration videochiamate gold and precious metals was not observed. It is established that the leaching of noble metals and occurs at the 2-hour heating of the pulp and at a content of 25 g of sodium sulfite per 1 g of elemental noble metals and. The leaching does not exceed 70% of the original amount of precious metals and re-leaching with the addition of Na₂SO₃ increases the content of noble metals while in solution. The study of sorption leaching of precious metals and gold from pulps by anion exchange resin of AM-2B Checked sobiraemosti 75Se and 198Au on the anion exchanger AM-2B, depending on the concentration of NaOH and Na₂SO₃ with radio-nuclides. Experiments showed that the concentration of NaOH does not affect the sorption of Se and Au, and with increasing concentration of Na₂SO₃ sorption of noble metals and decrease, and at a concentration of 200 g/l sorption of Se almost ceases, while the degree of sorption of gold ions SeO₃ -- are not affected, which allows to separate precious metals from gold. Desorption of precious metals and gold from the resin. After sorption of Au and Se from the pulps, the pulp is passed through a mesh and washed 5-6 times with hot water, then placed in a desorption column, separated on 1 g of the ion exchanger, and determine the content of precious metals and gold in resin, that is, the capacity of the ion exchanger. After that, the resin is placed in a column and a solution of sodium sulfite with a concentration of 200 g/l, heated to 70-800 C and is passed through the ion exchanger at a rate of 10 ml/min deformiruemogo Ratio of solution to resin was 4:1. This is a quantitative desorption of noble metals, and the gold is

desorbed sulfate tiomochevina solution remains in the resin. Next determined the capacity of the resin for precious metals, which amounted to 25 mg/g. furthermore, we investigated the possibility of co-deposition of noble metals and commodity regenerate with the hydroxide of gold and silver. For this commodity in the regenerate were added different amounts of precious metals and then precious metals are precipitated with alkali at pH 10. The precipitate was filtered. In the filtrate was determined by precious metals . It is established that with increasing concentration of noble metal in solution, its coprecipitation with the hydrates of noble metals increases.

III. CONCLUSION

Thus, noble metal hydrates are carriers of noble metals a, and when melting their precipitate of noble metals will evaporate in the form of SeO₂, for which it is necessary to install filters that absorb oxides of noble metals. The obtained laboratory results at the mining and metallurgical complex allowed creating a scheme for the extraction of precious metals and gold from the mining and metallurgical wastes. According to the proposed scheme, more than 20 g of rough precious metals were isolated.

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