

Materials of the Conferences

SORPTION OF GOLD IONS BY MODIFIED SHUNGITE

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Sorption procedures utilizing expensive anion-exchanger AM-2B have been widely applying in gold mining enterprises of Kazakhstan and CIS countries. There is a problem for utilization of new cheap sorbents at growing gold extraction. As results of the investigation a series of such anion-exchangers based a modified epoxy- and amino-containing schungites accessible in our region have been prepared [1-3]. The study carried out for recovery of silver and platinum ions by amined natural sorbents showed that surface-modified schungites recover noble metals ions for short duration time [2, 3].

The aim of the research is to study properties of amined schungite in relation to gold ions from model solution and their determination.

Schungite concentrate containing 80 % carbon was prepared by demineralization of the natural schungite (20 % carbon) with following granulation [4]. Amined schungite was obtained by polymerization of 2-methyl-5-vinylpyridine in sorbent granules, where nitrogen content by elemental analysis and polymer weight gain constituted 27.16 % and 2.51 %, respectively. Gold ions sorption was carried out under static conditions. A degree of gold ions recovery was determined as difference between the initial concentration of metal ions and residual one after sorption.

Study of sorption characteristics of the new sorbent based on amined schungite and containing polyvinylpyridines showed that the presence of functional groups with donor nitrogen atom leads to its ability to recover noble metals ions.

In order to study optimal conditions for gold ions recovery utilizing amined schungite the kinetics of the process at ambient temperature was investigated. Dependence of a degree of recovery of gold ions by both the

initial and modified schungite versus process duration showed that nature of surfacial groups of the samples causes discrepancies in their kinetic characteristics. Equilibrium of metal ion distribution between the sorbent and solution under such conditions achieved within 4 hours with 80 % of gold ions for schungite, however the amined sample reached these results within 2 hours.

High kinetic characteristics of the last sample is mainly due to the presence of chemically active groups and selectivity in relation to noble metal ions. It should be noticed that half saturation time for the natural sorbent is about 2 hours, and 15 minutes for the modified sample. It was found out that high degree of gold ions recovery (99.3 %) from chloride solutions at concentration 10 mg/l achieved using the amined schungite. Thus its sorption activity could emphasize its profitable for extraction of metal ions microadmixture.

Acidity could effect on ratio of different forms of gold complex ions in solution. As it is known [5], ions exist as following anions: AuCl_4^- , AuCl_3OH^- , $\text{AuCl}_2\text{OH}_2^-$ etc. in chloride solutions. They could interact with functional groups of sorbent. Hydrolysis of Au(III) occurs at $\text{pH} > 3$ and content of Au(III) hydroxy chloride complexes decrease, as well as sorption of gold ions decreases. Therefore, sorption behavior was studied at pH within 1 to 3. It was found out that pH from 0.5 to 2 is an optimal acidity of solution. Analysis gold ions recovery degree onto amined schungite and HCl concentration let's talk about extraction completeness and its high efficiency.

Investigation of sorption activity of gold ions in dependence of pH of solution shows that they extracted in solid phase as a result of complex-formation of functional groups (ketonic, pyridine) and acidity of media characterizing a degree of ionization doesn't influence on the process. These results testify to the fact that in this case nitrogen atom of heterocycle participates in the sorption.

This fact makes ion-exchange mechanism be unlikely. Incidentally recovery of metal ions occurs due to complex-formation with electron-donor groups of pyridine as macromolecular

ligand. Therefore, gold ions are recovered predominantly on the investigated modified sorbent due to coordination of pyridine ring by nitrogen atom and by surface active sites of the natural sorbent. A study of possibility of regeneration of aminated schungite with the aim of its multiple application has been showed that sorbed gold ions can be desorbed by hydrochloric acid solution of thiocarbamide. It has been established that Au (III) is desorbed quantitatively by 7 % solution of thiocarbamide in 1M solution of HCl by 90 % at the room temperature. An increase of volume of eluent 2-3 times up results in a complete desorption of gold ions by 96-100 %.

Pyridine nitrogen forms complex compounds and displays selectivity in relation to transient elements. Hence kinetics of the process in the presence of copper, cobalt and nickel ions (concentration of each metal constitutes 10 mg/l) has been studied to determine a possibility of recovery of gold ions on the aminated schungite. Analysis of sorption curves shows that selectivity of the investigated sorbent alters in the range $Au > Cu > Co > Ni$. In this case we have succeeded in extracting completely Au(III). A degree of recovery of

copper, cobalt and nickel ions constitutes 87, 56, 38 %, respectively. A saturation of the sorbent by metals ions occurs for 4-5 hours.

It was shown [1] that gold ions can be extracted quantitatively from transient elements from 0.5 M HCl solutions. Under established conditions a difference in the degree and the rate of their sorption on the investigated sorbent allows one to determine Au(III) in the presence of 10- and 50-fold quantities of Cu^{2+} , Co^{2+} , Ni^{2+} (Table). A selectivity of the investigated sorbent in relation to noble metal ions is due to the presence of symmetry-like π -orbitals in both the metal and pyridine ring that permit to suppose a formation of additional π -bond. This fact effects positively on the recovery and allows one to remove a main mass of accompanying elements and to recover gold ions in the presence of the admixture metals.

Thus it has been established on the basis of conducted investigations that schungite concentrate containing polyvinylpyridine in the granules is an effective sorbent of gold ions from hydrochloric acid solutions. Its high selectivity allows one to solve a task of concentration and extraction of gold ions even upon an excess of admixture elements.

Table. Sorption of gold ions by aminated schungite in the presence of accompanying metals ($C_{Au}=10$ mg/l, $m_{sorbent}=0.5$ g, $V_{el}=50$ ml, 0.5 M HCl)

Element (E)	Relation E: Au	R(Au), %
Cu (II)	10	98.9 ± 1.1
	50	98.8 ± 1.2
Co (II)	10	98.9 ± 1.3
	50	98.9 ± 1.2
Ni (II)	10	98.9 ± 1.4
	50	98.9 ± 1.2

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