Polymeric metal sorbents based on polyvinyl alcohol and phosphazene-containing extractant

Yudaev Pavel

The relevance of the research topic. Polymers are increasingly used in the processes of sorption of heavy metals, lanthanides and actinides. Unlike inorganic sorbents, their polymer analogs have a higher sorption capacity.

Liquid organophosphorus extractants, which are often toxic, have acquired the greatest importance in extraction processes. To eliminate this disadvantage, organophosphorus extractants are introduced into the matrix of a biocompatible non-toxic polymer.

At the same time, chelate compounds are used to increase the efficiency of metal sorption. Functional aryloxycyclophosphazenes are promising as such compounds, since they are biocompatible, resistant to hydrolysis in an acidic medium, insoluble in water, and easily undergo chemical modification by introducing various coordination centers into their structure.

To facilitate the separation of the sorbent from the aqueous phase using a permanent magnet, magnetic particles, for example, magnetite nanoparticles, are added to the polymer along with the extractant. Magnetite particles used today have poor dispersibility in the polymer matrix and tend to aggregate due to high surface energy. To solve this problem, a fine powder of carbonyl iron particles was used.

The use of magnetic polymeric sorbents containing polydentate aryloxycyclophosphazene in the processes of sorption of metals from wastewater and soil will solve many problems and make the sorption process more cost-effective and environmentally safe.

The purpose of the work is to develop new magnetic polymeric metal sorbents based on polyvinyl alcohol containing a polydentate organophosphorus extractant in their structure.

Work tasks. To achieve this goal, it was necessary to solve the following tasks:

1) to develop methods for the synthesis of phosphorus-containing polydentate extractants compatible with the polymer matrix, to study their effect on soil microflora;

2) to develop methods for the synthesis of iron particles that are stable in acidic media;

3) to establish the optimal conditions for combining the developed extractants with a polymer matrix and particles of acid-resistant iron;

4) evaluate the magnetic properties of the sorbent, the efficiency and selectivity of the extraction of palladium (II) from hydrochloric acid aqueous solutions of various concentrations using the developed sorbent.

Scientific novelty.

1. Radical copolymerization of triethylene glycol dimethacrylate and linseed oil yielded hydrochloric acid-resistant encapsulated powder of fine carbonyl iron.

2. The addition of diethylphosphite to the azomethine groups of aryloxycyclophosphazene in the presence of *p*-toluenesulfonic acid yielded a previously undescribed aryloxycyclophosphazene with six α-aminophosphonate groups, which can be used in the study of the extraction of metals from soil, since it did not have an inhibitory effect on soil microflora.

3. It has been established that magnetic polymeric sorbents based on acid-resistant carbonyl iron, polyvinyl alcohol and modified with aryloxycyclophosphazene (extractant) have sufficient water absorption (64%) and saturation magnetization (13.75 emu/g) for use in sorption processes;

4. It was revealed that polymeric sorbents containing 12.5 wt. % extractant (relative to the mass of polyvinyl alcohol), selectively extract palladium (II) from a 0.25 molar hydrochloric acid aqueous solution with an efficiency of 57% in one cycle and 89% in two cycles of sorption-desorption in the presence of copper (II).

Practical significance of the results.

The developed magnetic polymer sorbents containing organophosphorus polydentate extractants are recommended for highly efficient, selective, and

environmentally safe extraction of palladium (II) from hydrochloric acid solutions formed during the leaching of automotive catalysts or electronic scrap.

Defense provisions.

1. Approaches to the production of polymer gels based on polyvinyl alcohol, characteristics of these gels.

2. Preparation and structure of single crystals of aryloxycyclophosphazene containing six azomethine groups.

3. Synthesis of aryloxycyclophosphazene containing six aminophosphonate groups.

4. Obtaining particles of carbonyl iron, stable in acidic environments.

5. Establishment of optimal conditions for obtaining a magnetic polymeric sorbent based on polyvinyl alcohol, aryloxycyclophosphazene, and acid-resistant carbonyl iron.

6. Evaluation of the magnetic and sorption properties of a magnetic polymeric sorbent modified with aryloxycyclophosphazene.