ANNOTATION

for the dissertation work on the topic «The experimental bases of technology extraction of prozeodymium and neodymium in hydrometallurgy» for the degree of Doctor of Philosophy (PhD) in the specialty 8D05301 - "Chemistry" by Malimbayeva Zamira Bakytzhankyzy

Research topic: «The experimental bases of technology extraction of prozeodymium and neodymium in hydrometallurgy»

The purpose of the study is to:

Creation of a selective interpolymer system for neodymium and praseodymium ions; determination of optimal conditions for the sorption of each of the listed rare earth metal ions.

Research objectives:

1. Study of the electrochemical state of industrial ion exchangers and hydrogels (PAA, PMAA, P4VP, KU-2-8, AV-17-8, Amberlite IR120, Lewatit CNP LF). Creation of interpolymer systems PAA-P4VP, PMAA-P4VP, KU-2-8-AV-17-8, Amberlite IR120-AV-17-8, Lewatit CNP-AV-17-8 in various molar ratios (X:Y).
2. Study of the interaction features of the created interpolymer systems PAA-P4VP, PMAA-P4VP, KU-2-8-AV-17-8, Amberlite IR120-AV-17-8, Lewatit CNP-AV-17-8 in an aqueous environment;
3. Study of the degree of binding of polymer chains and the effective dynamic capacity of interpolymer systems in relation to the specified metal ions;
4. Determination of optimal conditions for the separation of ions of the specified metals from mixed solutions using interpolymer systems;
5. Study of distribution and separation coefficients of metal ions in individual polymer hydrogels and ion exchangers.

Research methods:

theoretical: the distribution of praseodymium and neodymium metals in nature, their use and methods of isolating these metals from various minerals.

empirical: conductometry, gravimetry, photocolorimetry, inductively coupled plasma atomic emission spectroscopy, scanning electron microscope, IR spectroscopy, thermogravimetry.

The main provisions (proven scientific hypotheses and other conclusions that are new knowledge) submitted for defense

A change in the initial state of one of the components in the interpolymer system leads to a change in the electrochemical properties of ion exchangers and interpolymer systems. It has been proven that when studying the physicochemical and sorption properties of ion exchangers in interpolymer systems, it is necessary to take into account the initial state of the components. The degree of modification of the functional groups of ion exchangers in IP systems during their mutual activation was determined by potentiometric titration: The degree of modification of the Amberlite IR120 ion exchange resin was 20%, and the degree of modification of the AV-17-8 ion exchange resin was 60%.

2. At a certain ratio of acidic and basic ion exchangers, a significant increase in

the sorption of metal ions was observed compared to the original ion exchangers. Intensive sorption of praseodymium ions in the ratio PAA-P4VP=3:3 after 48 hours of interaction, the initial concentration decreases to 6.4 mg/l, and for PAA to 35.2 mg/l and for P4VP to 46.8 mg/l. Intensive sorption of neodymium ions is observed after 48 hours of interaction, the initial concentration of neodymium decreases in the ratio Amberlite IR120-AV-17-8=5:1 to 55.6 mg/l, and for Amberlite IR120 - to 61.59 mg/l, for AV-17-8 to 77.98 mg/l.

3. It was found that the overall degree of polymer chain binding by neodymium and praseodymium ions in interpolymer systems has the greatest value at the following ratio of hydrogel and ion exchanger: for the neodymium ion of the interpolymer system Amberlite IR120-AV-17-8=5:1 for the 3.23%, for individual cation exchangers it was 2.89%, for individual anion exchangers it was 1.80%; for the praseodymium ion of the interpolymer system PAA-P4VP=3:3 it was 3.5% for the pair, 1.75% for the individual cation exchanger and 1.45% for the individual anion exchanger.

4. The effective dynamic capacity of individual polymer hydrogels and ion exchangers with respect to the specified ions in the polymer was studied: after 48 hours of interaction, the effective dynamic capacity with respect to neodymium ions was 3.15 mmol/mg for Amberlite IR120-AV-17-8 in a ratio of 5:1, and for praseodymium ions it was 5.54 mmol/mg for the PAA-P4VP interpolymer system in a ratio of 3:3.

5. A method for optimal separation of Pr (III) and Nd (III) ions using interpolymer systems based on hydrogels and ion exchangers with different properties has been determined. Distribution coefficients and degrees of separation of metal ions in individual polymer ion exchangers have been calculated: it has been proven that distribution coefficients of neodymium (III) and praseodymium (III) ions in the PAA-P4VP interpolymer system show high values at the interpolymer system ratios of 6:0, 5:1. In the 6:0 pair, it is 4.1832 ml/mg for neodymium ions and 9.5562 ml/mg for praseodymium ions. In the 5:1 pair, it is 2.8755 ml/mg for neodymium ions and 7.2647 ml/mg for praseodymium ions. The distribution coefficient calculated for 1 mol of polymer shows a high value in the 1:5 pair. It was found to be 0.6912 ml/mg for neodymium ions and 2.9511 ml/mg for praseodymium ions.

6. The possibility of separating neodymium and praseodymium ions from mixed solutions using interpolymer systems consisting of two industrial sorbents - KU-2-8 (Na^+) and AV-17-8 (Cl^-) in different molar ratios in two different modes was studied. In the dynamic mode, sorption at ratios of 4:2 and 3:3 did not lead to any selectivity. However, a high degree of sorption of both ions was observed: 99.36% for the Pr^{3+} ion, 95.67% for the Nd^{3+} ion in a ratio of 4:2 and 81.33% for the Pr^{3+} ion, 79% for the Nd^{3+} ion in a ratio of 3:3. In the static mode, the degree of sorption of both metals was significantly lower than in the dynamic mode: 19.33% for the Pr^{3+} ion and 24% for the Nd^{3+} ion in a ratio of 4:2. However, it was shown that neodymium is sorbed 24.16% better than praseodymium in the 4:2 system, and 39.83% better in the 3:3 system.

Justification of the novelty and significance of the results obtained and their compliance with the directions of scientific development or government programs:

1. For the first time, based on industrial ion exchangers and hydrogels, interpolymer systems PAA-P4VP, PMAA-P4VP, KU-2-8-AV-17-8, Amberlite IR120-

AV-17-8, Lewatit CNP LF-AV-17-8 were created and the electrochemical properties of the obtained interpolymer systems were studied.

2. For the first time, the influence of the conditions of mutual activation of the created IP systems on the high degree of sorption was studied.

3. The features of separation of neodymium and praseodymium ions from aqueous solutions using mutually activated IP systems were studied and new results were obtained.

4. The selective separation of neodymium ions from praseodymium ions from mixed solutions was studied using different molar ratios of polymers with different functional groups, and the distribution and separation coefficients were calculated.

The study was carried out in the laboratory of synthesis and physicochemistry of polymers at JSC "Institute of Chemical Sciences named after A.B. Bekturov" and on the basis of the engineering laboratory "Methods of physical and chemical research" of Karaganda University named after academician E.A. Buketov within the framework of state grant funding under the programs "Development of a technology for the periodic separation of rare earth metal ions from industrial hydrometallurgical solutions" (AP05131451, 2018-2020) and "Development of fundamentally new methods for obtaining rare metal ions based on the effect of long-range interaction of functional polymers and molecular imprinting" (AP08856668, 2020-2022).

Description of the doctoral student's contribution to the preparation of each publication:

The main results of the dissertation research were published in 12 publications, including: 2 articles in international scientific journals included in the scientometric database Scopus *(Chemistry & chemical technology, percentile 33 and Polymers, percentile 76)*:

1. Anomalous sorption of neodymium and praseodymium ions by intergel system polyacrylic acid hydrogel – poly-4-vinylpyridine hydrogel // Chem. Chem. Technol. -2022. -Vol. 16, No. 1, -P. 7–14 (Malimbayeva Z.B. 65%, co-authors: Dzhumadilov T., Kondaurov R., Imangazy A., Himersen H.)

2. Features of Selective Sorption of Neodymium and Praseodymium Ions by Interpolymer Systems Based on Industrial Sorbents KU-2-8 and AV-17-8 // Polymers. - 2025. - Vol. 17, №4. – P. 440 (Malimbayeva Z.B. 65%, co-authors: Dzhumadilov T., Kabzhalelov K., Korganbayeva Zh.)

5 articles published in publications recommended by the Committee for quality assurance in the field of Science and higher education of the MSHE of the Republic of Kazakhstan:

1. Impact of Neodymium and Scandium Ionic Radii on Sorption Dynamics of Amberlite IR120 and AV-17-8 Remote Interaction // Materials. - 2021. - 14, 5402. (Malimbayeva Z.B. 65%, co-authors: Dzhumadilov T., Totkhuskyzy B., Kondaurov R., Imangazy A., Himersen H., Grazilyavichus J.)

2. Особенности взаимной активации интергелевой системы, состоящей из гидрогелей катионита КУ-2-8 и анионита АВ-17-8 // Chemical journal of Kazakhstan. - 2020. No. 3 (71). 116-212 B. (Malimbayeva Z.B. 80%, co-authors: Dzhumadilov T.K., Saparbekova I.S., Suberlyak O.V.)

3. Особенности извлечения неодима интергелевой системой на основе гидрогелей полиметакриловой кислоты и поли-4-винилпиридина // Chemical Journal of Kazakhstan. - 2020. No. 1 (69). – P. 54-61. (Malimbayeva Z.B. 70%, co-authors: Dzhumadilov T.K., Saparbekova I.S., Kondaurov R.G., Imangazy A.M., Suberlyak O.V.)

4. Specific features of praseodymium extraction by intergel system based on polyacrylic acid and poly-4-vinylpyridine hydrogels // Bulletin of the University of Karaganda – Chemistry 103(3). –P. 53-59. (Malimbayeva Z.B. 70%, co-authors: Dzhumadilov T.K., Khimersen H., Saparbekova I.S., Imangazy A.M., Suberlyak O.V.)

5. Синтез молекулярно-импринтированных полимеров для сорбции ионов неодима // Chemical journal of Kazakhstan. - 2020. No. 3 (71). - P. 247-254. (Malimbayeva Z.B. 90%, co-authors: Dzhumadilov T.K., Saparbekova I.S., Suberlyak O.V.)

In the materials of international scientific and practical conferences, including the far and near abroad, 5 articles were published:

1. Некоторые особенности дистанционного взаимодействия катионита КУ-2-8 с анионитом АВ-17-8. Proceedings of the X International Birimzhanovsky Congress on Chemistry and Chemical Technology. -2019. October 24-25. -P. 148-149. (Malimbayeva Z.B. 80%, co-authors: Dzhumadilov T.K., Saparbekova I.S.)

2. Some features of the remote interaction of ku 2-8 cation exchanger with ab-17 anion exchanger // СУЧАСНІ ТЕХНОЛОГІЇ ОДЕРЖАННЯ ТА ПЕРЕРОБКИ ПОЛІМЕРНИХ МАТЕРІАЛІВ Львів, 06–08 листопада 2019 р. (Malimbayeva Z.B. 65%, co-authors: Saparbekova I.S., Suberlyak O.V., Yskak L.K., Myrzakhmetova N.O., Dzhumadilov T.K.)

3. Sorption activity of interpolymer systems and molecularly imprinted polymers based on vinyl monomers in relation to rare-earth and transition metal ions // X МІЖНАРОДНА НАУКОВО-ТЕХНІЧНА КОНФЕРЕНЦІЯ «Поступ в нафтогазопереробній та нафтохімічній промисловості» Львів, 18–23 травня 2020 р. (Malimbayeva Z.B. 65%, co-authors: Dzhumadilov T.K., Saparbekova I.S., Suberlyak O.V., Yskak L.K., Imangazi A.M., Myrzakhmetova N.O.)

4. Особенности сорбции ионов неодима и лантана интерполимерной системой на основе гидрогелей полиметакриловой кислоты и поли-4-винилпиридина // «GLOBAL SCIENCE AND INNOVATIONS 2020: CENTRAL ASIA» No. 6(11). December 2020, Astana. SERIES "CHEMICAL SCIENCES" (Malimbayeva Z.B. 65%, co-author: Yskak L.K.)

5. Особенности псевдоматриц синтезированных с различным количеством сшивающего агента // International scientific and practical conference "Modern problems of development of technology of low- and high-molecular compounds and fundamental and applied chemistry in solving industrial and environmental problems", dedicated to the 70th anniversary of the birth of the honored scientist of Kazakhstan, member of the American Chemical Society, academician DZHUMADILOV TALKIBEK KOZHATAYULY (Malimbayeva Z.B. 90%, co-authors: I.S. Saparbekova, S.M. Safarmamadzoda)

Structure and scope of work.

The dissertation work consists of standard sections: normative references,

notations and abbreviations, introduction, literature review, experimental part, experimental results and their discussion, list of references and appendix.

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