

## ANNOTATION

of the dissertation of Usserbayeva Banu Abdrayimovna on the theme "Development of multifunctional adsorbents technology from bentonite clays of South Kazakhstan" proposed for the degree of Doctor of Philosophy (PhD) on the speciality 6D072000 "Chemical technology of inorganic substances"

**The relevance of the topic of the research.** Recently the sorption processes with a large variety of sorption-active substances of inorganic and organic origin with different functional properties are actively used for the solution of environmental problems. The use of any sorbent is always preceded by preparatory work aimed at the most efficient use of a particular sorbent in a given technological cycle.

There are industrial reserves of natural aluminosilicates in the territory of Kazakhstan - bentonite, kaolinite, opoka and other types of clays and clay formations, which have certain adsorption and catalytic properties. Due to polymineralism and high mineralization, they are qualitatively inferior to activated and synthetic aluminosilicates. Therefore, in order to expand the field of application of natural aluminosilicates in adsorption processes, experiments on their activation are necessary. In this case, the main attention, apparently, should be given to the development of a rational way of activation of natural aluminosilicates.

The physical and chemical properties of bentonites, especially their adsorption and cation-exchange properties, directly depend on the content of the main rock-forming component montmorillonite and its structural features.

Application of a complex of modern mineralogical and analytical methods of bentonite quality evaluation when studying new occurrences and additional studying of the known deposits allows to determine the presence of bentonites and bentonite-like clays, to discover easy-modifiable varieties among low- and medium quality bentonites, to estimate quality and technological properties and finally to forecast the directions of these valuable minerals usage.

**Aim and objectives of the research.** Development of technology for obtaining multifunctional adsorbents from bentonite clays of South Kazakhstan to use them as multifunctional sorbents in the treatment of industrial wastewater contaminated with toxic compounds.

In this regard, the dissertation work provides the conduction of the following research:

- Analytical review of studies of mineral and technological criteria for assessing the quality of bentonite raw materials in Kazakhstan and the difference between bentonite clays in the Southern region;
- study of the structure and the physico-chemical characteristics of natural bentonite and modified sorbents on its basis;
- study of the adsorption capacity of the obtained sorbents in relation to chemical production wastewater;



- studies of the structural and adsorption properties of natural clays and activated bentonites;
- thermodynamic studies of the formation of sorption minerals in the presence of organic compounds;
- mathematical planning of the sorption treatment process of chemical production wastewater;
- kinetic studies of multifunctional sorption actions of bentonites and establishment of the adsorption mechanism of the studied sorbents;
- selection of the optimum technical and technological solution for the development of the technological scheme of production of modified sorbents.
- technical and economic indicators of obtaining multifunctional sorbents from bentonite clays of South Kazakhstan.

**The object of the research work.** Bentonites of South Kazakhstan Kyngrak and Darbazi deposits and refractory clays of the south-eastern horizon of Lenger deposit, oil sludge of PetroKazakhstanOilProducts JSC.

**Research methods.** When carrying out the research work, physico-chemical and physico-mechanical analyses were carried out in dedicated laboratories using modern methods and instruments (spectral analysis, X-ray phase analysis, emission spectrum, quantity determination). X-ray diffraction, infrared spectrometric, microstructural analyses of the investigated samples and processed products were used to determine the features of the phase mineralogical composition. By means of thermodynamic, kinetic studies and by mathematical planning method the physical and chemical regularities of sorbents preparation process and technological parameters of production of high-strength sorbents have been established.

**Relation to the scientific-research work plan.** The topic of the dissertation work is connected with the Kazakhstan 2050 Development Programme with the direction of rational use of natural resources, including water, geology, processing, new materials and technologies, safe products and constructions.

Dissertation work is executed according to the scientific direction of the department "Chemical technology of inorganic substances" of M.Auezov South Kazakhstan University, within the framework of the state budget theme B-16-02-03 in the direction of research on "The development of alternative-innovative technologies of raw materials enrichment and obtaining products of synthesis of inorganic compounds from natural mineral resources and technogenic waste of various industries".

The scientific novelty is defined by the set of new results obtained in the work:

- The technology for obtaining multifunctional adsorbents from bentonite clays of South Kazakhstan for the treatment of water bodies for various purposes has been developed based on the targeted modification of natural bentonite;
- The structural and adsorption properties of natural clays and activated bentonites were investigated;



-- Thermodynamic modelling of working systems  $\text{Al}_2\text{O}_3\text{-}0,5\text{SiO}_2\text{-C}_2\text{H}_6\text{-O}_2$  and  $\text{Al}_2\text{O}_3\text{-}2\text{SiO}_2\text{-C}_2\text{H}_6\text{-O}_2$  and the studies of the formation of sorbent minerals in the presence of hydrocarbon-containing compounds typical to oil sludge composition was carried out for the first time;

- Using mathematical planning methods, the technological parameters of chemical production wastewater sorption treatment were optimised.

- The technological scheme of obtaining multifunctional sorbents on the basis of natural bentonite with the addition of oil sludge was developed.

#### **Main conclusions put to the defence:**

1. Methods for modifying natural bentonite of the Southern region to increase sorption activity in relation to oxygen-containing mineral impurities and organic compounds.

2. Thermodynamic regularities of formation of minerals of montmorillonite composition in the presence of organic compounds and equilibrium distribution of the elements and compounds of the working system during heat treatment.

3. Methods of determination of optimum technological parameters of sorption treatment of wastewater of chemical industries using developed multifunctional, modified sorbents based on natural bentonite of the Southern region of Kazakhstan.

4. Technological scheme of production of multifunctional granular sorbents based on bentonite with the addition of oil refinery waste.

**The practical significance of the work.** The high chemical activity of bentonites allows using methods of chemical modification to directly control the adsorption properties of sorbents on their base. The plasticity and binding ability of clays allow creating multifunctional sorbents combining three methods of water treatment: mechanical, sorption and ion-exchange. The developed sorbents based on local bentonites can be used in the chemical industry in the production of phosphorus compounds and oil refining, in the treatment of wastewater from toxic impurities.

**Approbation of experimental results.** Pilot scale tests of wastewater treatment of phosphorus production with the use of aluminosilicate sorbents were carried out. Results of the tests showed that the degree of purification of industrial wastewater of Zhambyl branch of LLC "Kazphosphate" Novodzhambul phosphorus plant reaches 86-92% in the sorption unit when using sorbents based on bentonite clay of Darbazi field with the addition of 30% oil sludge by weight of the mixture. At the same time, after repeated use, the sediment after purification and clarification can be used as an additive in the production of complex mineral fertilizers.

**Author's personal contribution.** The results presented in the dissertation were obtained by the author or with his direct participation. The author carried out thermodynamic, experimental and kinetic studies, participated in pilot scale tests, interpretation of results, preparation of publications and presentations at conferences.

**Publications on the topic of work.** Based on the results of research scientific work it was published 15 articles, including 3 articles in journals approved by the order of the Committee for Control in the sphere of Education and Science of the MES RK, 1 article in ranking journals with a high citation index (included in the database Scopus and Web of Science), 6 articles at the international scientific and practical conferences, 4 articles at the international scientific and practical conferences in foreign countries. Three certificates of the invention of the Republic of Kazakhstan were obtained (Invention No. 98255 dated 13.06.2016).

**Structure and volume of the dissertation.** The dissertation consists of an introduction, six chapters, conclusions, a list of references and 9 appendixes. The work is stated on 131 pages of typewritten text and contains 46 figures, 38 tables and a list of references of 125 titles.