Development of a method for regulating the adsorption capacity of natural montmorillonite for the extraction of anionic impurities from aqueous solutions

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Abstract

Topicality of the research is due to the high industrial demand for multifunctional and environmentally friendly adsorbents for liquid-phase processes. Among the promising materials that meet these requirements, it is necessary to specify montmorillonite, a layered aluminosilicate of the smectite group, which is one of the most widespread amphoteric ion exchangers in nature. The possibility of regulating porosity in a wide range, as well as the presence in the structure of montmorillonite of various chemical activity centers that can serve as adsorption centers for both cations and anions, cause a relentless interest in research in the search for new ways to modify it.

The aim of the study is to develop a method for regulating the adsorption capacity of montmorillonite and obtaining adsorbents for the extraction of anionic impurities from aqueous solutions.

To achieve **the goals** of the thesis, the following tasks are set out and solved:

1. Investigation of the mechanism of inversion of the adsorption properties of montmorillonite modified with cationic surfactants.

2. Investigation of the relationship between the degree of delamination of the layered framework of montmorillonite in water and changes in the double electric layer of its particles.

3. Investigation of the relationship between the charge sign of the adsorbed ions and the type of surface available for the adsorbent of alumosilicate layers of montmorillonite.

4. Investigation of the mechanism of adsorption of anionic azo dyes on montmorillonite modified with a solution of sodium metasilicate.

5. Development of technology for modifying montmorillonite with a solution of sodium metasilicate.

Scientific novelty of the work.

1. The concepts of the mechanism of inversion of the adsorption properties of montmorillonite modified with cationic surfactants, the adsorption of anions in which includes two successive stages: adsorption on the surface of the edges and anion exchange adsorption on the surface of the faces, are expanded.

2. The dependence between the sign of the ion adsorbed by montmorillonite and the degree of delamination of its framework in an aqueous medium has been established. The

sign of the adsorbed ion depends on the type of surface of the alumosilicate layers of montmorillonite available for the adsorbent in water, which generally determines the sign and the value of the ζ-potential of the surface of the adsorbent particles.

3. The chemisorption mechanism of adsorption of anionic dyes on montmorillonite modified with sodium metasilicate has been established.

Practical significance of the work

A technology for modifying montmorillonite with a solution of sodium metasilicate has been developed, which allows to obtain an environmentally safe, well-filtered material with an adsorption capacity against anions. The technical novelty of the invention is confirmed by patent RU 2 714 077 C1 dated 02/11/2020. The resulting material also has catalytic activity in the reaction of oxidative degradation of organic substances in the aqueous phase by the Fenton-Raff mechanism.

Provisions submitted for consideration.

1. Analysis of the relationship between changes in the structure and character of the surface of montmorillonite modified by cation surfactants and its adsorption capacity with respect to anions.

2. Results of the study of copper adsorption on montmorillonite samples with a different tendency to delamination of the framework in an aqueous medium.

3. Analysis of the relationship between the type of surface available for the adsorbent of alumosilicate layers of montmorillonite in an aqueous medium and the type of adsorbed anion.

4. Analysis of the relationship between changes in the structure and character of the surface of montmorillonite modified with sodium metasilicate and its adsorption capacity with respect to anions (chromates, azo-dyes).

5. Technological scheme of modification of montmorillonite with a solution of sodium metasilicate.