Sorption and Acidic-Basic Properties of Saponite-Based Nanocomposites

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Purpose: research of nanocomposites based on saponite clay. Influence of impregnation with magnetite, tungsten disulfide and molybdenum disulfide on the acid-base properties and sorption properties of the obtained nanocomposites.

The synthesis of two nanocomposites based on native saponite clay was carried out by impregnation. The first nanocomposite Sap-WS_2 was obtained by penetrating into native clay a 1% suspension WS_2 with ultrasonic dispersion. The second nanocomposite MCS-WS_2 was obtained by permeating native clay with a 1% WS_2 suspension after it was mixed clay and magnetic fluid.

All nanocomposites were investigated by SEM, potentiometric method and Hammett method. Sorption activity was studied on the dyes of both cationic (methylene blue) and anionic (congo red) types.

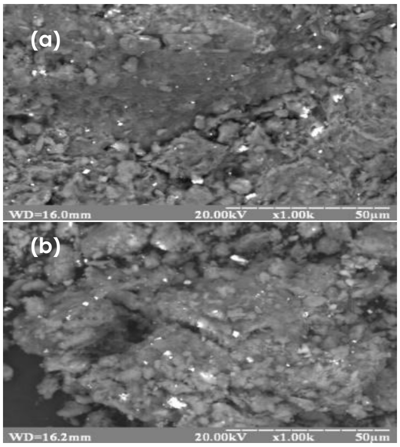

Fig. 1. SEM-images of Sap-WS_2 (a)and MCS-WS_2 (b) nanocomposite samples

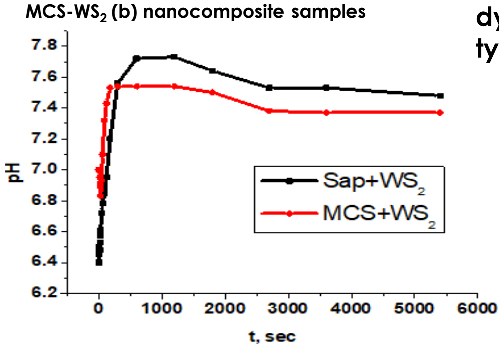

Fig. 2. Change in pH of 1% nanocomposite suspensions

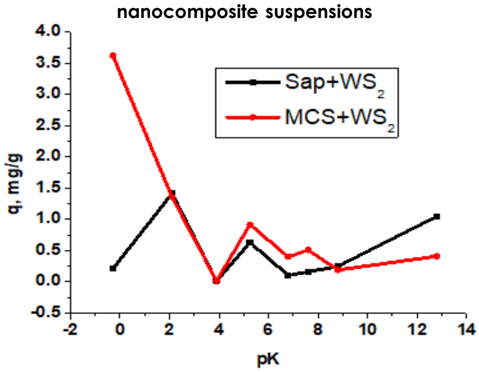

Fig. 3. Distribution of active sites on the surface of nanocomposites

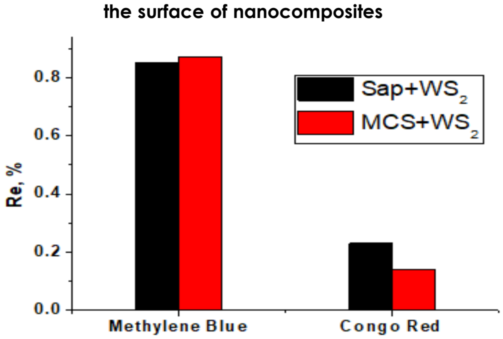

Fig. 4. Removal degree of methylene blue and congo red by nanocomposite sorbents

SEM-images of Sap-WS_2 and MCS-WS_2 nanocomposite samples (Fig. 1) have similar morphology and can be characterized by a dense structure that is typical of laminated clay minerals. The results of the surface point analysis recorded the content of mainly such elements as Mg, Al, Si, Ca, Fe, W and S. Moreover, for MCS-WS_2 nanocomposite there is a significant increase in the iron content, which is associated with the deposition of magnetite on the surface of saponite.

Acidic-basic properties. It is possible to conclude that MCS-WS_2 composite has a larger amount of active Lewis sites compared to Sap-WS_2 (Fig. 2), but Sap-WS_2 sample is characterized by greater basicity. Obtained distribution curves of the active sites on the surface of Sap-WS_2 and MCS-WS_2 nanocomposites are shown in Figure 3. Sap-WS_2 nanocomposite really has more active Lewis sites.

The sorption activity of the obtained nanocomposites (Fig. 4) indicates that, in both cases, the cationic dye is removed to a greater extent than the anionic one. The MCS-WS_2 nanocomposite showed a slightly higher methylene blue removal (88%). Thus, the conducted studies of the acid-base and sorption properties are in complete agreement with each other, which confirms the importance of studying the surface chemistry and its features.

Conclusions: The study of the active sites of nanocomposites shows that the total amount of active sites for a composite based on the clay modified with magnetite and molybdenum disulfide is higher compared to the clay modified only with molybdenum disulfide. Results of the sorption study of the obtained nanocomposites are in a complete agreement with the results of their acidic-basic properties study.