



Effect of surfactants adsorption on the structure of bentonite-based sorbents

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In the present study, we investigated the effect of the adsorption of cationic and nonionic surfactants on the structure of bentonite. Although there is a large amount of data on the modification of bentonite with different surfactants, information regarding the effect of a nonionic surfactant on the properties of bentonite is limited. Nonionic surfactant-based organo-bentonites are less toxic and more environmental-friendly, thus their application as sorbents should be evaluated.

For modification of bentonite two surfactants were used: t-octylphenoxypolyethoxyethanol (Triton X-100; TX100) and hexadecyltrimethylammonium bromide (HDTMA). The samples of bentonite were stirred with 2000 g of HDTMA or TX100 solutions at concentrations of 48 mmol/100 g at 40 °C. After 24 h of stirring, the samples were centrifuged for 10 min at 14,000 rpm and dried at 40 °C for 24 h.

XRD results show that the main peak (001) from montmorillonite was observed to shift towards higher interlayer distances only in case of modification with HDTMA. This indicates that TX100 molecules are too big and cannot intercalate into interlayer space of montmorillonite; therefore, the modification of bentonite with TX100 was seen mostly on the surface. The FTIR spectrum of HDTMA-modified bentonite shows bands which correspond to the anti-symmetric and symmetric tensile vibrations of methylene groups ($-\text{CH}_2$) of the hydrocarbon tails of the surfactants and bands ascribed to the bending vibrations of C-H originated from surfactant molecules. The effectiveness of the modification of bentonite with TX100 is confirmed by the presence of the absorption bands, which represent methylene groups ($-\text{CH}_2$), CH stretching and bending vibrations, CO and OH bending vibrations and a band from C-C bonds of phenyl rings. DTA curves of HDTMA-bentonite indicate the occurrence of several endothermic and exothermic effects. Exothermic effects in the temperature range of 303–383 °C are attributed to the combustion and loss of the surfactant molecules from the surface and from the interlayer space. For bentonite modified with TX100 exothermic effects related to the decomposition or combustion of TX100 are strong and shift to high temperatures (approximately 250 °C and 400 °C). The interaction of surfactant molecules with the structure of the mineral minimizes the disintegration of the surfactant, which occurs at a temperature higher than what is required to disintegrate pure TX100. The morphology of the sample after the modification with HDTMA did not change significantly

with respect to natural bentonite; thus, the typical tissue-like morphology of montmorillonite is evident. It is caused by the modification type—HDTMA is mostly intercalated into the interlayer space of smectite. Modification with TX100 takes place mostly on the surface of the sample; thus, the surface is coated with surfactant.

In conclusion, this work demonstrates the changes in bentonite due to adsorption of the cationic and nonionic surfactants. Intercalation of surfactants increases the structural and thermal stability of the system. The results achieved by this study can contribute to the further exploration of the utilization of nonionic surfactants in clay and clay mineral modification.

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