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Mesoporous metal catalysts templated on clay nanotubes for aromatics hydrogenation

A.P. Glotov*, A.V. Stavitskaya, M.I. Artemova, A.A. Novikov, V.A. Vinokurov, Y.M. Lvov
Gubkin Russian State University of Oil and Gas, Russia

Hydrogenation of aromatic compounds is a very important trend in modern petrochemistry. Catalysts for hydrogenation based on noble metals are sensitive to water in feedstock. Thus, it leads to the limited mass transfer of the organic molecules to the catalyst active sites and, as a result, substrate conversion and product selectivity decrease. In this regard, the development of catalysts resistant to the presence of water in feedstock providing high conversion of aromatic compounds in two-phase hydrogenation process is of current interest.

New synthesis procedure of Ru-containing catalysts based on aluminosilicate halloysite nanotubes (HNT) preliminary functionalized by silanes with various structures followed by ruthenium deposition by microwave irradiation leading to selective intercalation of metal nanoparticles into the nanotubes lumen is proposed. The composition and structure of the catalysts obtained were confirmed by XRF, low-temperature nitrogen adsorption/desorption, TEM and TPR H_2 techniques.

The hydrogenation activity of the catalysts obtained was performed at the temperature of 80°C and hydrogen pressure of 3 MPa in both hydrocarbon and in the two-phase hydrocarbon-water systems. Benzene, toluene, ethylbenzene and its mixtures were used as substrates.

The modified by silanes HNT-based ruthenium catalysts are more active in aromatics hydrogenation in water media than pristine HNT one. The limiting step of hydrogenation is the diffusion rates of the substrate molecules to the active sites of the catalyst. HNT modification by silanes leads to hydrophobization of the outer surface providing intercalation of Ru nanoparticles in the internal cavity of the HNT forming nanoreactor, which allow to exclude the diffusion limitations in a two-phase hydrogenation.

Keywords: halloysite, ruthenium catalysts, hydrogenation, aromatics