

The influence of the structural and electronic characteristics of palladium on the activity and selectivity of Pd/Al₂O₃ and Pd-Co/Al₂O₃ catalysts for the hydrogenation of acetylene hydrocarbons

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Abstract

The influence of the structural and electronic characteristics of nonpromoted and cobalt-promoted Pd catalysts on their adsorption and catalytic properties is studied. It is shown that the conversion of vinylacetylene depends on the dispersion of palladium for both types of catalysts synthesized from acetate and acetylacetonate complexes. The palladium acetylacetonate catalysts have a higher palladium dispersion than the samples obtained from acetate complex solutions, thus leading to a higher conversion of vinylacetylene. It is established that the selectivity of vinylacetylene conversion into 1,3-butadiene on palladium acetate and acetylacetonate catalysts depends on the state of the 3d orbitals of surface Pd atoms. The palladium acetate catalysts are characterized by a higher electron density on the 3d orbital in comparison with the acetylacetonate samples, thus producing higher selectivities of vinylacetylene conversion into 1,3-butadiene. The introduction of cobalt into Pd/δ-Al₂O₃ catalyst synthesized from acetylacetonate complex leads to the formation of bimetallic Pd-Co particles, in which Pd atoms have higher electron density than those in the nonpromoted Pd/δ-Al₂O₃ catalyst, due probably to the donation of electron density from promoter atoms, with a resulting decline in the adsorption ability of bimetallic particles with regard to 1,3-butadiene and hydrogen. As a consequence, the selectivity of vinylacetylene conversion into 1,3-butadiene increases. Requirements for the size, dispersion, and electronic characteristics of the active component in the catalysts for the selective hydrogenation of vinylacetylene are formulated, and two techniques for their synthesis are proposed. © 2011 Pleiades Publishing, Ltd.

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Keywords

Pd catalysts, promoter, selective hydrogenation, vinylacetylene