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Insights into the dehydrogenation selectivity of alloys through hydrogenation kinetics

Keoni E Baty,
Chemical and Biological Engineering, University of New Mexico

Steven Purdy, Jeff Miller
Davidson School of Chemical Engineering, Purdue university

ABSTRACT

Platinum alloy catalysts have a multitude of industrial applications due to their superior selectivity compared to pure platinum catalysts. The two properties believed to be responsible for high alloy selectivity in dehydrogenation are the electronic effect and the geometric effect. Currently, both effects are cited as the predominant effect leading to alloy selectivity. Our research seeks to quantify how the electronic effect of alloying changes the kinetics of hydrogenation, and to relate these changes to the observed olefin selectivity in dehydrogenation by alloys. We measured and compared apparent kinetics of ethylene hydrogenation on platinum and a Pt₃V alloy catalyst of the same particle size. X-Ray Absorption Spectroscopy (XAS) was used to characterize the electronic changes that occur upon alloy formation. The similarity in reaction orders and activation energies between platinum and the alloy suggests that the electronic effect influences the kinetics of ethylene hydrogenation. The implications of this result on dehydrogenation selectivity are discussed.

KEYWORDS

Catalysis, materials, alkane transformation, energy, shale gas