ABSTRACT OF THE DOCTORAL DISSERTATION

Preparation of innovative heterogeneous catalysts for hydrogenolysis processes

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The production of 1,2-propanediol presents a significant challenge for the chemical industry due to the increasing demand for this versatile product and government-driven environmental regulations, which address, among other things, the reduction of CO_2 emissions and the prohibition of certain chemicals, such as hexavalent chromium compounds, in catalysts. The traditional method of producing 1,2-propanediol through the hydrolysis of petroleum-derived 1,2-epoxypropane (propylene oxide) is energy-intensive, and more sustainable pathways based on renewable feedstocks could provide viable alternatives. One of the most promising routes is the glycerol hydrogenolysis process, which holds immense potential to replace petroleum-based 1,2-propanediol, yielding significant environmental and economic benefits. However, current glycerol hydrogenolysis technologies, developed by BASF/Air Liquide and ADM (Archer Daniels Midland Company), suffer from several drawbacks, including insufficient catalyst selectivity, which leads to high product purification costs.

This doctoral dissertation focuses on the development of a new type of doped pseudoboehmite-based catalysts for the hydrogenolysis of glycerol to 1,2-propanediol. The catalyst preparation involved the direct introduction of the active phase and other catalyst components during the carrier formation stage. The resulting pre-catalyst was then extruded, dried, and calcined. This preparation method significantly enhances the catalyst's activity and selectivity in the glycerol hydrogenolysis process. The dissertation explores the quantitative and qualitative selection of catalyst components, including the carrier, gelation agents, promoters, and organic additives, and their effects on catalyst selectivity and activity in glycerol hydrogenolysis. A comprehensive series of physicochemical analyses and tests performed on a high-pressure flow reactor for hydrogenolysis demonstrated that the catalyst achieved a selectivity of 95.9% and a glycerol conversion of 86.5% in a continuous process lasting 1000 hours, indicating high catalyst stability.

Furthermore, the dissertation reports the successful scaling of both the catalyst preparation process to a large laboratory scale and the glycerol hydrogenolysis process to a quarter-technical scale. The results form the foundation for the base project developed by the

Łukasiewicz Research Network – Institute of Heavy Organic Synthesis "Blachownia" aimed at producing 1,2-propanediol from glycerol.