ABSTRACT OF DOCTORAL DISSERTATION

Projectable catalytic systems for the fine chemicals synthesis sector

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One of the main challenges associated with the ecological transformation of chemical technologies is the search for alternative, highly selective, active, and stable catalysts to replace the currently used conventional acid catalysts, as well as the elimination of volatile organic compounds and toxic reagents. The design and implementation of new catalytic systems with high activity and stability, which allow for their multiple recovery and reuse, play a crucial role in reducing the negative impact of the chemical industry on the natural environment.

The main goal of the studies conducted as part of the doctoral dissertation was to develop highly active and stable catalysts based on enzymes or acidic ionic liquids dedicated to clean chemical technologies from the fine chemicals synthesis sector. An important aspect of this work was also the transformation of selected processes from batch to continuous-flow system.

As part of the studies, three new catalytic systems were designed and successfully applied in selected model processes: Diels-Alder cycloaddition, kinetic resolution of ibuprofen racemate, and esterification of furfuryl alcohol with carboxylic fatty acids. The new heterogeneous catalysts were based on the Lewis type trifloaluminate acidic ionic liquids or lipase from *Aspergillus oryzae* and various silica materials. All developed catalysts were precisely characterized using TGA, SEM-EDX, ^{29}Si MAS NMR, FT-IR, ICP, and adsorption-desorption analysis (BET/BJH), followed by testing their catalytic activity in selected model processes. The developed technologies were optimized in terms of selecting appropriate parameters, such as the solvent choice, temperature, reagents molar ratio, and potential for recycling.

The studies demonstrated that the proper design of the matrix for the active phase immobilization is crucial for obtaining a heterogeneous, active, and stable catalytic system. In most cases, the stability of the catalysts allowed for the synthesis transformation from batch to continuous-flow system, which maximized production efficiency. The technologies developed as part of the doctoral dissertation are characterized by a minimized impact on the environment, which aligns with the principles of green chemistry and sustainable process design. The obtained results surpass previous literature reports in this field.