

## SUMMARY OF THE DOCTORAL DISSERTATION

### Chemoenzymatic methods of obtaining lactic acid esters

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The main scientific goal of the doctoral dissertation was to develop an effective, low-waste and energy-saving method of producing lactic acid esters in the presence of non-standard catalysts. These esters, as non-toxic, biodegradable substitutes for petrochemical solvents, are a very important group of compounds that perfectly fit into the assumptions of the sustainable development strategy.

As a part of the doctoral dissertation, research was carried out on the synthesis of selected lactic acid esters by the esterification method, using two types of catalysts, i.e. new, protic ionic liquids based on triethylamine and sulfuric acid (VI) and enzymes from the lipase group. The research was carried out on three commercially valuable esters: *n*-butyl lactate, 2-ethylhexyl lactate and ethyl lactate. The obtained results allowed for the development of mass balances of the processes of obtaining lactic acid esters in the scale of 100 kg of the product. On the basis of the prepared mass balances, the indicators of the consumption of raw materials needed to determine the profitability of the synthesis processes were estimated.

Both the use of ionic liquids and enzyme catalysts as catalysts allowed to carry out the esterification process of lactic acid at lower temperatures compared to esterification against classic acid catalysts, which are usually conducted at a temperature close to the boiling point of the substrates. As a part of the research, the possibility of repeated use of the proposed catalysts or conducting the process in a continuous manner was confirmed. All these aspects are beneficial in terms of environmental impact and are in line with the expectations set for new technologies.

The research carried out in this work is an extension of the chemistry of ionic liquids, and also has the potential to be implemented in industrial conditions. Research on the enzymatic esterification of lactic acid has shown that these catalysts can be successfully used in industrial processes as an alternative to classic acid esterification catalysts.