Summary of the doctoral dissertation entitled:

Utilization of waste poly(ethylene terephthalate) for the production of polymer plasticizers

The doctoral dissertation focused on the management of post-consumer poly(ethylene terephthalate) (PET) through its chemical recycling into terephthalate esters, which can serve as plasticizers for polymers. The starting point of the research was the need to develop sustainable methods for recovering valuable chemical compounds from PET waste and to mitigate their negative environmental impact.

The aim of the work was to develop and optimize alcoholysis processes of waste PET using C_3, C_4, and C_8–C_{10} alcohols, and to evaluate the properties of the obtained products as plasticizers for plastics. The effectiveness of various catalytic systems was compared, including organotin catalysts, superbases, and ionic liquids. Organotin catalysts—tin(II) oxalate and monobutyltin tris(2-ethylhexanoate)—showed the highest activity and selectivity, enabling high yields of terephthalate esters, reaching up to 90% in alcoholysis with higher alcohols. A key advantage of these catalysts is their resistance to impurities commonly found in post-consumer waste.

A crucial stage of the work involved scaling up the process to a 20 dm^3 reactor, which enabled the evaluation of catalyst stability, reaction reproducibility. It confirmed the implementation potential of the developed technology. The obtained plasticizers were tested in PVC formulations, where they demonstrated mechanical and migration properties comparable to, and in some cases superior to, commercial plasticizers. Additional studies on colour impurity removal have revealed the high efficiency of carbon-based sorbents, enabling the production of high-purity products.

In summary, the dissertation presents an effective method for the chemical recycling of PET, enabling the production of alternative, environmentally friendly plasticizers with high efficiency and quality. The developed process is characterized by tolerance to feedstock impurities, scalability, and industrial implementation potential. The work makes a significant contribution to the development of sustainable polymer recycling technologies, aligning with the current principles of the circular economy and green chemistry.

The research results were published in three scientific articles, presented at seven conferences, and submitted in five patent applications, one of which resulted in a granted patent. The outcomes of the work also served as the basis for preparing a funding application for further development aimed at implementing the developed technology on a semi-technical scale.