Załącznik 2

Summary of the doctoral dissertation

The catalytic hydrogenation of products from the thermal cracking process of plastic waste

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In the current work, the hydrotreating process of hydrocarbons resulting from cracking plastics to obtain valuable products, such as hydrogenated raw material for the steam cracking process and aliphatic solvents, was investigated. Regranulates of polyethylene, polypropylene and polystyrene, derived from mechanical recycling of post-production waste and a mixture of polyolefins acquired from municipal waste, were used as raw materials for thermal cracking. In the first stage, a detailed analysis of the composition of cracking products was carried out at the plant according to Clariter's procedures. It was shown that low and high-density polyethylene cracking intermediates obtained with similar yields have a very similar composition, dominated by linear alkanes and alkenes. At the same time, 96% of the polypropylene cracking product consisted of cyclic or unsaturated hydrocarbons, difficult to identify. In the product of polystyrene cracking, over 90% were arenes, including polycyclic aromatic hydrocarbons, with the largest share of styrene. Based on the analysis of the composition, proper fractions from the cracking process of the waste mixture were selected for the research on hydrotreatment, as raw materials rich in unsaturated components and requiring hydrogenation. The whole PS cracking product was hydrotreated.

The choice of the catalyst, proper space velocity, process temperature and pressure, which would enable the hydrogenation of alkenes and arenes, were the parameters for testing. In the process of hydrotreating the polyolefin cracking product, three commercial catalysts were tested: nickel-molybdenum, cobalt-molybdenum and platinum-based ones. It was shown that high-value hydrocarbon products could be obtained by upgrading processes using commercial catalysts at relatively low pressures (below 5 MPa). The next stage of the research aimed to compare the activity of catalysts in the hydrotreating process with synthesis gas. In addition, the length of the catalyst's activity was checked, which showed the highest activity in the hydrogenation process was maintained with the use of synthesis gas. Hydrotreating the polystyrene cracking product was also carried out with different catalysts: two nickel catalysts, a platinum catalyst and a nickel-molybdenum catalyst. Products with very low aromatics contents were obtained - a valuable base for cycloalkane (naphthenic) solvents.

The GC-MS technique was used to determine the composition of cracking products. An attempt was made to apply the method of analysis based on the fragmentation patterns of the mass spectrum, characteristic for individual groups of hydrocarbons, previously used only for middle distillates of crude oil. A method based on the addition of model compounds was developed to evaluate the activity of catalysts in the hydrogenation process of specific groups of hydrocarbons. Proper methods of data presentation were selected depending on the needs. The analytical methodologies developed were implemented and are currently used by Clariter in comparative studies of the hydrotreatment of intermediates and products, as well as in estimating the composition of raw material for the cracking process of waste origin.