Abstract

[Project Information]

Project Title :	Development of Processes for Chemical Upcycling of Polyolefinic Waste Plastics
Project Number :	JPMEERF20223002
Project Period (FY) :	2022-2024
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Keywords :	Chemical recycling, Polyolefin, Lubricating oil, Solid catalyst, Hydrogenolysis

[Abstract]

In this study, we aim to acquire essential fundamental information and data, including target waste plastic selection, detailed experimental results, product evaluation, and LCA, necessary for progressing to scale-up and demonstration studies. For this purpose, we addressed the material and process engineering challenges associated with the chemical upcycling of waste plastics into valuable chemicals such as lubricants using solid catalysts. Our focus is on (1) the development of highly durable catalytic systems, and (2) the establishment of technologies for liquefying plastics and introducing them into fixed-bed reactors. Furthermore, based on the experimental data obtained, we conducted process simulations and life cycle assessments (LCA) to evaluate CO_2 reduction effects, energy efficiency, and cost, thereby constructing a conceptual image of a demonstration-scale process from raw materials to final products.

Regarding the development of highly durable catalysts, we have developed catalysts such as Ru/Al_2O_3-ZrO_2 and Ru/La_2O_3-ZrO_2 that exhibit high resistance to catalyst poisons such as sulfur and phosphorus, respectively. These ruthenium-based catalysts demonstrate excellent durability, which confirms the ability to maintain catalytic performance with at least 140 times the amount of plastic feedstock per catalyst mass. In addition, we developed Cu-Ru/CeO_2 and Ru/La_2O_3-CeO_2 catalysts that suppress the formation of low-value gaseous products while yielding high amounts of valuable chemicals (waxes and liquid chemicals), achieving up to 96% yield of the valuable chemicals and up to 71% yield of lubricating oils.

Using the data obtained from experiments, we constructed a kinetic model of the reaction through simulation. Through LCA, we evaluated CO_2 reduction, energy efficiency, and costs, and constructed

a process flow from raw material input to product output, identifying conditions necessary for scale-up.

Close collaboration with partner companies participating in the consortium enabled smooth progress in sample procurement and process development. Component analysis of the products from plastics confirmed that the current liquid chemicals meet the required specifications.

[References]

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This study was supported by the Environment Research and Technology Development Fund of the ERCA ({JPMEERF20223002}) funded by the Ministry of the Environment.