Impact of CO_2 as a Tunable Medium on the Catalytic Conversion of Polyolefins

Nicholas Gorschak,[1,2] Lakshmiprasad Gurrala[1,2] Allison Tran,[1,2] and Ana R. C. Morais[1,2*]

[1]Department of Chemical and Petroleum Engineering, University of Kansas, Lawrence, Kansas, 66045 United States

[2]Wonderful Institute for Sustainable Engineering, University of Kansas, Lawrence, Kansas, 66045,

United States

*Corresponding author: Ana R. C. Morais, Department of Chemical and Petroleum Engineering, Wonderful Institute for Sustainable Engineering, University of Kansa, ana.morais@ku.edu, 785-760-7615

Abstract

Plastics have been widely used in many applications due to their desirable performance properties and cost-effectiveness. However, this widespread use has resulted in the accumulation of significant quantities of plastic waste in the environment, posing enormous threats to human health and our ecosystem. Despite the ongoing efforts to develop chemical processes to transform waste plastics, with particular focus on polyolefins, into valuable products, polyolefins' long carbon chains, low thermal conductivity and high melt viscosity cause severe heat and mass limitations. In this work, we investigate the effect of sub-and supercritical CO_2 as a tunable media for the hydrocracking of polyethylene (PE) into liquid alkanes. Our results show when PE was catalytic hydrocracked with 5% Ru/ H-β catalyst with 3 MPa of initial CO_2 resulted in 53% higher selectivity toward C6-C10 alkanes at 200 °C for 4h and with 3 MPa of H2 pressure relative to the process in the absence of CO2 (only H2). Thermogravimetric analysis revealed that adding subcritical CO_2 resulted in an 8% decrease in coke deposition on the catalyst compared to the control reaction (without CO_2) using 5% Ru/H-β at 200°C, 3 MPa of H2 for 8 h. Further details will be discussed on how CO_2 can improve the hydrocracking performance of Ru supported on various zeolite-based materials (parent H-β and HY, and hierarchical HY) at different temperatures and CO_2 pressures over reaction times of 2-8 h. These findings are significant for advancing sustainable plastic waste management by offering insights into designing efficient catalyst systems for converting polyolefins into valuable products.