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Integration of plastic waste pyrolysis oils into FCC processes

T. Dreising, S. Tavakkol, D. Stapf
Karlsruher Institut für Technologie (KIT), Institut für Technische Chemie (ITC), Eggenstein-Leopoldshafen, Germany

Chemical recycling of mixed plastic waste via pyrolysis offers a promising pathway to reduce fossil resource consumption and recover value from otherwise non-recyclable waste streams. While plastic pyrolysis oils are widely discussed as alternative feedstocks for steam crackers, their integration into Fluid Catalytic Cracking Units (FCCUs) has received comparatively little attention, particularly regarding operational constraints and refinery integration strategies.
This study investigates the technical and ecological implications of co-processing LDPE-derived pyrolysis oils in FCC units using process simulation and life cycle assessment (LCA). An industrial FCCU is modeled in Aspen HYSYS and validated against commercial operating data to establish a representative base case. Different substitution rates of conventional vacuum gas oil (VGO) with pyrolysis oil were evaluated regarding process stability, product distribution, and operational feasibility.
Simulation results show that up to 10 wt.% of fossil feedstock can be substituted without major operational instability. Higher substitution rates significantly alter the product spectrum, particularly by increasing naphtha yields. While conventional FCC operation does not further convert this additional naphtha fraction, Deep Catalytic Cracking (DCC) configurations provide an opportunity for enhanced conversion toward light olefins through elevated reaction severity and optimized catalyst systems. The results therefore indicate a potential process synergy between pyrolysis oil co-feeding and olefin-oriented DCC operation. In addition, critical operational constraints are identified, including limitations in feed preheating, air blower capacity, and gas condensation systems.
Based on these findings, different FCC process configurations are comparatively assessed regarding their ecological and economic trade-offs. Preliminary LCA results indicate a significant reduction in greenhouse gas emissions compared to waste incineration pathways, depending on substitution rate and process configuration. The combined assessment of process performance, operational constraints, and environmental impacts provides guidance for integrating circular carbon feedstocks into existing refinery infrastructure.