Maximizing Olefin Yields: Fluid Catalytic Cracking as Conversion Technology for Pyrolysis-Oils from Plastic Waste

S. A. Schunk[1,2], S. Hanf[1,3], CP Kelkar[2], D. Köpke[2], K.-E. Finger[1],
S. Wodarz[1], M. Paul[1], K. Friese[2]
[1]hte GmbH, Kurpfalzring 104, 69123 Heidelberg,[2]BASF SE, Germany / BASF Corporation, Iselin, USA, [3]Karlsruhe Institute of Technology, Institute for Inorganic Chemistry,

Abstract

The reintegration of plastic waste forms into chemical value chains is a challenging topic which in at large is driven by the urge to make circularity in chemicals production a reality. Pyrolysis oils are an important primary product that can be obtained from thermal conversion of suitable plastic waste forms and have the advantage that these oils can be easily transported, pumped and be submitted to established or novel upgrading technologies to remove undesired heteroatoms. The cracking of hydrocarbon feedstock, such as pyrolysis oils obtained from plastic waste forms, is an important operation to obtain small olefins, that can be reintegrated into chemical value chains. Cracking can be performed thermally (steam cracking); BASF has pioneered the reintegration of pyrolysis oil derived feedstock in the proprietary ChemCycling® approach, using steam cracking as preferred conversion technology. It should be noted here that steam cracking requires a specific segment, which is very light boiling, so heavier boiling fractions do need to be upgraded first or must be separated thermally.

Alternatively cracking can be performed in the presence of a catalyst; given aromatics content and heteroatom content are in an appropriate range, fluid catalytic cracking (FCC) is today a major platform, to convert such feedstock into downstream products useful for refining and chemical purposes. Typical feedstock in a refinery context are heavy oil fractions, such as vacuum gas oil or so called resids, are submitted to FFC conversion. Fluid catalytic cracking is a very well-established technology with a typical minimum scale used in refineries of ≥1000kt/a. Such FCC-based processes are a key refinery conversion step in upgrading heavy feeds and contribute also to the world's small olefin supply such as propylene to feed chemical value chains. In the context of the study presented here, pyrolysis oils from plastic waste have been applied in a fluidized catalytic cracking process. For this purpose, the micro downflow technology (MDU) of hte GmbH has been used, which is a lab-scale technology for the assessment of reaction conditions and catalyst types for FCC. The MDU offers an entrained catalyst flow reactor system analogous to commercial fluid catalyst cracking units (FCCUs). The MDU can be operated under a wide range of process conditions and only small amounts of catalysts and feeds are required. Further, a broad range of feedstocks, varying from naphtha and vacuum gas oil to residue feeds and crude oils have been successfully processed. In the context of this study we want to illustrate how olefin yields can be maximized in optimising reaction conditions (temperature, cat/oil ratio, residence time) along with catalyst properties of the BASF catalyst portfolio.