Production of Sustainable Transportation Fuels and Chemicals via Catalytic Cracking

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Abstract

The refining industry has played a vital role supplying much of the world's transportation fuels and commodity chemicals, yet new regulations are forcing them to transition to more sustainable processes. The transition will require fossil-based feedstocks be partially or entirely replaced with more sustainable feedstocks derived from renewable & recycled materials. Compared to conventional fossil-based feedstocks, these materials will present new challenges such as additional metal and mineral components and differences in feedstock chemistry. Catalytic cracking has proven to be a cost effective, flexible process for the conversion of crude oil into transportation fuels and chemicals for more than 80 years. The ability of catalytic cracking to manage metal contaminants and tolerate a wide variety of feedstocks will likely prove to be valuable again.

One challenge refiners will face is choosing from a wide variety of distinctive feedstocks prepared using different processes. Those variations will yield oils with diverse properties that will ultimately influence their upgradability. In this work, we have conducted a broad survey of potential feedstocks spanning vegetable oils, plastic pyrolysis oils, and oils derived from biogenic wastes that were produced from commercial scale processes and a model laboratory process. Each oil was characterized using a several techniques to gain a deeper understanding of its chemistry and the implications on upgrading to final products. The catalytic cracking performance was assessed using lab-scale ACE® units with different commercial FCC catalyst technologies.

In this presentation, we will discuss the broad spectrum of upgradability associated with different feedstocks and catalyst technologies. On one end of the upgradability spectrum will be pyrolysis oils derived from recycled polyethylene and polypropylene where random scission of these polymers during pyrolysis results in a broad distribution of hydrocarbons that will be well behaved during catalytic cracking. The findings to date indicate that catalytic cracking of these oils is clearly suitable, yet how to most optimally apply it in the conversion to final products needs to be understood. On the other end of the spectrum will be oils produced from the pyrolysis of biogenic wastes that are significantly more complex and more problematic in any process, not just during catalytic cracking. For these feedstocks, the combination of the high content of oxygen, lack of hydrogen, and nature of the molecules inherent to biomass will tend to result in higher yields of coke and gas. Opportunities and challenges for catalyst design for all feedstocks will also be discussed.