Petrochemistry and Refining in a Changing Raw Materials Landscape
DGMK Conference October 9 – 11, 2017 in Dresden, Germany

Coke Formation and Distribution in Catalytic Conversion of Methanol to Propene

Y. Liu*, F. M. Kirchberger*, S. Müller*, M. Tonigold**, M. Sanchez-Sanchez*, J.A. Lercher*/***
*Department Chemie & Catalysis Research Center, TU München, Garching, Germany
**Clariant Produkte (Deutschland) GmbH, Bruckmühl, Germany
***Institute for Integrated Catalysis, Pacific Northwest National Laboratory, Richland, USA

Abstract

Coke formation on zeolite catalyst is the main reason for the catalyst deactivation in the conversion of methanol to olefins (MTO) [1]. Over H-ZSM-5 catalyst, two types of cokes have been identified, heavy aromatic coke and oxygen-containing coke [2]. In a fixed bed reactor, due to concentration gradients of the methanol/DME reactants and olefin/aromatic products along the catalyst bed, coke deposits non-uniformly over the H-ZSM-5 making inhomogeneous deactivation [3].
In this work, by sequentially connecting multi fixed bed reactors, we achieved mimicking the behavior of different H-ZSM-5 catalyst layers in a single fixed bed reactor. Detecting gas phase molecules over each reactor, and analyzing the coke and catalyst after deactivation allowed us to correlate the coke formation rate over a certain catalyst layer with the local gas phase composition and the loss of catalyst active sites.
The result showed that most of the coke formed on the catalyst layers where both olefin and methanol were present. Only small amounts of coke were detected on the catalyst top layers where only methanol/DME were present and on the bottom layers where only hydrocarbons were present. This coke distribution agrees with the hydrogen transfer rate along the catalyst bed, which is higher in presence of both olefin and methanol than in presence of only methanol/DME or only hydrocarbons [4].

References

[1] D. Mores et al., Chem. Eur. J. 14, (2008) 11320
[2] S. Müller et al., J. Catal. 325, (2015) 48
[3] J. Haw et al., Top. Catal. 34 (2005) 41
[4] S. Müller et al., J. Am. Chem. Soc. 238 (2016) 15994