

## **Co-Catalytic Cracking of n-Decane and 2-Ethylphenol over Various Zeolites for the Co-Conversion of Fossil- and Bio-Based Feeds in Co-FCC**

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### **Abstract**

The European Union (EU) has set itself the 20-20-20 targets [1]. Despite other goals, these aim for a share of 20 % of renewables within the energy sector. For the transport fuel sector 10 % are pursued. In order to reach this goal a shift towards biomass is needed. Especially lignocellulosic biomass is an attractive source for the production of carbon-based fuels. Forest residues can be converted by pyrolysis into an oil. Due to the poor stability, the pyrolysis oil needs an upgrading step [2]. Treatment with hydrogen attenuates the pH value while lowering the oxygen content and improving the stability of the oil. The obtained hydrodeoxygenated oil (HDO) can be co-fed with vacuum gas oil (VGO) into the fluid catalytic cracking (FCC) process [3]. Depending on the severity of the H<sub>2</sub> treatment, oxygenated species are still present such as phenolics.

We investigated the hydrothermal stability of a variety of medium- and large-pore zeolites at elevated temperatures to examine their suitability. Afterwards, zeolites that were claimed as stable were further used as catalysts in the co-cracking of model compounds. For a VGO oil n-decane and for an HDO oil 2-ethylphenol were used. Experiments were conducted in the gas phase in a fixed-bed reactor at a low weight hourly space velocity in order to observe catalyst deactivation within a reasonable timeframe.

Results reveal that several structures besides the common used faujasite structure in FCC show good hydrothermal stability and might therefore be potential candidates as catalyst or additive in FCC. High constant conversion in pure n-decane cracking can be obtained over some medium-pore zeolites. However, co-cracking with 2-ethylphenol requires the use of large-pore catalysts such as the beta or faujasite structure. Furthermore, only the investigated faujasite zeolites (Y, USY and RE-USY) are able to convert the phenolic co-substrate into aromatics. This is believed to be due to the good H-transfer with this type of zeolite and underlines its outstanding activity - not only in general FCC but also for an application in Co-FCC. Further experiments were conducted with beta and faujasite zeolite in its non-hydrothermally treated form with varying Si/Al ratio and therefore varying amount of active sites. These shed more light into the co-cracking of both compounds.

- [1] [http://ec.europa.eu/clima/policies/strategies/2020/index\\_en.htm](http://ec.europa.eu/clima/policies/strategies/2020/index_en.htm), Accessed: 24.02.2017.
- [2] P.M. Mortensen, J.-D. Grunwaldt, P.A. Jensen, K.G. Knudsen, A.D. Jensen, *Appl. Catal. A Gen.* 407 (2011) 1–19.
- [3] A. de R. Pinho, M.B.B. de Almeida, F.L. Mendes, L.C. Casavechia, M.S. Talmadge, C.M. Kinchin, H.L. Chum, *Fuel* 188 (2017) 462–473.