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Preparation of MFI Zeolites and Zeotypes to Generate Stable Product Selectivity from Olefin Oligomerization

Small-crystallite ZSM-5 catalysts that maintain stable selectivity and yield heavier fuel products over longer runs.

Light alkene oligomerization is a method to produce higher molecular weight hydrocarbons for fuels, utilizing MFI zeolites such as ZSM-5 due to their resistance to coke formation and selectivity for linear olefins. These zeolites feature structures that enable catalytic activity, with variations in crystallite size influencing their performance. However, the oligomerization process often faces challenges like unwanted cracking reactions and catalyst deactivation over time, which affects both reaction rates and product selectivity. Thus, there remains a need for improved catalysts that enable more stable time-on-stream operation for both the reaction rate and product selectivity.

Purdue researchers have developed a method for synthesizing MFI zeolite catalysts, particularly ZSM-5, that show enhanced olefin oligomerization selectivity and product distribution over traditionally available catalysts. The zeolites utilize various materials such as organoammonium compounds and sources of sodium, aluminum, silicon for their synthesis within an aqueous environment. These zeolites feature high silicon-to-aluminum ratios and small crystallite sizes, enhancing their performance in olefin oligomerization over extended periods. One key benefit the researchers demonstrated was the catalyst's ability to maintain stable product selectivity even as it deactivated over time. This stability results from the smaller crystallite sizes, which limit diffusion path lengths and mitigate the effects of catalyst deactivation. The synthesized catalyst was shown to favor heavier, liquid products to primary oligomers like dimers and trimers. The developed method offers a potential way for the scalable synthesis method for MFI zeolites that addresses the need for more stable catalysts in olefin oligomerization.

Technology Validation:

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Further information
Will Buchanan
wdbuchanan@prf.org

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-Comparison of time-on-stream conversion and selectivity for propene oligomerization showed that the synthesized MFI zeolite maintained a more stable product distribution over time compared to the commercially available MFI zeolite.

-X-ray diffraction and scanning electron microscopy were used to determine crystal size of the catalyst, demonstrating the interplay between crystal size and product distribution

Advantages:

-Improved stability in product selectivity over time

-Enhanced control over the product distribution

-Faster and cheaper catalyst synthesis

Applications:

-Production of transportation fuels and additives

-Synthesis of chemical feedstocks

TRL: 4

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