Application of UZM-14 for Improved Aromatic Transalkylation

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Introduction
To meet the growing industrial demand for xylenes, in the early 1970’s the UOP Tatoray™ process was commercialized to transalkylate toluene with heavier aromatics like trimethylbenzene to increase the xylene yield from aromatics complexes1. At present, this solid-acid catalyzed aromatic transalkylation process is estimated to produce up to 60% of all the xylene produced by a modern complex. Although alternate zeolites such as beta, mazzite, MCM-22 and ZSM-12 have been claimed recently, mordenite has remained the main catalyst component for commercial Tatoray applications. Over the past two decades, major improvements have been made in catalyst activity and stability, mainly through the introduction of a metal function, secondary zeolites and improvements in the properties of the mordenite.

Materials and Methods
As part of UOP’s ongoing New Materials program, a zeolite with the MOR framework but with crystal size significantly smaller than current state-of-the-art mordenites was synthesized. This material, designated UZM-14® (for UOP Zeolytic Material #14), was formulated into an aromatics transalkylation catalyst and evaluated in this application. The UZM-14 material was also further characterized to better understand its efficacy in this reaction compared to other MOR framework materials.

Results and Discussion
This study highlights the importance of zeolite morphology for the catalytic performance in aromatics transalkylation. Substantial improvements in catalyst activity, catalyst stability, aromatic ring retention and xylene selectivity were observed for aromatic transalkylation with catalysts formulated with the nano-crystalline UZM-14 compared to typical larger crystal materials. Figure 1 shows the significantly improved activity for the UZM-14 containing catalyst relative to one made from conventional mordenites. In a similar study, at a constant 50% conversion level, the xylene yield was found to be increased by >1% for the UZM-14 containing catalyst.

The zeolite structures of a series of materials with the MOR framework (including UZM-14) were characterized by nitrogen adsorption, electron microscopy, XRD line broadening analysis, and FTIR measurements. Detailed analysis of these measurements was performed to yield key parameters such as crystallite length in the direction of the 12-MR channel, mesoporosity, and accessibility of acid sites. Two important variables correlating with catalytic activity are mesoporosity and crystallite length along the pore direction. This is understood in terms of decreased diffusion path length in the micropores leading to improved accessibility of feed molecules to the interior of the zeolite crystals.

Figure 1. Conversion of UZM-14 Containing Transalkylation Catalyst compared to typical larger particle size mordenite containing catalysts.

Significance
Additional optimization of transalkylation catalyst metal function in combination with the implementation of the UZM-14 zeolite function leads to further yield, activity and stability enhancements. This improved catalyst performance can be exploited in many ways, including reduction of CAPEX and OPEX, as well as the ability to successfully process significantly higher molecular weight aromatic by-product streams that would otherwise be blended into Fuel Oil.

References