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Nanosized Zeolites with Exceptional Adsorption Properties

The transition of the global energy system from traditional fossil fuels to renewable and sustainable energy sources and processes necessitates the development of new materials and the reinvention of existing ones. Zeolites will play a key role in facilitating this transition due to their exceptional qualities, which make them valuable in essential catalytic and adsorption processes, such as carbon capture and storage. The zeolites used in these processes consist of micrometer-scale particles. Consequently, small molecules must diffuse a distance approximately tens of thousands of times their own size through the particles. This results in a relatively large mass transfer zone within a fixed bed configuration, limiting the usable capacity in separation processes.

Nanozeolites offer several key advantages over their conventional micron-sized counterparts, such as high surface-to-volume ratios that provide greater access to more active sites, rapid diffusion properties, and rich chemistry. Furthermore, the direct synthesis using inorganic structure-directing agents ensures the formation of nanozeolites with uniform elemental composition and desirable adsorption properties, eliminating the need for post-synthetic calcination treatment.

In this presentation, I will discuss the synthesis of nanosized zeolites with various sizes, morphologies, and framework structures by tailoring the crystallization process. The diffusion properties of the nanosized zeolites were studied through breakthrough curve analysis, revealing exceptionally sharp curves indicative of rapid diffusion due to the nanosized crystals and desired morphology. The unique adsorption properties of nanozeolites make them interesting candidates for gas separation applications in humid streams.

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