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State-of-the-art manipulation of clinoptilolite crystalline structure for gas separation

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Zeolites are the porous crystalline materials that can be used for gas separation because the size of the pores is comparable with the kinetic diameters of gas molecules. However, the crystalline structure of the zeolite can be manipulated by changing the type of the cations occupying the pore, different heat treatments or de-allumination of the structure. In this work, clinoptilolite that is a natural zeolite is selected and different treatments were done on this zeolite. The pore size of clinoptilolite with regard to the occupying cations that is mainly Na⁺ and K⁺ is comparable with the kinetic diameter hydrogen. Clinoptilolite is basically used for hydrogen separation from other gases like ethane and ethylene. Therefore, the pore size is too small to let ethane and ethylene get in. To make the pores of the zeolite expand and big enough to let ethane and ethylene in, first Na⁺ and K⁺ cations are replaced by H⁺ by ammonium exchanging and calcining. In this step, the pore can accommodate both ethane and ethylene, however, there is a strong affinity for both gases in particular ethylene and it is chemically adsorbed on the surface of the zeolite. To alleviate this affinity and make the structure more selective toward non-polar molecules like ethane, steaming treatments have been done. Starting with 300°C as the steaming temperature it was observed that at low steaming temperature the de-allumination of the zeolite did not happen or at least was not noticeable. As the steaming temperature was increased up to 600°C de-allumination of the zeolite happened and contraction of the lattice occurred. In order to check or confirm the changes in the structure of the zeolites different characterization or testing such as, EDX, XRD TGA, IGC, acquiring isotherms and calculation of the unit cell constants was done and almost all of them confirmed that by steaming, reduction of the crystalline structure took place and separation selectivity for ethane/ethylene improved.

Biography

Afroz Farjoo is a PhD Candidate in University of Alberta, Canada, department of chemical and materials engineering. Specialized in gas separation processes by membranes or adsorbents. In my PhD project I used a novel method and coating process to utilize zeolites as microporous crystalline materials for separation of hydrogen from light hydrocarbons. The PhD project is with direct collaboration with NOVA chemicals in Calgary, Alberta, Canada, Nova Chemicals, leading producer of plastics and chemicals in North America is the sponsor of this project so every progress in this project will be and have been industrialized so far.

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