

ADSORPTIVE INTERACTION MECHANISMS FOR SMALL SIZED MOLECULES ONTO ZEOLITES IN VIEW OF UREMIC TOXIN REMOVAL

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Abstract

The adsorption properties of zeolites for uremic toxins have been investigated in view of selective removal of such molecules from physiological solutions at 37°C. These investigations were performed in order to explore alternative methods to blood purification by dialysis in case of renal failure. Two zeolite structure types have been retained, each of them showing selective adsorption properties for creatinine (a free soluble uremic toxin molecule) and *p*-cresol (a partially protein bound uremic toxin molecule), respectively.

MFI type zeolites, anhydrous Silicalite 1 and Na-ZSM-5 were synthesized and employed for the adsorption of *p*-cresol. Two modified commercial MORdenite type zeolites (different Si/Al ratios) were used containing Na⁺ and H⁺ as charge compensating cations. Adsorption isotherms- and microcalorimetric measurements in pure water, in physiological buffer solution (D-PBS) as well as in D-PBS containing Bovine Serum Albumine in physiological concentrations, were performed.

While affinity for *p*-cresol vs. the MFIs is mainly modified by the cation presence in the void system, spectroscopic investigations (MAS-NMR), XRD with Rietveld refinement, and Monte-Carlo simulations confirmed a physisorption mechanism. Concerning MOR, only the H⁺-Mordenites show high and selective chemisorption for creatinine (confirmed by MAS-NMR), however, influenced by the composition of the liquid.

Two commercial zeolites, faujasite (FAU 13X, channel opening 0.74 x 0.74nm with Na⁺ as charge-compensating cation) and ferrierite (FER, channel opening 0.54 x 0.42nm with H⁺ as charge-compensating cation), were found to reduce ischemia-modified albumin formation by more than 65% due to removal of HO[•] relative to reference values. It was established that partial ion exchange of the zeolites' respective charge-compensating cation vs. Fe³⁺ implicated in the HO[•] generating Fenton reaction plays a major role in HO[•] deactivation process. Moreover, our results show that no saturation of the respective zeolite active sites occurred. This is possible only when HO[•] are actively converted to water molecules within the zeolite void system, which generates H⁺ ion transport.