Sr$^{2+}$ Adsorption and Xenon Diffusion Mechanisms Behavior onto Original Mesoporous LTA Zeolite Generated by Using Organosilane Surfactant

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There is an increasing concern with respect to contamination of aqueous ecosystems. Sorption processes are very attractive for water treatment applications. The removal of heavy metal cations can be explored using efficient technological solution based on innovative materials. The high cation-exchange capacity of zeolites offers an efficient separation base. In this context, mesoporous LTA zeolites were synthesized in order to overcome usual diffusion problems due to the microporosity. LTA zeolite containing mesoporosity was hydrothermally synthesized using a mesopore-generating organosilane surfactant (OSS) added into a conventional zeolite synthesis mixture. The solids were extensively characterized using classical techniques. Their structural and textural properties were correlated the strontium adsorption and the molecular diffusion characterized by xenon uptake measurement and $^{129}$Xe NMR spectral analysis. It was shown that the morphology of the LTA zeolite is strongly affected by the amount of the OSS used. Compared to the bulk LTA zeolite, the mesoporous zeolite materials have a crystal-like overall morphology, which appears to consist of small nanocrystals and the void space around the nanocrystals shown in the SEM images represents the mesopores. The size and volume of the mesopores gradually increase up to 10.0 nm and 0.42 cm$^3$ g$^{-1}$, respectively, as the amount of OSS is increased.

The results of Sr$^{2+}$ adsorption measurements give strong indication of the adsorbent affinity since complete removal from aqueous solution is observed, even in competition with high amount of background electrolyte. Hence, this cation appears small enough to enter the microporous network. The maximum exchange capacity ($\Gamma_{\text{max}}$) is not ascribed to the degree of mesoporosity, but is directly correlated to the Si/Al ratio. The comparison between the strontium adsorption capacity and the amount of sodium released from the surface suggests that the exchange process is not exactly stoichiometric for the smallest amounts adsorbed. In this adsorption range, the Na/Sr ratio depends strongly on the degree of mesoporosity, which evidences that the mesoporosity modifies the accessibility of the exchangeable cations. Besides, the mesoporosity of LTA zeolite was found to enhance the molecular diffusion into zeolite crystals. The diffusion rate of xenon atoms into the LTA zeolite at 297 K gradually increased, proportionally to the degree of mesoporosity (up to 200 times). $^{129}$Xe NMR spectrum shows the significant increase in the xenon uptake of LTA zeolite. Contrary to the bulk LTA zeolite, six intense peaks ranging between 70 and 200 ppm can be observed in the NMR spectrum of the mesoporous sample after 12 h of contact with xenon at 298 K. This indicates that a significant amount of xenon has diffused into the micropores of LTA zeolite.

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