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Evaluation of a Commercial Chabazite-Type Zeolite Aging in the Industrial Process of Dehydration of Natural Gas CO2-Enriched

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In this work, a commercial zeolite, in two states of fresh and aged, is considered for investigation. The aged sample obtained from an industrial natural gas (NG) dehydration plant was used as a reference. The effect of the aging process on the sample structure and the capability to perform the adsorption/desorption process were assessed using different characterization methods. Analytical and spectrometry techniques such as XRF, XPS, DRIFTS, and EDS/SEM were applied for elemental and bonding analysis, in addition to recognizing the type of carbon deposition. XRD was used to verify any structural changes during the aging process, and N2 adsorption/desorption was employed to measure the specific surface and volume of the samples [1,2].
Abundant adsorption/desorption cycles for the gas dehydration process showed that the aging mainly affected the activation of zeolite by hydrocarbon deposition. Minor changes, such as the size and migration of cations, were detected in the structures. The TGA curves for the chabazite zeolite used in the industrial plant showed the oxidation/burning of amorphous carbonaceous material (coke), between 250 and 400℃ and the oxidation of carbonaceous material structurally organized in the temperature range of 400-700℃. Therefore, TGA identified the presence of coke deposition on the surface of the aged sample after use in the NG dehydration. The Temperature-programmed CO2 desorption (TPD-MS) showed significant deactivation of the adsorbent evidenced by the reduction in CO2 adsorption from 128.8 µmols/g to 13.6 µmols/g after the adsorption and regeneration cycles during the industrial operation of NG dehydration. The TPD-MS analysis was presented as an efficient technique to investigate the interaction of the adsorbent CO2 molecules with the solid surface of the studied zeolite, being an important tool for the evaluation of active surface sites. For this reason, TPD-MS can provide crucial information for the qualification of molecular sieves for the NG dehydration process.

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