Institute of Chemical Engineering

Effect of support structure and polyamine type on CO2 capture in hierarchically structured monolithic sorbents

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The objective of this work was to study properties of monolithic CO2 sorbents. The materials were obtained by molecular basket approach with polyethyleneimine (PEI) and grafting method using the silane-modified polyamines (trimethoxysilylpropyl-modified polyethylenimine and dimethoxymethylsilylpropyl-modified polyethylenimine). Adsorption measurements were carried out by means of thermogravimetry to determine the impact of the monolith structure, type of amine precursor and its loading on sorption capacity and performance of adsorption/desorption process. Highly effective sorbents were fabricated using hierarchically structured silica monoliths of cylindrical shape (dimension of 4 × 4 mm), which were characterized by large surface area, SBET, ca. 650 m2/g and high porosity (pore volume ca. 4.1 cm3/g). The PEI-modified sorbents, due to larger content of amine groups, enabled much more efficient CO2 capture in comparison to the grafted materials. The complexity of pore structure/amine loading/thickness of active layer/sorption capacity relationships was demonstrated. It was shown that the thickness of active layer had a strong impact on CO2 diffusion and accessibility of amine groups, and thus on the sorption performance. Due to large surface area of the hierarchically structured monolithic support, the thickness of active layer in sorbents highly loaded with polyamines was low and thus the accessibility to the adsorption centres was improved. Multiple adsorption/desorption cycles clearly demonstrated good stability and recyclability of PEI and silane-modified materials.

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