INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Programme of Study	:	Ph.D.

Thesis Title: Amine Functionalized and Cation-Exchanged Zeolites for Selective Adsorption of Carbon Dioxide over Nitrogen and Methane

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SHORT ABSTRACT

This Ph.D. research works addressed enhanced CO_2 capture through the adsorption-based processes and with Zeolite-Y as the primary support material. To assess alternate commercial as well as synthesized sorbents, single gas sorption experiments with CO_2, N_2 and CH_4 were conducted. Among alternate sorbents, Zeolite-Y was selected after comparing its CO_2 adsorption capacity (highest of 1.89 mmol g^{-1} at 303K and 1bar) with respect to other commercial zeolites (Beta and ZSM-5 commercial sorbents). After selecting Zeolite Y as the primary support material, the study followed a three-phase approach. Among these, firstly, Zeolite-Y was functionalized with mono-, di-, and triethanolamine. Thereby, the monoethanolamine-loaded samples exhibited the highest CO_2 uptake (up to 2.26 mmol/g at 303 K and 1 bar). The adsorption behavior was modeled with the Langmuir and Virial isotherm, and selectivity was assessed via IAST. In the second phase, cation-loaded Zeolite-Y (Li^+, Na^+, K^+ at 5 wt.%) were prepared and the sorbents exhibited enhanced CO_2 selectivity and for the loading order of $K^+ > Na^+ > Li^+$. Among all, potassium loaded Zeolite Y sorbent exhibited highest CO_2 uptake (2.89 mmol g^{-1} at 303K and 1bar). The third phase examined K_2CO_3-impregnated Zeolite-Y. Accordingly, the variant carbonate loadings affirmed optimal CO_2 capacity at 10 wt.% loading of the carbonate (3.61 mmol g^{-1} at 303K and 1bar). Also, the synthesized functional materials exhibited excellent cyclic stability and selectivity. In summary, the Ph.D. thesis research works novelty can be mentioned in terms of cation-carbonate loading for cost-effective, stable and high-performance zeolite-based adsorbents and for the proximity towards industrial-scale CO_2 capture.