Post-combustion capture of CO_2 in potassium-exchanged binder-free beads of Y zeolite

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BIOGRAPHY

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ABSTRACT

The generation of carbon dioxide is inherent in the combustion of fossil fuels, and the efficient capture of CO_2 from industrial operations is regarded as an important strategy to achieve a significant reduction in atmospheric CO_2 levels. Adsorption processes are promising capture technologies as they can use specific adsorbents by acting in the limit as molecular sieves to separate CO_2 from other flue gas constituents. Experimental and theoretical studies concerning the adsorption of CO_2 and N_2 and their mixtures in potassium-exchanged Y zeolite (KY) are lacking information in the literature. Accordingly, this work aims to investigate by a series of fixed-bed adsorption breakthrough experiments the adsorption of single and binary mixtures (under compositions typical of post-combustion) of CO_2/N_2 in binder-free beads of KY zeolite, at 313, 373, and 423 K and total pressures up to 350 K. The single and multi-component breakthrough apparatus used in this work is shown in Figure 1. The dynamic equilibrium loading is calculated by integrating the molar flow profiles of the breakthrough curves, as explained in previous works [1]. The adsorption equilibrium data was then modelled by the extended dual-site Langmuir model, and the breakthrough curves were numerically simulated using ASPEN ADSORPTION. At 313 K and 350 kPa, the single-component data obtained showed that the amount adsorbed of CO2, and N2 is around 6.42 and 0.671 mol.kg-1, respectively. The binary experiments CO_2/N_2 carried out under typical post-combustion conditions, show a selectivity of CO_2 over N_2 around 104. Overall the numerical simulations performed on ASPEN ASDSORPTION provided results with decent accuracy and the model can predict the systematic behaviour of the breakthrough experiments as well as the dynamics of the fixed bed adsorption system. The results shown in the present work proves that potassium-exchanged binder-free beads of Y zeolite is a promising adsorbent that can efficiently separate CO_2 from post-combustion streams by fixed bed adsorption.

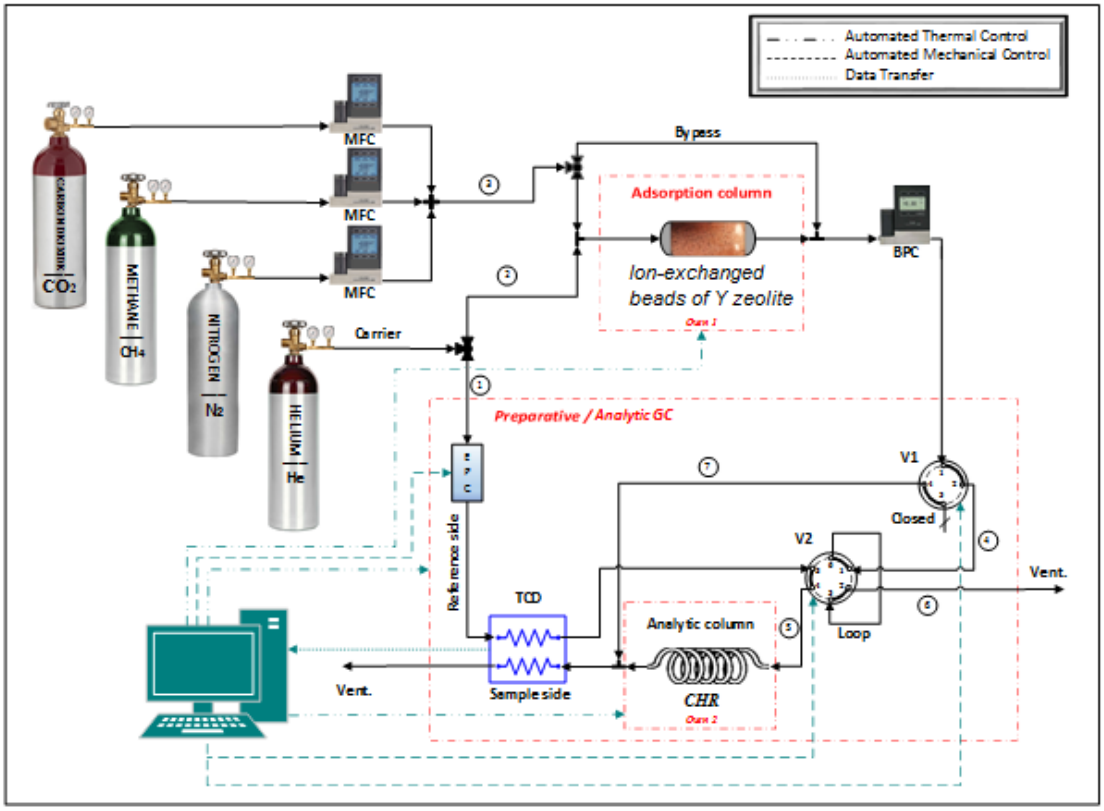

Figure 1- Schematic drawing of the experimental apparatus used to perform single- and multicomponent breakthrough experiments.

REFERENCES

[1] E. Aly *et al.*, "Fixed Bed Adsorption of CO2, CH4, and N2 and Their Mixtures in Potassium-Exchanged Binder-Free Beads of Y Zeolite," *Ind. Eng. Chem. Res.*, vol. 60, no. 42, pp. 15236–15247, Oct. 2021, doi: 10.1021/acs.iecr.1c02261.

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