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Adsorption separation of CO_2, CH_4, and N_2 on microwave activated carbon

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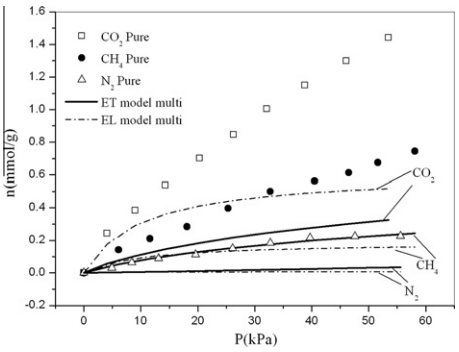
HIGHLIGHTS

- The adsorption capacities of three gases on MAC follow the order: $CO_2 > CH_4 > N_2$.
- CO_2 still dominate the adsorption system in dynamic adsorption of ternary mixture.
- The separation factors of mixtures follow the order: $CO_2/N_2 > CO_2/CH_4 > CH_4/N_2$.
- MAC may be a new material candidate for the purification of biogas.

GRAPHICAL ABSTRACT

Competitive effect for adsorption of multi component (CO_2, CH_4 and N_2) at 298 K. The adsorption isotherms of the pure gases and the prediction adsorption isotherms of multi component which were calculated by two models were depicted in the figure. It can be seen that each component gets large loss in adsorption amount due to the existence of competition adsorption for both prediction models. The loss of adsorption amount varies with pressure. The higher the pressure, the greater the loss is. In addition, CO_2 still dominate the adsorption system and accounts for large share in multi component adsorption with the lower partial pressure compared with CH_4, N_2 are trace components.



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ABSTRACT

In this study, the adsorption equilibrium isotherms of carbon dioxide, methane and nitrogen on microwave activated carbon (MAC) at three temperatures (298, 308 and 323 K) have been obtained by a static volume instrument. The adsorption equilibrium data of CO_2, CH_4 and N_2 at various temperatures were fitted to Langmuir and Toth isotherm models. It was found that the fitting results of Toth model were fine. The capacities of pure gas CO_2, CH_4 and N_2 were 2.13, 0.98 and 0.33 mmol g^{-1} at 298 K and the partial pressure of 100 kPa. The competition adsorption behavior of multi component was predicted by the extend Langmuir and Toth model. The results indicated that CO_2 still dominate the adsorption system in the ternary mixtures. Additionally, the separation factors of the binary mixtures CO_2/CH_4, CO_2/N_2 and CH_4/N_2 were calculated from the isotherms data. The results showed that the separation factors (S) of different binary mixtures at 298 K and the total pressure of 100 kPa were as follows: CO_2/N_2 (14.6) > CO_2/CH_4 (4.37) > CH_4/N_2 (3.33). Finally, thermodynamic functions integral Gibbs' free energy (ΔG), integral molar enthalpy change (ΔH) and entropy change (ΔS) were calculated to characterize adsorption behavior.

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