Non−isothermal diffusion mechanism of four gases on pelletized zeolite 13X: $CO_2$, $CO$, $N_2$ and $CH_4$

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In industrial adsorptive cyclic processes, pelletized zeolites are widely applied, instead of powder zeolites, because of pressure drop in a bed. Therefore, the understanding of adsorption kinetics of pelletized zeolites is important to design efficient adsorption processes. In the study, the adsorption kinetics of $CO_2$, $CO$, $N_2$, and $CH_4$, which are the main components in various effluent gases, on pelletized zeolite 13X was measured via a volumetric method at 293, 308 and 323 K. The experimental uptake curves were correlated with a non−isothermal diffusion model because the adsorption kinetics was controlled via heat generation and transfer. Adsorption rates of the gases on pelletized zeolite 13X were affected by the heat of adsorption, heat transfer rate and adsorption affinity. At the same temperature and pressure, the sequence of the effective diffusional time constant revealed the following sequence: $CH_4 \fallingdotseq N_2 < CO < CO_2$, showing pressure and temperature dependency. While the diffusion rates of $CO$ and $N_2$ were controlled via micropore diffusion, $CO_2$ and $CH_4$ were significantly affected by macropore diffusion due to high heat transfer resistance. The results could contribute to designing adsorptive processes using zeolite 13X for $CH_4$ recovery and $CO_2$ capture from various effluent gases.