288j Kinetic Separation of Co_2/Ch_4 Mixture Using Carbon Molecular Sieve by Two-Bed Psa: Nonisothermal Operation

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Fixed-bed adsorption process, especially pressure swing adsorption (PSA), has been an important unit operation for purification and bulk separation of gas mixture. Separation of a gas mixture by PSA is generally accomplished by either selective adsorption (equilibrium separation) or by differences in the diffusion rates of different molecules into an adsorbent (kinetic separation). A third mechanism (steric separation) derives from the molecular sieving property of zeolite. A large majority of processes operate through the equilibrium adsorption of the gas mixture, and only a few steric separation processes were commercialized.

Kinetic separations have lately attracted considerable attention with the development of functional microporous adsorbents and efficient modeling tools. Among the microporous adsorbents, carbon molecular sieve (CMS) has a bidispersed pore structure with clearly distinguishable macropore and micropore, and its micropore size is known in the range of 3~5Å. This adsorbent has the pores of molecular dimensions that provide the relatively a high adsorption capacity and kinetic selectivity for various gases. The pressure-dependence of the apparent time constant had a large effect on the performance and, when this effect was allowed for, the predictions of the model were in good agreement with the experimental data.

The present work studies the methane separation from landfill gas (LFG, CO_2/CH_4=50/50 Vol.%) in a commercial CMS (Takeda-3A) using the modified Skarstrom cycle with co-current pressure equalization. Comparison in adsorption dynamics between supercritical structural model with pressure-dependent diffusivity and the LDF model with constant diffusivity was made. In addition, the thermal effect was evaluated by using a non-isothermal dynamic model. The effects of operating variables such as adsorption step time, feed flow rate, purge-to feed ratio, and adsorption pressure on the performance of methane separation were investigated.