

Adsorption Technologies for BIOGAS Upgrading and CO₂ Sequestration

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The reduction of CO₂ and CH₄ emissions to atmosphere is a matter of great concern nowadays since both gases can contribute significantly to the so-called greenhouse effect. At the same time, CO₂/CH₄ separations are of interest in treating gas streams like landfill gas, biogas and coal-bed methane. Biogas is mainly composed by CH₄ (60 to 70%) and CO₂ (30 to 40%) and to obtain a high energy content CO₂ needs to be separated from CH₄. For this purpose a variety of solid physical adsorbents have been considered including Zeolites and Metal-Organic Frameworks (MOFs). The technology for biogas upgrading using adsorbents is called Pressure Swing Adsorption (PSA). With this technique, carbon dioxide is separated from the biogas by adsorption using a porous solid under elevated pressure. In this work, we will present breakthrough experiments and selectivity data of CH₄/CO₂ in zeolite 13X at 303, 313, 323, 343, 373 and 423 K and partial pressures up to 0.5 MPa. These data was used to develop a mathematical model useful to design (simulation) a cyclic adsorption processes (PSA) for the purification of biogas and CO₂ sequestration. Figure 1 shows an experimental breakthrough curve performed in a fixed bed containing zeolite 13X feed with a 50/50-CH₄/CO₂ mixture at 313 K and 0.5 MPa. The breakthrough curve clearly shows the potential of zeolite 13X to separate a CH₄/CO₂ mixtures since a clear separation is observed at the outlet of the bed with a long plateau of pure CH₄ for a period around 4 minutes. Through this work it is also shown that the new 13X zeolite can improve significantly the existing PSA technologies for BIOGAS upgrading with selectivities CO₂/CH₄ that can reach the value 34 and amounts adsorbed of CO₂ around 5.2 mmol/g. A mathematical model was also developed and validated through experimental data to design PSA adsorption processes for biogas upgrading and CO₂ sequestration.

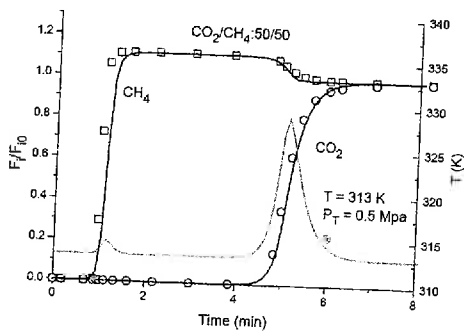


Figure 1 - Binary 50/50 breakthrough curve of CO₂/CH₄ in 13X zeolite at the temperature of 313 K and total pressure in the column of 0.5 MPa. Points are experimental data and lines represent model (simulated) predictions (black for fluxes and red for temperature).