Adsorption Technologies for BIOGAS Upgrading and CO_2 Sequestration

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The reduction of CO_2 and CH_4 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, CO_2/CH_4 separations are of interest in treating gas streams like landfill gas, biogas and coal-bed methane. Biogas is mainly composed by CH_4 (60 to 70%) and CO_2 (30 to 40%) and to obtain a high energy content CO_2 needs to be separated from CH_4. 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 CH_4/CO_2 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 CO_2 sequestration. Figure 1 shows an experimental breakthrough curve performed in a fixed bed containing zeolite 13X feed with a 50/50-CH_4/CO_2 mixture at 313 K and 0.5 MPa. The breakthrough curve clearly shows the potential of zeolite 13X to separate a CH_4/CO_2 mixtures since a clear separation is observed at the outlet of the bed with a long plateau of pure CH_4 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 CO_2/CH_4 that can reach the value 34 and amounts adsorbed of CO_2 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 CO_2 sequestration.

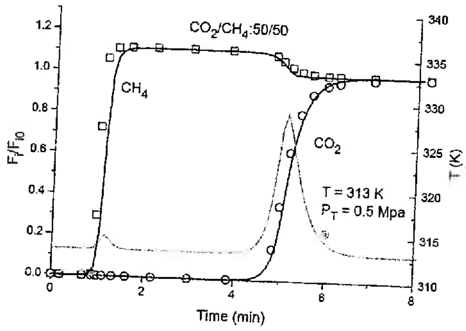

Figure 1 - Binary 50/50 breakthrough curve of CO_2/CH_4 in 13X zeolite at the temperature of 313 K and total pressure in the column of 0.5 MPa. Points are experimental data and lines represent model (simulated) predictions (black for fluxes and red for temperature).