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AUTHORS
Fernando Castro, Cândida Vilarinho, Joana Carvalho, Alexandra Castro, Jorge Araújo, Alexandra Pedro.

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Rui Ferreira

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CVR - Centro para a Valorização de Resíduos
Campus de Azurém da Universidade do Minho
4800-058 Guimarães
PORTUGAL

Telef.: +351 253 510 020
Fax: +351 253 510 029
http://www.cvresiduos.pt
e-mail: geral@cvresiduos.pt

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POROUS SOLIDS FOR BIOGAS UPGRADING

silva, jose [1][a], rodrigues, alirio [2][b]

[1] LSRE-IPB
[2] LSRE-FEUP
[a] jsilva@ipb.pt
[b] arodrig@fe.up.pt

ABSTRACT

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 that describes the trapping of heat near earth's surface by gases in the atmosphere. At the same time CO2/CH4 separations are of interest in treating gas streams like landfill gas, biogas and coal-bed methane. Accordingly, there is a need to investigate on this topic and that can be done with improved efficient technologies to separate or remove CO2 and CH4 from exhaust gases. Two recent reviews discuss this matter with great detail concerning the use of adsorbents (porous solids) based technologies to handle CO2 capture and CO2/CH4 separations [1,2].

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 molecular sieve zeolites and a new class of adsorbents named 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 under elevated pressure. The adsorbing material, is regenerated by a sequential decrease in pressure before the column is reloaded again, hence the name of the technique.

In this work, we will present sorption equilibrium, kinetic and fixed bed data of CO2, CH4 in MOF-508b and zeolite 13X at 303, 323 and 343 K and partial pressures up to 4.5 bar. These data are fitted with appropriate isotherm models. At the same time single, binary and ternary breakthrough curves were measured to provide required data to develop and validate a mathematical model based on the LDF approximation for the mass transfer, which could be used in the design (simulation) of 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 5 atm. The breakthrough curve clearly shows the potential of zeolite 13X to separate a CH4/CO2 mixture since a clear separation of CH4 from CO2 is observed at the outlet of the bed with a long plateau of pure CH4 for a period around 4 minutes.

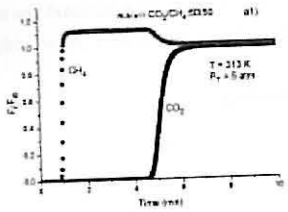

Figure 1 - Experimental breakthrough curve for sorption of a binary mixture 50/50- CO2/CH4 at 313 K and 5 atm in a fixed bed containing binderless beads of 13X zeolite

[Keywords] Biogas Upgrading; Pressure Swing Adsorption; Zeolite 13X; MOF-508

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