## Programa Científico

| | | | | |
|---|---|---|---|---|
| **28 de novembro - Quarta-feira** | | | | |
| 9:00 - 11:30 | Entrega de documentação e afixação de painéis | | | |
| **Sala** | **Aula Magna** | | | |
| 11:30 - 12:10 | Sessão de abertura e boas-vindas | | | |
| **Chairperson**<br>**Sala** | **José Luis Figueiredo**<br>**Aula Magna** | | | |
| 12:10 - 13:00 | **PL 1 – Gianluca Li Puma**, Departamento de Engenharia Química, Universidade de Loughborough, Inglaterra<br>*Semiconductor photocatalysis and photoreaction engineering for environmental and renewable energy applications* | | | |
| 13:00 - 15:00 | **Almoço** | | | |
| **Chairperson**<br>**Sala** | **Baltasar Romão de Castro**<br>**Aula Magna** | | | |
| 15:00 - 15:50 | **PL 2 – Juan Mogín del Pozo**, Colégio Oficial de Químicos de Galícia<br>*Presente y futuro del papel de la química en el tratamiento de los residuos* | | | |
| **Chairperson**<br>**Salas** | **Comunicações Orais** | **Auditório 1** | **Auditório 2** | **Auditório Geociências** |
| 15:50 - 16:40 | | Química e Energia | Química Alimentar | Química Ambiental |
| | 15:50 - 16:05 | ENER-1 | AMA-1 | AMB-1 |
| | 16:05 - 16:20 | ENER-2 | AMA-2 | AMB-2 |
| | 16:20 - 16:35 | ENER-3 | AMA-3 | AMB-3 |
| | 16:35 - 16:40 | *Discussão* | *Discussão* | *Discussão* |
| 16:40 - 17:00 | **Café, discussão de painéis e *wine party*** | | | |
| 17:00 - 18:40 | | Química Fundamental | Química e Saúde | Química Industrial |
| | 17:00 - 17:15 | F-1 | SAU-1 | IND-1 |
| | 17:15 - 17:30 | F-2 | SAU-2 | IND-2 |
| | 17:30 - 17:45 | F-3 | SAU-3 | IND-3 |
| | 17:45 - 17:50 | *Discussão* | *Discussão* | *Discussão* |
| | 17:50 - 18:05 | F-4 | SAU-4 | IND-4 |
| | 18:05 - 18:20 | F-5 | SAU-5 | IND-5 |
| | 18:20 - 18:35 | F-6 | SAU-6 | IND-6 |
| | 18:35 - 18:40 | *Discussão* | *Discussão* | *Discussão* |
| 18:40 – 19:30 | **Discussão de painéis e *wine party*** | | | |
| | | | | |
| **29 de novembro - Quinta-feira** | | | | |
| **Chairperson**<br>**Sala** | **Antonio Macho**<br>**Aula Magna** | | | |

IND-06

# Adsorption and separation of $CO_2/CH_4$ on Binderless Beads of 13X Zeolite

José A. C. Silva*[1], Kristin Shumann[2], Alirio E. Rodrigues[3]

[1] Instituto Politécnico de Bragança, Apartado 134, 5301-857 Bragança, Portugal
[2] Chemiewerk Bad Köstritz GmbH, Heinrichshall 2, 07586 Bad Köstritz, Germany
[3] LSRE, Faculdade de Engenharia, Rua do Dr. Roberto Frias, S/N, 4200-465 Porto, Portugal

*jsilva@ipb.pt

$CO_2/CH_4$ separations are of great economical and technological importance 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 $CO_2$ and $CH_4$ from exhaust gases.

To be used as adsorbents zeolite powder needs to be transformed into pellets or beads and this reduces it's working capacity in 20% or more which is the amount of adsorptive inert clay binder generally used. Recently a technology has been recovered and improved for the synthesis of binderless beads of 13X zeolite where the non-zeolitic components (temporary binder) are converted to zeolite during a hydrothermal conversion after the manufacturing procedure [1]. The resulting binderless beads can increase in this way the working capacities of existing zeolite adsorbent technologies.

The sorption equilibrium of $CO_2$ and $CH_4$ has been investigated on the binderless beads of 13X zeolite between 313 and 373 K and pressure up to 4 atm. The amount adsorbed of $CO_2$ and $CH_4$ is around 5.2 mmol/$g_{ads}$ and 1.2 mmol/$g_{ads}$, respectively, at 313 K and 4 atm. Comparing these values with the ones in literature the value of $CO_2$ is 20% higher than in similar 13X binder pellets.

The sorption kinetics has been also investigated by the Zero-Length Column technique (ZLC). Recipes to analyze ZLC desorption curves in pellets and beads of adsorbents are reviewed and it is derived a criteria which indicates that for the sorption rate be measured macroscopically the time of the experiment (that should be above a few seconds) is directly calculated with the following expression: $t_{0.1} = 7.02 \times 10^{-2}\ r_c^2/D_c$ .The crystal diffusivity of $CO_2$ measured experimentally in the binderless zeolite 13X is $5.8 \times 10^{-15}$ $m^2/s$ and $1.3 \times 10^{-15}$ $m^2/s$ at 373 and 313 K, respectively. Figure 1 shows the adsorption equilibrium isotherms of $CO_2$ and $CH_4$ and the effect of temperature on ZLC desorption curves for $CO_2$ measured through this work on 13X zeolite.

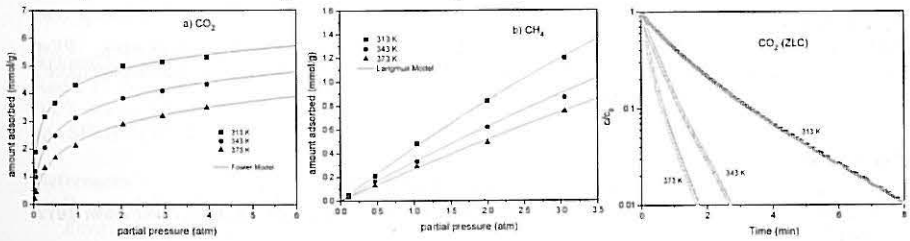


Figure 1. Adsorption equilibrium isotherms of $CO_2$ and $CH_4$ and ZLC desorption curves for $CO_2$ as a function of temperature on binderless beads of 13X zeolite.

**References:**

[1] K. Schumann *et al.*, Investigation on the pore structure of binderless zeolite 13X shapes Micropor. *Mesopor. Mater.***2012**, 154, 119-123.