41RIA IBA3

41ª RIA Reunión Ibérica de Adsorción

3er Simposio IBEROAMERICANO de ADSORCIÓN

41ª Reunión Ibérica de Adsorción

3er Simposio Iberoamericano de Adsorción

5-7 septiembre/setembro/September 2018 · Gijón, Asturias (España)

# ABSTRACTS BOOK


# 41ª Reunión Ibérica de Adsorción - 3er Simposio Iberoamericano de Adsorción

## 41ª Reunião Ibérica de Adsorção - 3º Simpósio Ibero-Americano de Adsorção

41st Iberian Adsorption Meeting - 3rd Iberoamerican Adsorption Symposium

Palacio de Congresos de Gijón, Sala Anfiteatro

Recinto Ferial Luis Adaro, Gijón

5-7 Septiembre/Setembro/September 2018

## Organized by:





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## VENUE

**Conference.** Gijón Convention Center. Av. Dr. Fleming, 481, Gijón

**Adsorption School.**

**Tuesday**. Casino de Asturias, Sala Acapulco, Fernández Vallín St., 5, 33205, Gijón

**Wednesday-Friday**. Gijón Convention Center. Av. Dr. Fleming, 481, Gijón

**Iberoamerican Women Scientists Round Table (OPEN ACTIVITY).** Antigua Escuela de Comercio, Francisco Tomás y Valiente St., 33201 Gijón

**Opening Ceremony and Welcome Cocktail.** Casino de Asturias, Sala Acapulco. Fernández Vallín St., 5, 33205, Gijón.

**Adsorption at the pub (OPEN ACTIVITIY).** Savoy, Covadonga St, 5, 33202 Gijón

**Gala Dinner.** Bellavista Restaurant, Av. José García Bernardo, 256, 33203, Gijón

# Comparison between the Ability of Sulphuric Acid, Nitric Acid and Urea as Chemical Activators of Commercial Activated Carbons for $CO_2$ Capture

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Physical adsorption process has been considered as a promising technique for $CO_2$ capture, due to low energy consumption and high efficiency. In this way, several adsorbents including activated carbons [1], zeolites [2] and MOFs [3] have been extensively studied for $CO_2$ adsorption in the recent years. Activated carbon has attracted much attention, because of amorphous porous form, hydrophobic character and low energy for desorption [4]. To preparation of this adsorbent, physically (thermally) and chemically methods are the two main strategies. In the first method, the materials are carbonized in the temperature range of 400-850 $^0$C, while in the second one by using some chemical components activation takes place by heating the mixture of precursor and dehydrating agent or oxidant. Hereby, based on BLUE Map Scenario of the International Energy Agency (IEA) [5], an activated carbon (Norit ROX 0.8) has been modified by using different chemical and thermal treatments, following the procedures described elsewhere [6]. In order to obtain adsorbents with smaller particle size, commercial activated carbon was first grinded and sieved to particle sizes ranging from 0.106 to 0.250 mm, resulting in a powder activated carbon (PAC). Three of the materials were prepared directly from the PAC sample by liquid phase treatments with hydrogen peroxide, sulphuric acid and nitric acid, resulting in PACHP, PACSA and PACNA materials, respectively. The treatment with hydrogen peroxide was performed wetting 25 g of PAC with 500 mL of hydrogen peroxide solution 30% (w/v) at room temperature for 24 h. In sulphuric acid oxidation, 25 g of PAC was immersed in 500 mL of 18 M acid solution for 3 h at 423

K. Oxidation with nitric acid was carried out boiling 25 g of PAC in 500 mL of 5 M nitric acid solution for 3 h. After the liquid phase treatments, all samples were thoroughly washed with distilled water until the neutrality of the rinsing waters and further dried in oven for 18 h at 383 K, resulting in samples PACHP, PACSA and PACNA, respectively. The other two samples were obtained in successive treatments of the PACNA material. 2 g of PACNA was immersed in 50 mL of 1 M urea solution and kept in a 125 mL stainless steel high pressure batch reactor under its own atmosphere at 473 K for 2 h, the recovered solids being thoroughly washed with distilled water until the neutrality of the rinsing waters, and further dried overnight in oven at 383 K, resulting in the PACNAU material. Then, a gas phase thermal treatment was applied, in which 1 g of PACNAU was heated, under a $N_2$ flow (100 $cm^3$ $min^{-1}$), at 393 K, 673 K and 873 K during 60 min at each temperature and then at 1073 K for 240 min, resulting in the PACNAUT material.

The textural properties of the materials were determined from $N_2$ adsorption–desorption isotherms at 77 K, obtained in a Quantachrome NOVA 4200e adsorption analyzer. The specific surface area ($S_{BET}$) was calculated using the BET method. The external surface area ($S_{ext}$) and the micropore volume ($V_{mic}$) were obtained by the *t*-method (thickness was calculated by employing ASTM standard D-6556-01). The total pore volume ($V_{Total}$) was calculated at $p/p^0$ = 0.98. The microporous surface area ($S_{mic}$) was determined as the subtraction of $S_{ext}$ from $S_{BET}$ and the average pore width ($W_{mic}$) by approximation ($W_{mic}$ = 4 $V_{mic}/S_{mic}$).

The equilibrium adsorption of $CO_2$ onto prepared samples was evaluated in a fixed bed reactor by using breakthrough method at selected temperatures (40, 70, 100 $^0$C) and total pressures (1, 2, 3, 4, 5 bar). The isothermal comparison of prepared sample at 40 $^0$C and different partial pressure of $CO_2$ has been depicted in Fig. 1.

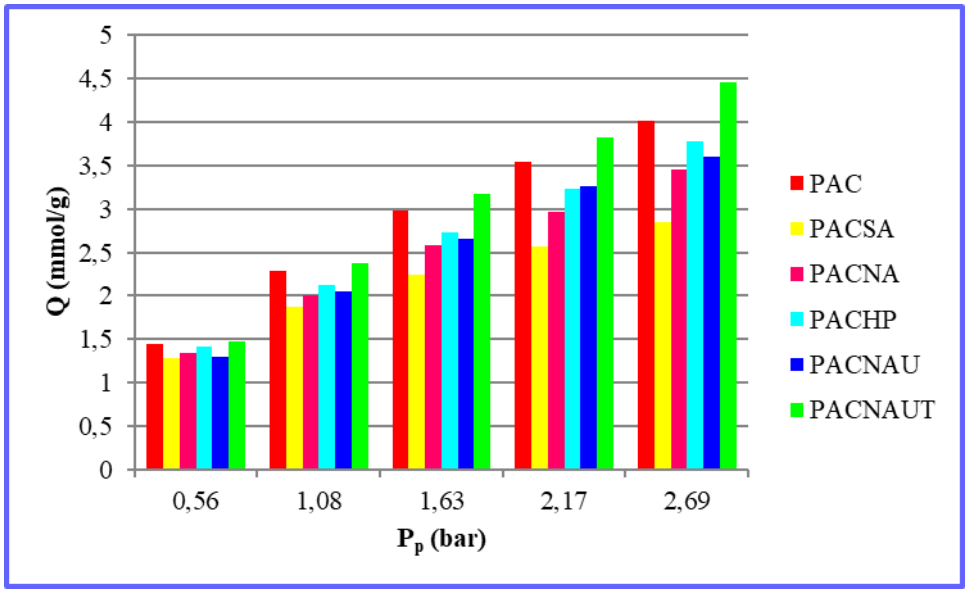


**Figure 1.** The comparison between $CO_2$ uptake capacity (mmol/g) of prepared adsorbents at 40 C.

As can be seen, the results show that the sample which was subsequently treated with nitric acid, urea and thermal calcination has a higher uptake capacity when compare to the other ones. This behavior can be interpreted based on the higher external surface area (Table 1) that was ascribed for the likely desorption of weak superficial groups as consequence of the thermal treatment at 800 ºC under nitrogen flow to obtain the material.

**Table 1.** Textural properties of the powdered activated carbons determined from BET and *t*-Plot methods.

| | $S_{BET}$ ($m^2 \cdot g^{-1}$) | $S_{ext}$ ($m^2 \cdot g^{-1}$) | $S_{mic}$ ($m^2 \cdot g^{-1}$) | $V_{mic}$ ($mm^3 \cdot g^{-1}$) | $V_{mic}/V_{Total}$ (%) | $W_{mic}$ (nm) |
|---|---|---|---|---|---|---|
| **PAC** | 885 ± 10 | 160 ± 2 | 725 ± 12 | 314 ± 1 | 58 | 1.73 ± 0.03 |
| **PACSA** | 862 ± 9 | 150 ± 2 | 712 ± 11 | 308 ± 1 | 59 | 1.72 ± 0.03 |
| **PACHP** | 893 ± 10 | 159 ± 2 | 734 ± 12 | 319 ± 1 | 58 | 1.73 ± 0.03 |
| **PACNA** | 889 ± 10 | 170 ± 2 | 719 ± 12 | 311 ± 1 | 57 | 1.72 ± 0.03 |
| **PACNAU** | 960 ± 11 | 181 ± 2 | 778 ± 12 | 336 ± 1 | 58 | 1.72 ± 0.03 |
| **PACNAUT** | 1055 ± 11 | 197 ± 2 | 858 ± 12 | 367 ± 1 | 58 | 1.71 ± 0.03 |

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