Using Waste Recycled PET for AC Production for Pesticides Removals from Aqueous Solutions.

• I.P.P. Cansado • C. Galacho • A.S. Nunes • M.M.L. Ribeiro Carrott • P.J.M. Carrott

UNIVERSIDADE DE ÉVORA

Centro de Química de Évora

I Objectives

- Adsorption of methylene blue, MB, a well-established organic dye probe, for ascertaining adsorption capability of the Activated Carbons (AC) prepared, by chemical activation, from recycled PET.
- Adsorption of 4-chloro-2-methylphenoxyacetic acid, MCPA, an organic pollutant (herbicide), from the liquid phase.
- Comparative study of the influence of the textural and chemical parameters of activated carbons on the liquid phase adsorption..

II Introduction

The extensive contamination of soils and ground water from the widespread use of pesticides in modern agriculture is a current concern that is impelling research looking for remedies. Since the presence of herbicides in water can cause serious problems in the environment and to human health, their removal from wastewaters is a crucial issue. Adsorption onto porous materials is, amongst the methods currently employed to remove herbicides from aqueous phase, one of the most used [1]. Activated carbons, with high surface areas, capacity of being texturally and chemically modified and regenerated by thermal desorption or combustion have been powerful and dominant adsorbents for liquid phase adsorption.

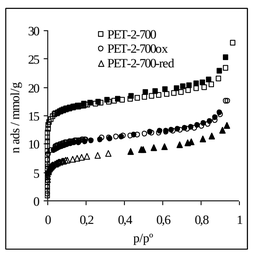
III Experimental

- **Synthesis** Waste granulated PET was used as raw material to prepare AC by chemical activation with KOH at 973 K and a ratio of KOH/precursor=2; (PET-2-700) [2]. Part of this sample was treated with concentrated HNO_3 at 358 K for 1 hour (PET-2-700ox); another part was heated at 1173 K during 2 hours in a nitrogen flux of 85 mL/min (PET-2-700red).
- **Characterisation** AC Nitrogen adsorption at 77 K, Elemental analysis (EA), Fourier transform infrared spectroscopy (FTIR) and point of zero charge (pcz).
- **Liquid phase adsorption of MB and MCPA**

A fixed amount of adsorbent was added to a flask containing the same volume of aqueous solutions with different initial known concentrations. The flasks were then placed in a thermostated shaker bath, at 298 K, for different times, to establish the equilibrium time (4 days). The pH of the medium with MCPA was controlled by the addition of HCl or NaOH (0.1mol/L) to adjust the pH to 3, 7 and 11. All suspensions were then filtered, diluted if needed, and the residual concentrations of the MB and MCPA were determined by UV-Vis by measuring the absorbance at characteristic wavelengths, respectively, 630 / 228.6 or 279 nm. The Langmuir and Freundlich models were applied to the experimental results as reported before[3].

IV Results / Discussion

- **Structural Characterisation**



- **Chemical Characterisation**

N_2 Adsorption at 77K

➲AC materials: Type I Isotherms ⇒ microporous materials

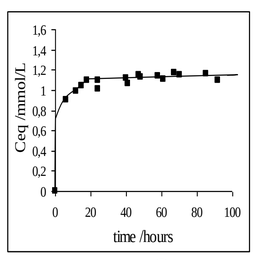
Micropore volume - 0.23-0.57 cm^3g^{-1} mean pore size ~1.03–1.45 nm

➲AC materials: Point of zero charge

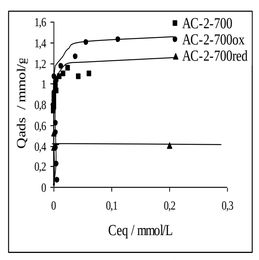
PET-2-700 - 6.49 PET-2-700ox - 2.15 PET-2-700red - 8.73

- **Liquid Phase Adsorption**

MB Adsorption on AC Materials at 298K



Kinetic Study



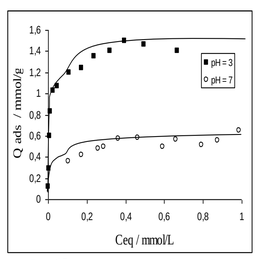
Adsorption Isotherms

Minimum equilibrium time ⇒ 20h

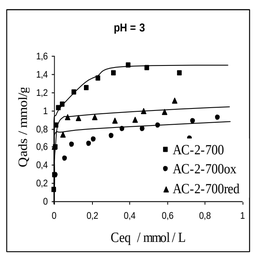
➲ Maximum adsorption capacity ⇒

~1.4 mmol/g on AC-2-700ox

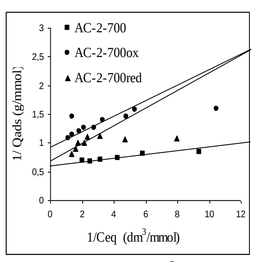
MCPA Adsorption on AC Materials at 298K



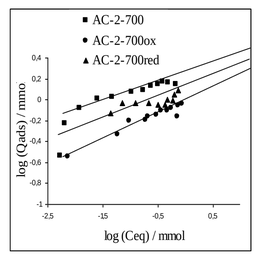
Influence of pH



Adsorption Isotherms



Langmuir representation



Freundlich representation

Optimal pH value ⇒ 3

Maximum adsorption capacity ⇒

~1.4 mmol/g on AC-2-700

Good fit of Langmuir and Freundlich models

AC-2-700red exhibit the worse adjustment

V Conclusions

- The AC textural characteristics and the results of the MB and MCPA adsorption show that recycled PET can be used, as precursor, for the production of activated carbon capable of herbicide removal from wastewater.
- The MB removal was more efficient on the AC-2-700ox and the MCPA on AC-2-700, in an acidic medium.
- The adsorption capacity of the AC prepared was only slightly inferior for MCPA when compared with the commercial AC-ONEP used in drinking water treatments [4].

VI References

[1] G.G. Stavropoulos, Fuel Processing Technology **86** (2005) p. 1165.
[2] I.P.P. Cansado, M.M.L. Ribeiro Carrott, P.J.M. Carrott, P.A.M. Mourão, Materials Science Forum **587** (2008) p. 753.
[3] K.Y. Ho, G. McKay and K.L. Yeung, Langmuir, **19** (2003) p. 3019.
[4] A. Baçaoui, A. Dahbi, A. Yaacoubi, F.J. Maldonado-Hódar, J. Rivera-Utrilla, F. Carrasco-Marín, C. Moreno-Castilla, Env. Sci. Technol. **36** (2002) p.3844.

Acknowledgements: This work was supported by FCT , COMPETE, QREN and FEDER under project FCOMP-01-0124-FEDER-007142

International Year of CHEMISTRY 2011