

# Removal of Bisphenol A by adsorption onto novel carbon materials: Effect of environmentally-relevant aqueous matrices

S. Álvarez-Torrellas<sup>(1)</sup>, A.B. Hernández-Abreu<sup>(1)</sup>, V.I. Águeda<sup>(1)</sup>, M. Larriba<sup>(1)</sup>, J.A. Delgado<sup>(1)</sup>, P.Á. Calvo<sup>(2)</sup>, J. García<sup>(1)</sup>

<sup>(1)</sup>*Grupo de Catálisis y Procesos de Separación (CyPS), Departamento de Ingeniería Química y Materiales, Facultad de Ciencias Químicas, Universidad Complutense de Madrid, Avda. Complutense s/n, 28040 Madrid, España.*

+34913944118; satorrellas@ucm.es

<sup>(2)</sup>*I+D+i Biocombustibles, ENCE, Energía y Celulosa, Calle Lourizán s/n 36153 Pontevedra, España*

**1. Introduction.** Bisphenol A (BPA) is one of the highest produced and consumed chemical compounds in the world. This xenoestrogenic substance has been broadly used for the production and manufacture of many kinds of polycarbonate and epoxy resins-based products. Although they are usually detected in wastewater at very low concentrations ( $\mu\text{g-ng/L}$ ), the exposure to endocrine disrupting compounds (EDCs) is extremely harmful to humans and aquatic organisms because they can interfere with the endocrine functions, either by directly activating or inactivating endocrine target receptors or by disrupting or inhibiting the synthesis of hormones and metabolism of enzymes [1].

In this context, adsorption has been proposed as an efficient and low-cost technology. In this work, two carbon materials were synthesized in the laboratory; a xerogel (RFX) prepared by an optimized conventional sol-gel method and a lignin-based activated carbon (KLP) obtained via chemical activation from Kraft lignin.

**2. Experimental.** The adsorbents were synthesized in the laboratory and then they were fully characterized by using several characterization techniques ( $\text{N}_2$  adsorption-desorption, SEM, FTIR and determination of isoelectric point). The adsorbents were used in batch mode operation, using different weights of adsorbent (250-500  $\mu\text{m}$ ) put in contact with 25 mL of BPA solution ( $100 \text{ mg L}^{-1}$ ) at constant shaking (250 rpm) and temperature ( $\pm 25 \text{ }^\circ\text{C}$ ). BPA concentration was analysed by high performance liquid chromatography (HPLC) using a Varian Prostar chromatograph with a Perkin Elmer column (220 mm x 4.6 mm; 5  $\mu\text{m}$ ). The mobile phase was acetonitrile/acidified water (45:55 v/v) at a volumetric flow rate of  $0.4 \text{ mL min}^{-1}$  and the detection was carried out at a wavelength of 275 nm.

**3. Results and Discussion.** The adsorptive efficiency of the lab-synthesized materials was compared to that obtained for a commercial granular activated carbon (F400). The synthesized adsorbents (RFX and KLP) reached the equilibrium adsorption in only 24 hours, whereas F400 activated carbon required 48 hours. In addition, F400 and KLP materials showed higher BPA equilibrium adsorption capacity values ( $q_e = 407$  and  $220 \text{ mg/g}$ , for F400 and KLP, respectively) than that obtained for the xerogel ( $q_e = 78 \text{ mg/g}$ ). The adsorption kinetic data were fitted to several kinetic models, e.g., pseudo-first order, pseudo-second order and Elovich equations. Thus, the adsorption process could be described by the intra-particle diffusion model, finding two steps associated to the main mass transfer resistances involved in the adsorption process. In addition, the experimental adsorption isotherms were fitted to several empirical models, finding the best agreement for Sips and dual-site Langmuir equations.

Finally, the adsorption tests accomplished using environmentally-relevant aqueous matrices, e.g., WWTP effluent, river water and a hospital wastewater, spiked with BPA revealed a competitive effect between BPA molecule and the natural organic matter (NOM) content for the adsorbent active sites, resulting in a dramatic decreasing of the BPA adsorption capacity.

**4. Conclusions.** The adsorption can be considered as an end-of-pipe technology to remove emerging contaminants from different kinds of wastewater matrices.

**Acknowledgments.** This research has been supported by the Spanish MICINN through the project CTM2017-84033-R. In addition the authors thank the financial support from the Regional Government of Madrid provided through REMTAVARES Network (S2018/EMT-4341) and the European Social Fund.

## References

[1] L.N. Vandenberg, R. Hauser, M. Marcus et al., *Reprod. Toxicol.*, **24**(2), (2007) p. 139.