Activated Carbon Post Treatment Influence on Phenolic Compounds Removal

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I Objectives

- AC preparation from different precursors and their modification / optimisation with sodium hydroxide and urea to improve the adsorption capacities for phenolic compounds from the liquid phase.
- Comparative study of the influence of textural and chemical parameters of AC on the liquid phase adsorption.

II Introduction

Phenols are typically considered as one of the important organic pollutants discharged into the environment causing unpleasant taste and odour and are also toxic, even at low concentrations. Adsorption onto activated carbons (AC) is often considered, amongst the methods currently employed to remove inorganic and organic pollutants, from aqueous or gaseous phases, as the most efficient [1-3]. AC can be produced from a large selection of relatively low cost carbonaceous materials, containing high carbon content, and allow adsorbents to be obtained more economically when compared to other conventional materials. It was reported in the literature, that AC presenting a basic character and also a high nitrogen content show a higher adsorption capacity for phenolic compounds from liquid media. Naturally, the AC post treatment modification with sodium hydroxide or with urea, leading to the formation of basic and nitrogen groups, will contribute to an increase in the phenolic compounds removal capacity.

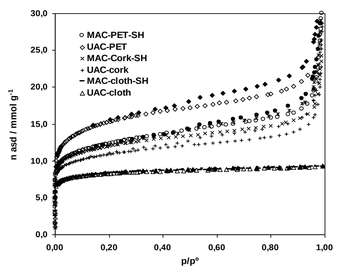
III Experimental

- **Synthesis and modification** Waste cork and recycled PET were used as precursors to prepare AC by chemical activation with KOH at 973 K and a ratio of KOH/precursor=2. Part of theses samples and an AC from charcoal cloth were treated with urea. 0.5 g of AC were mixed with 100 cm^3 of solution, with 2.0 g of urea, (5 hours/363 K). After, the samples were heated at 973 K (2 hours / N_2 at 85 mL/min). The samples were cooled and washed, with 1 dm^3 of distilled water (1 hour/353 K). The AC were designated as MAC-cork-U, MAC-PET-U and MAC-cloth-U. Another part of the untreated AC, 0.5 g, were mixed with 100 cm^3, of 1 $moldm^{-3}$ NaOH solution (2 hours / 363 K). The AC were washed and designated as MAC-cork-SH, MAC-PET-SH and MAC-cloth-SH.
- **Characterisation** AC Nitrogen adsorption at 77 K, EA, FTIR and point of zero charge (pcz).
- **Liquid phase adsorption of phenolic compounds**

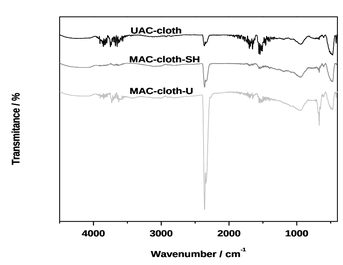
A fixed amount of AC was added to a flask containing the same volume of aqueous solutions of the mono-phenolic compound with different initial known concentrations. The flasks were then placed in a thermostated shaker bath, at 298 K, for four days. The suspension of AC were then filtered, diluted if needed, and the residual phenolic compounds was measured by UV/visible spectrophotometry at 399 and 269 nm for PNF and P.

IV Results / Discussion

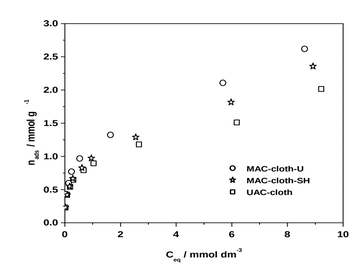
- **N_2 Adsorption at 77 K**



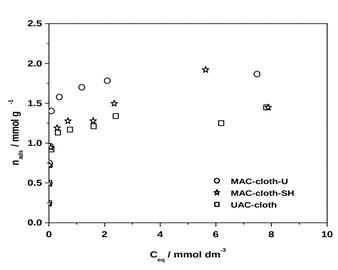
- **FTIR spectra on the AC cloth**



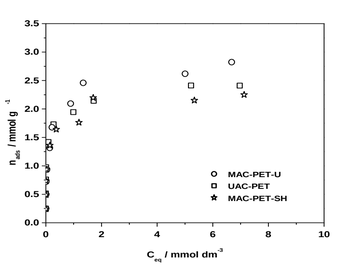
- **Phenol and p-nitrophenol adsorption on the AC at 298K**



a) Phenol on the AC cloth



b) p-nitrophenol on the AC cloth



c) p-nitrophenol on the AC from PET

➲AC materials: Type I Isotherms ⇒ microporous materials

Micropore volume – UAC-cloth - 0.18 and UAC-PET- 0.46 cm^3g^{-1}

Mean pore size - UAC-cloth - 0.78 and MAC-PET-U – 1.32 nm

➲AC materials: Point of zero charge

UAC-cloth – 7.14, MAC-cloth-U – 8.79 and MAC-cloth-SH – 10.12

Phenol

Maximum adsorption capacity ⇒ ~2.5 mmol/g on MAC-cloth-U

p-nitrophenol

Maximum adsorption capacity ⇒ ~1.8 mmol/g on MAC-cloth-U

Maximum adsorption capacity ⇒ ~2.8 mmol/g on MAC-PET-U

V Conclusions

- The textural and chemical characteristics of untreated and modified AC bring to light the influence of the precursor nature during the activation and modification step.
- The modified AC presented a higher basic character, also confirmed by FTIR spectra analysis.
- The phenolic compounds removal was more efficient with the AC submitted to a post-treatment with urea. This treatment promoted the incorporation of nitrogen groups, an increase in the pore volume and mean pore size, and also an increase in the PZC.

VI References

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