ADSORPTION OF PESTICIDES ONTO ACTIVATED CARBONS FROM WOOD COMPOSITES

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I Objectives

Preparation and characterization of activated carbon obtained from particleboard (PB) and medium-density fibreboard (MDF) monoliths

Evaluation of AC adsorption potential, for phenoxyacetic acids removals, such: 2,4-dichlorophenoxyacetic acid (2,4-D), 4-chloro-2-methylphenoxyacetic acid (MCPA) and 3-(3,4-dichlorophenyl)-1,1-dimethylurea (diuron)

Comparative study on the influence of the textural parameters of activated carbons on the pesticides removals from liquid phase..

II Introduction

Agricultural residues such as pesticides are widely found on water courses and in water treatment facilities near large farming fields, a great concern according to the World Health Organization [1]. Adsorption is considered an attractive method for removing pollutants and in particular pesticides from dilute solutions which involve the previous determination of the adsorptive behavior on various adsorbents. Activated carbons (AC) have an important place among the adsorbents tested, as they can be prepared from a wide variety of relatively low cost, natural or synthetic precursors and their improved properties allow them to adsorb various organic and inorganic compounds for a long time, being able to be regenerated and reused for several times [2-5]. The constant demand for innovative, environmental friendly and cheaper AC materials, retaining or increasing the capabilities as the ones nowadays found in the market, the usage of industrial by-products to produce these materials can be the way to follow in order to ally the material efficiency and its final cost [2].

III Experimental

Carbonization - Activation

Tf = 1073 K

T= 383 K; t = 60 min

10ºC / min until 1073 K

All adsorbents were characterised by adsorption of N_2 at 77K and the isotherms were analysed with the DR equation and BET and α_s method.

The AC presenting a wider mean pore size and highest pore volume were selected, for MCPA, 2,4-D and diuron removals from the liquid phase.

AC = 10 mg

V_{sol}= 25 cm^3

Time = 24 h

MCPA-228,6 nm

2,4-D-284 nm

Diuron-250 nm

IV Results / Discussion

Structural Characterisation and Chemical Characterisation

N_2 Adsorption at 77K

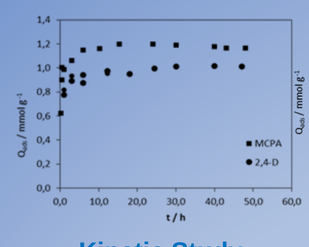
AC materials: Type I Isotherms ⇒ microporous materials

Micropore volume - 0.33-0.58 cm^3g^{-1} mean pore size - 0.66–1.15 nm

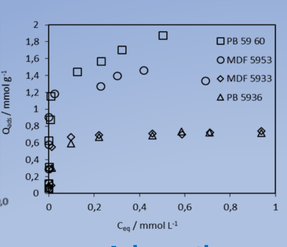
AC materials: Point of zero charge »10

Liquid Phase Adsorption

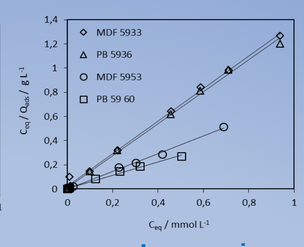
Pesticides Adsorption on AC Materials at 298K



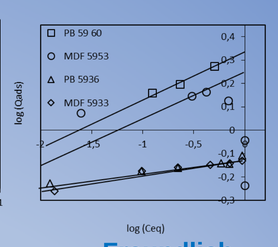
Kinetic Study



Adsorption Isotherms



Langmuir representation



Freundlich representation

Equilibrium time ⇒ 24h
Optimal pH value ⇒ 3
Maximum adsorption capacity ~1.87 mmol/g on PB 5960

Good fit of Langmuir and Freundlich models
The more activated samples exhibit the worse adjustment

Table 3. Adsorption isotherm parameters of MCPA, 2,4-D and diuron onto AC prepared from MDF and PB

	System	n_{max}	n_{mL}	K_L	K_F	n_F
		/mmolg^{-1}	/mmolg^{-1}	/dm^{3}mmol^{-1}	/mmolg^{-1} (dm^{3}mmol^{-1})$^{1/n}_F$	
MCPA	MDF 5953	1.46	1.44	188.6	1.54	13.9
	MDF 5933	0.73	0.72	185.6	0.74	23.2
	PB 5960	1.87	1.68	165.9	1.99	7.1
	PB 5936	0.78	0.73	161.2	0.74	20.5
2,4-D	MDF 5953	1.19	1.18	55.1	1.34	5.6
	MDF 5933	0.71	0.72	42.5	0.72	12.1
	PB 5960	1.37	1.40	65.2	1.48	10.9
	PB 5936	1.11	1.09	60.6	1.12	10.4
Diuron	MDF 5953	0.88	0.91	232.9	1.20	7.64
	PB 5960	0.97	1.03	158.7	4.53	1.93
	PB 5936	0.35	0.38	203.6	0.38	27.8

V Conclusion

The produced AC retain the monolithic shape, allowing a cheaper and easier usage on flow applications.

The AC textural characteristics and the results of the 2,4-D, MCPA and diuron adsorption show that PB and MDF monolithis can be used, as precursor, for the production of activated carbon capable of herbicide removal from wastewater.

The results obtained with the three pesticides, point us in a good direction onto the real life application of these materials.

VI References

[1] www.who.int (World Health Organization)

[2] Kercher, A. K.; Nagle, D. C. Carbon. 2003, 41, 3-13

[3] Mourão, P.A.M.; Gomes, J.A.F.L.; Cansado, I.P.P.; Nabais, J.M.V.; Carrott, P.J.M.; Ribeiro Carrott, M.M.L. XXXIX REUNIÓN IBÉRICA DE ADSORCIÓN. 2014, 175-176 (ISBN: 978-84-15873-45-7)

[4] Gomes, J.A.F.L; Azaruja, B.C.; Mourão, P.A.M; Cansado, I.P.P.; Nabais, J.M.V.; Carrott, P.J.M.; Ribeiro Carrott, M.M.L.; XX Encontro Luso-Galego de Química. 2014, 217 (ISBN: 978-989-98541-7-8)

[5] Cansado, I.P.P; Mourão, P.A.M.; Almodôvar, V.; Gomes, J.A.F.L.; Nabais, J.M.V.; Ribeiro Carrott, M.M.L.; Carrott, P.J.M.; XX Encontro Luso-Galego de Química. 2014, 255 (ISBN: 978-989-98541-7-8

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