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SUPPLEMENTARY MATERIAL TO

Influence of the precursor chemical composition on heavy metal adsorption properties of hemp (*Cannabis sativa*) fibers based biocarbon

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ADSORPTION KINETICS

Adsorption of heavy metal ions (Cd^{2+}, Zn^{2+} and Pb^{2+}) onto hemp-fibers based biocarbon is presented in Fig. S-1, as a dependence of adsorption capacity (q, mg g^{-1}) and time of adsorption (t, min). It can be observed that adsorption capacity, for all tested biocarbons, increases with the adsorption time, until it reaches equilibrium value after 120 min.

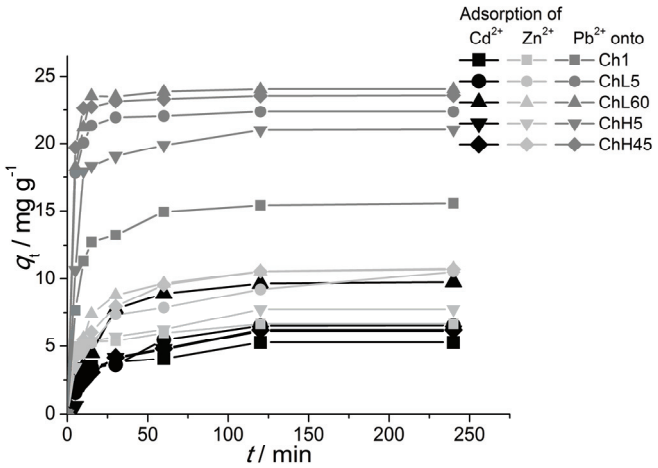

Fig. S-1. Adsorption of heavy metal ions (Cd^{2+}, Zn^{2+} and Pb^{2+}) onto hemp-fibers based biocarbon samples (initial ion concentration c_0 = 50mg dm^{-3}).

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Table S-I. Mathematical equations of the applied isotherm models and the error functions used to discriminate between models

Isotherm model	Equation
Langmuir[1,2]	$q_e = \frac{Q_0 K_A c_e}{1 + K_A c_e}$
Freundlich[3]	$q_e = K_F c_e^{n_F}$
Redlich and Peterson[4]	$q_e = \frac{K_R c_e}{1 + \alpha_R c_e^b}$
Multilayer[5]	$q_e = \frac{Q_m K_1 c_e}{(1 - K_2 c_e)[1 + (K_1 - K_2) c_e]}$
Error function	
Standard deviation (*STD*)	$\sqrt{\frac{1}{p}\sum_{i=1}^{p}\left(q_e^{exp} - q_e^{mod}\right)_i^2}$
Corrected Akaike Information Criterion (AIC_C)	$AIC + \left[\frac{2n(n+1)}{p-n-1}\right];\ AIC = 2n - p\left[\ln\left(\frac{SSR}{(p-n)}\right)\right]$

$$\ln K_a = \frac{\Delta S}{R} - \frac{\Delta H}{RT} \quad (1)$$

where

$$K_a = \frac{K_l}{\gamma_e};\ K_l = \frac{\theta_e}{(1-\theta_e)C_e};\ \theta_e = \frac{q_e}{q_{max}} \text{ and } \log \gamma_e = -Az^2 I_e^{1/2}$$

$$\Delta G = \Delta H - T\Delta S \quad (2)$$

By plotting ln K_a against $1/T$, the values of ΔH and ΔS can be estimated from the slopes and intercepts and the value of ΔG can be calculated from the corresponding values of ΔH and ΔS following the Eq. (2).

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