Wood branches: from an environmental burden to efficient biochars for micropollutants removal in aqueous solution

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Introduction

❖Worldwide production of chemicals has increased, however WWTPs fail to remove these pollutants → treatment methods incompatibility with the molecules physico-chemical properties

❖Adsorption onto biochars could be a very interesting method for the organic pollutants removal, especially if applied as a WWTPs tertiary treatment

Objectives

❖ Synthesis of high-efficiency adsorbent from abundant low-cost materials using pyrolysis and steam activation

❖ Physico-chemical characterization of the biochar

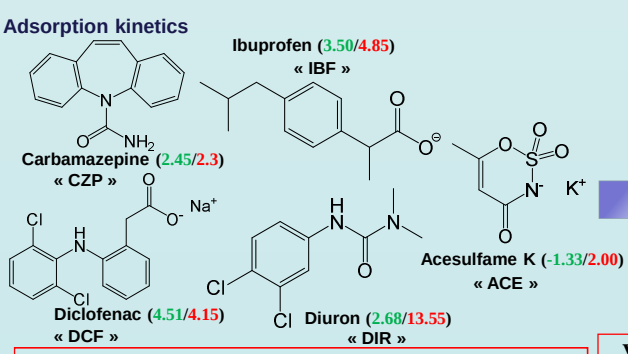
❖ Study of the removal kinetics of 5 micropollutants abundantly present in WWTP's waters

Materials and Methods

Biomass collection and biochar preparation and characterization

Spruce (Picea abies) and pine (Pinus Sylvestris) wood branches were used as feedstocks for the biochar production. The biochar has been prepared from sieved biomass (2–6 mm) issued from the wood Chips (Ch) at pyrolysis temperature of 600°C under N_2 atmosphere then activated at 900°C in steam flow. Biochars characterization was performed by (i) physical gas adsorption/desorption of N_2 at 77K and and CO_2 at 273K and (ii) Zeta potential analysis.

Adsorption kinetics



Initial pollutants concentration : 1 mg/L (Log(Kow)/pKa1)

Ch powder: 10 mg

Volume: 1L of natural source water (pH =7.3)

Stirring: 175 rpm for 240 min at 25°C

Samples analysis: LC-MS/MS apparatus (Perkin Elmer)

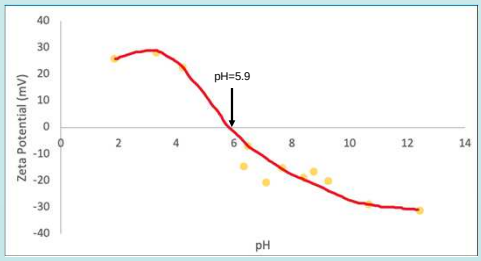
Results and Discussion

Physical characterization of the produced biochar

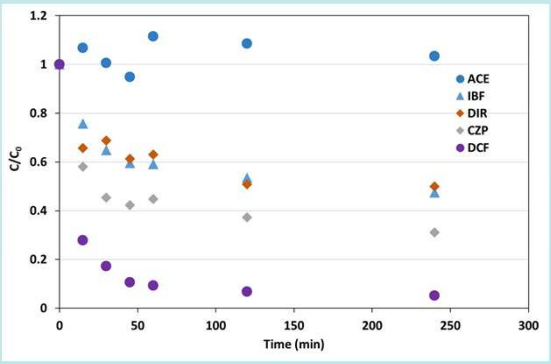
Gas adsorption/desorption parameters for wood chips biochar

Biochar precursor type	SSA (m^2/g) (BET/N_2)	Mesoporous volume (cm^3/g)	Microporous volume (cm^3/g)	Ultra-microporous volume (cm^3/g)
Wood chips (Ch)	1000	0.56	0.35	0.17

Zeta potential versus pH of wood chips biochar powder



Adsorption kinetics of 5 molecules onto wood chips biochar powder



❖ Removal of all five molecules is a time-depending process, characterized with a fast adsorption rate at early experimental stages between 0 and 15 min until equilibrium at 240 min

❖ The adsorption efficiency is intimately related to the physico-chemical properties of the targeted molecules. DCF (highest Kow value) presented the highest removal efficiency of 94.8% followed by CZP, IBF and DIR with a removal yield of 68.9%, 52.5% and 50.0%, respectively

❖ ACE failed to be adsorbed onto biochar → possible electronic repulsion due to the negative charge of the molecule and negative zeta potential of the biochar surface at pH=7.3 and hydrophilicity of ACE

❖ Experimental data were confronted to theoretical pseudo-first and pseudo-second order models. For all experiments, pseudo-second order model better fits the experimental data with R^2 values ≈ 1 and average percentage error below 9%

➢ **Adsorption uptake onto this biochar is related to the hydrophobicity of the pollutant molecules**

Conclusion and perspectives

- ➢ Wood chips biochar presented interesting specific surface area and developped porous properties
- ➢ DCF molecule exhibited the highest removal yield with over 94% while Acesulphame K failed to be adsorbed by the biochar
- ➢ Kinetics experiments showed a relatively fast intra-particle diffusion rate at early adsorption phases
- ➢ Future prospects will concern the adsorption kinetics at low concentration (100 mg/L)
- ➢ Straightforward characterization experiments are currently undertaken on this biochar among other biochars to understand their physico-chemical properties