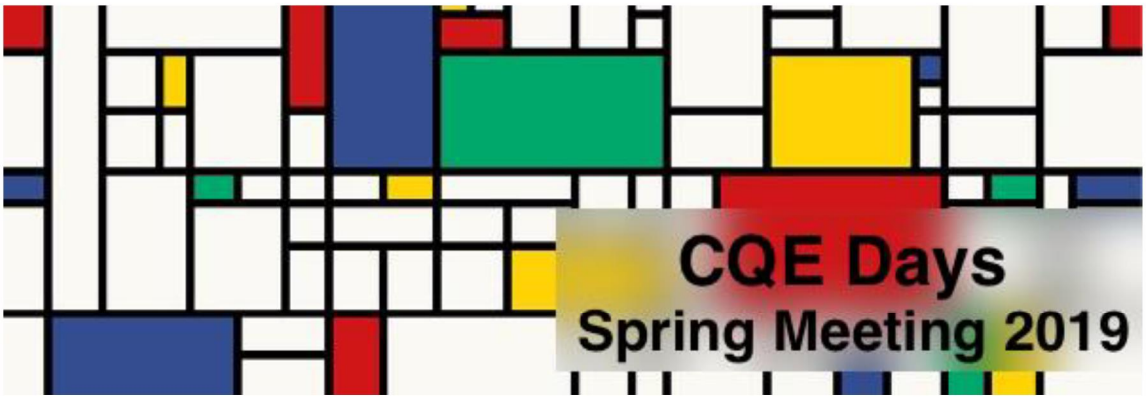

Novel environmental-friendly activated carbons for enhanced pharmaceuticals removal from wastewaters: contributions of LIFE IMPETUS project

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Thematic Lines: ☐ SYNCat ☒MATSoft ☒SUSChem ☐MEDLife

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Abstract
Improving pharmaceutical compounds (PhCs) removal during wastewater treatment is the smartest option to avoid their release into the environment, since conventional treatments fail to control several PhCs that end up in recipient water bodies. LIFE Impetus project (LIFE14 ENV/PT/000739) aims to tackle this problem by developing and testing novel powdered activated carbons (PACs) for improved control of PhCs in urban wastewater treatment plants (WWTPs) with conventional activated sludge (CAS) treatment.
PAC adsorption is one of the best available technologies for PhC control, yet its cost-efficiency and sustainability calls for environmental-friendly PACs and process design in a circular economy framework. Novel PACs were prepared by a two-step methodology (carbonization and steam activation)[1] using locally available biomass and were benchmarked against commercially available products (Pulsorb WP220 & Norit W35) for the competitive adsorption of a short-list of representative PhCs in synthetic inorganic matrix and in spiked secondary effluents (100 µg/L). The target PhCs were selected considering their worldwide occurrence and persistence in CAS-WWTP effluents, results validated in the two LIFE Impetus plants, and diversity in adsorption key-properties: carbamazepine (neutral, hydrophobic), diclofenac (anionic, relatively hydrophobic) and sulfamethoxazole (anionic, hydrophilic).
Both pine nut production residues – pine nut shell (PNS) and pine cone (PC) - allowed obtaining ACs with BET area values higher than 1000 m^2/g for steam activation burn-off degrees higher than 50 %. The N_2 isotherms of lab-made carbons with burn-off > 50 % and commercial samples are of type I(b)+IV(a) characteristic of micro-mesoporous materials, while materials PNS48 and PC44 have type I(a) isotherms indicating their microporous nature[2]. The hysteresis loops of type H4 observed for all but samples PNS48 and PC44 corroborate the micro-mesoporous features of the majority of lab-made and commercial materials[2].
A pine nut shell derived PAC obtained by steam activation (PNS77) proved to be the best performing material for the target PhCs and organic matter control in competition scenario, with the highest adsorption capacity and rate in synthetic and real wastewaters. Further, by modeling the lab results with the HSDM[3], it is shown that 80% removal of the target PhCs would be achieved dosing 10 mg/L PNS77 to the CAS bioreactor. The major goal of these set of results is to get more experimental data to better understand the complex adsorption phenomenon to identify the critical descriptors of the 3 players (AC, PhC and water matrix), so to improve adsorption performance and deliver a sound process prediction tool for a more accurate prediction of PAC performance for other PhCs, PACs and real water systems since it is impossible to test all the combinations.

Keywords: Biomass residues, Activated carbons, Pharmaceutical compounds, Wastewater treatment
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