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Recycling Biomass of Constructed Wetlands as Precursors of Electrodes for Removing Heavy Metals and Persistent Pollutants

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Abstract : In recent times, environmental problems have led to the extensive use of biological systems to solve them. Among the different types of biological systems, the use of plants such as aquatic macrophytes in constructed wetlands and terrestrial plant species for treating polluted soils and sludge has gained importance. Though the use of constructed wetlands for wastewater treatment is a well-researched domain, the slowness of pollutant degradation and high biomass production pose some challenges. Plants used in CW participate in different mechanisms for the capture and degradation of pollutants that also can retain some pharmaceutical and personal care products (PPCPs) that are very persistent in the environment. Thus, these systems present advantages in line with the guidelines published for the transition towards friendly and ecological procedures as they are environmentally friendly systems, consume low energy, or capture atmospheric CO_2. However, the use of CW presents some drawbacks, as the slowness of pollutant degradation or the production of important amounts of plant biomass, which need to be harvested and managed periodically. Taking this opportunity in mind, it is important to highlight that this residual biomass (of lignocellulosic nature) could be used as the feedstock for the generation of carbonaceous materials using thermochemical transformations such as slow pyrolysis or hydrothermal carbonization to produce high-value biomass-derived carbons through sustainable processes as adsorbents, catalysts..., thereby improving the circular carbon economy. Thus, this work carried out the analysis of some PPCPs commonly found in urban wastewater, as salicylic acid or ibuprofen, to evaluate the remediation carried out for the Phragmites Australis. Then, after the harvesting, this biomass can be used to synthesize electrodes through hydrothermal carbonization (HTC) and produce high-value biomass-derived carbons with electrocatalytic activity to remove heavy metals and persistent pollutants, promoting circular economy concepts. To do this, it was chosen biomass derived from the natural environment in high environmental risk as the Daimiel Wetlands National Park in the center of Spain, and the rest of the biomass developed in a CW specifically designed to remove pollutants. The research emphasizes the impact of the composition of the biomass waste and the synthetic parameters applied during HTC on the electrocatalytic activity. Additionally, this parameter can be related to the physicochemical properties, as porosity, surface functionalization, conductivity, and mass transfer of the electrodes lytic inks. Data revealed that carbon materials synthesized have good surface properties (good conductivities and high specific surface area) that enhance the electro-oxidants generated and promote the removal of PPCPs and the chemical oxygen demand of polluted waters.

Keywords : constructed wetlands, carbon materials, heavy metals, pharmaceutical and personal care products, hydrothermal carbonization
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