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APPLICATION OF NEW CARBON NANOMATERIALS TO ACCELERATE THE BIOLOGICAL REMOVAL OF RECALCITRANT MICROPOLLUTANTS UNDER ANAEROBIC CONDITIONS

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Keywords: Acid orange 10, Biological reduction, Tailored carbon nanotubes, Wastewater treatment

Introduction: Water pollution is a serious problem worldwide. The industrialization growth, coupled with ineffective conventional wastewater treatments, often results in the contamination of water resources with different pollutants, including azo dyes.
Anerobic treatments have been proposed for the biodegradation of micropollutants. However, the reactions proceed slowly due to the recalcitrant nature of these compounds. Redox mediators (RM), can be applied at very low concentrations, to accelerate the overall reactions. Carbon materials (CM) demonstrated to be excellent candidates for accelerating the reduction rates of different micropollutants during anaerobic biodegradation.
Methodology: Different carbon nanotubes (CNT) with modified surface chemistry were prepared by oxidation with HNO3 (CNT_HNO3), doping with Nitrogen in a ball milling process (CNT_MB), and also, magnetic CNT by impregnation of pristine and modified CNT with 2% of iron (CNT@2%Fe; CNT@2%Fe_HNO3 and CNT@2%Fe_MB). The new CM were tested as RM (0.1 g L^{-1}) in the biological removal of Acid Orange 10 (AO10), with anaerobic granular sludge (AGS), over 29h of reaction. Methane production was also assessed to verify the microorganism's activity and CM effect on the methanogenic activity.
Results: Above 90% of the biological removal of AO10 occurred in the presence of all CM, while in the control without CM was (29±3)%. The best results were obtained with the CNT_MB, leading to (98±1)% of biological AO10 removal at a 11-fold greater degradation rate. Comparing to commercial CNT, CNT_MB has higher surface area, pore volume, and pHpzc, this last, enhancing the electrostatic interaction between the CM, AO10 and AGS, and consequently promoting the electrons shuttling. Any dye removal was observed in the abiotic assays, so the removal was not due to adsorption on the CM. The results obtained in the presence of CM@2%Fe were similar to the obtained with the corresponding CNT, but the magnetic properties facilitated their recover and reuse.
Furthermore, the microorganism's viability was maintained during the assay, and methane production was not affected by the presence of different CM.
Conclusion: The removal of AO10 was improved by CM, which act as RM. The surface chemistry of the developed CM was an important factor for the catalysis, so, tailoring CM for specific micropollutants seems to be a good strategy. For AO10, CNT_MB and CNT@2%Fe_MB were the most effective RM. This screening in batch trials shows the possibility of implementation in high-rate anaerobic reactors, and in a sustainable way, through the recover and reuse of the magnetic CM.