Synergy of combined adsorption and electrochemical degradation of aqueous organics by granular activated carbon particulate electrodes

Electrochemical oxidation (EO) and activated carbon (AC) adsorption are, despite difference in maturation and market dissemination, both well-proven water treatment principles for the abatement of micropollutants. Both technologies suffer some drawbacks as mass transfer limitations (in case of EO) and poor adsorption affinity of some compounds (in case of AC). Granular active carbon may, when placed within an electric field, be polarized generating particulate reactive microelectrodes in bulk solution increasing the overall active electrode area, a concept known as 3D electrochemistry. In this paper, a potential synergy by combining EO and AC was studied in a potentiostatic batch setup at different applied electric field strengths (25-500 V/m), using boron-doped diamond (BDD) as active anode and the hydroxyl radical probe compound p-nitrosodimethylaniline (RNO) and the groundwater contaminants 2-methyl-4-chlorophenoxy acetic acid (MCPA), 2-methyl-4-chlorophenoxy propionic acid (MCPP or mecoprop) and 2,6-benzamide (BAM) as target model contaminants. Synergy was assessed based on comparison of the 3D process with removal kinetics in conventional 2D electrochemical process and pure AC adsorption. In demineralized water model solutions, synergies of 121-126% was found for RNO, MCPA and MCPA at 375 V/m electric field strength and w/w AC:organic ratio of 5:1. For BAM, the synergy was 192%, primarily due to stronger AC adsorption affinity. The study showed interesting perspectives of this treatment concept that needs to be pursued and studied in matrices of higher complexity.

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