**Synergistic removal of dye and pesticides using granular activated carbon particulate electrodes in 3D electrochemistry**

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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) (Radjenovic and Sedlak, 2015; Yang et al. 1997).

Granular activated 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 (Zhang et al. 2013). 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 low conductive demineralized water model solutions, synergies of 121% to 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 (Figure 1).

In drinking water, max. synergy was obtained at 150 V/m, due to easier polarization of GAC in water of higher conductivity. The treatment technology was also tested on groundwater from an old landfill contaminated with MCPA, MCPP and BAM. Following pre-aeration 112%, 145% and 195% of synergy was found, respectively. In flow cell experiments, a higher electric field strength of 1500 V/m was needed to achieve synergistic effects, but improvement in cell design may further enhance the combined adsorption and electrochemical degradation process. Initial operating cost estimations were in the range of 13-19 kr/m3 depending on the water matrix.



**Figure 1.** Degradation data of the MCPA, MCPP and BAM synergy study. (a) data of MCPA removal, (b) data of MCPP removal (c) data of BAM removal (d) Synergy of the processes. Electric field strength, E = 375 V/m, 100 mg AC/L, [MCPA]0 = 50 mg/L, [MCPP]0 = 50 mg/L, [BAM]0 = 50 mg/L. (Pedersen et al. 2019) *Reprinted with permission from Elsevier*.

The present study showed that 3D electrochemistry is a very interesting and potentially very efficient technology for abatement of micropollutants in contaminated water, not only as a polishing technology, but also as a pump-n-treat technology upgrading the conventional GAC treatment of contaminated groundwater providing *in-situ* continous regeneration of the GAC particulates.

**References**

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