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Influence of activated carbon on the behavior and bioavailability of PCB in soil

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Previously we demonstrated that the use of activated carbon (AC) may help overcome the toxicity of some organic pollutants to microbes and create better conditions for soil bioremediation. The main subject of this paper was to apply similar approach for PCB contaminated soils. The experiments were carried out with historically contaminated soils taken from 2 sites (1690 and 4100 mg PCB/kg) nearby a Capacitor plant in Moscow region (Russia). The influence of various doses and forms of AC was studied in vegetation experiments under conditions close to natural. Dynamics of readily available, potentially available and bound PCB congeners were studied in the AC-amended and unamended control soils. Besides, biotests with Daphnia magna, heterotrophic microorganisms and phytotests with clover seedlings were used to estimate bioavailability of PCB and toxicity of these soils. The results confirmed the extremely high persistence of PCB in both soils. Total amount of PCB in the unamended control soils was reduced only by 25-26% after 39 months. This reduction was mostly due to microbial degradation of three- and tetra-chlorinated congeners (by 60-82 and 20-26% respectively) while their volatilization was undetectable in the experimental conditions. The soil amendments with the AC created remarkable reduction of extractable PCB (by 20-72% depending on AC dose) already in 1 or 2 months after treating. For the beginning, the reduction of extractable PCB was due to formation of a bound fraction that could be recovered with boiling toluene. The ratio of bound PCB in both AC-amended soils closely negatively correlated with the number of chlorine atoms as well as with the content of planar congeners in every homologue group. Final reduction of total PCB (extractable and bound) in the AC-amended soils was similar to those in control samples, but mechanism of PCB degradation differed. In addition to

microbial degradation of lower chlorinated congeners the activated carbon catalyzed dechlorination of higher chlorinated congeners. As a result, contents of hepta-, hexa-, penta- and tetrachlorinated congeners in the amended soils were finally reduced by 46-22%, while concentration of dichlorinated biphenyls increased by a factor 6 or 8. Nevertheless these lowchlorinated congeners remained in trace amounts (<0,1% of total congeners) and mostly in a bound fraction. The content of readily available PCB in the AC-amended soils reduced much deeper then their solvent extractable fraction. It was confirmed by substantial reduction of their phyto- and biotoxicity in about a month after soil amendment, and gradually the soil toxicity was undetectable or did not exceed 25% to maximal depending on dose of the adsorbent. Meantime phyto- and biotoxicity of control soils remained very high during all the 39 months of experiment. It indicates that sequestration of PCB and other toxic compounds by activated carbon can be perspective for in situ remediation of historically contaminated soils.