# Remediation of a hydrocarbon chronically contaminated soil by combination of persulfate oxidation and bioremediation

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Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous compounds in the environment generated by natural and anthropogenic activities. Because their hydrophobicity and low water solubility they are highly persistent in soil. Although the use of chemical oxidants can overcome the limitations of bioremediation, it is known that it damages the community and soil structures. We studied the effect of combined technologies, chemical oxidation followed by bioremediation, on chronically hydrocarbon contaminated soil.

A chronically contaminated soil (S0) with 214 ppm of PAHs was treated with ammonium persulfate (PS) (3.3 g PS/ kg dry soil), OxS. Microcosms of oxidized soil were incubated (25°C, 25% moisture content), for 1 year as bioremediation process, BOxS. Soil microcosms without oxidation were used as bioremediation control, BS.

The PAH concentration, PAH bioavailability (%), dissolved total carbon (% DTC), absorption and fluorescence of organic matter (OM), total nitrogen (N), sulphate (SO42-), phosphorous (P) and bacterial diversity were analysed. Hill's numbers were used as diversity measures. The results were analysed using methods from the multivariate statistic.

The PS application produced 30% of PAHs elimination and an increase of DTC and PAH bioavailability. The aqueous extract fluorescence attributed to the organic matter was higher than S0, but the relative emission from PAHs was lower. The corresponding spectroscopic analysis (E4/E6) did not show changes.

Before the oxidation, S0 showed a very high diversity being an equal community. A dramatic decline in the richness was observed after PS oxidation. The OxS community showed an uneven assemblage with a few dominant species. The Actinomycetales (57%) and Bacillales (20%) were the predominant orders. By analysis of 16SrDNA hypervariable region, we found successional changes in the community along the treatment. The low richness and uneven assemblage remained until the fifth month but with Pseudomonadales as predominant order (71%). Slowly, the bioremediation allowed that the diversity was recovery (BOxS); despite of the richness was still low in compare with S0.

At the end of the treatment, 47.5% of total PHA elimination was observed, leaving a lower DTC value in BOxS. The fluorescence intensity from OM was similar to S0 but principally as consequence of humic-like substances contribution, suggesting that the bacterial successional changes were principally to expenses of the available compound from the oxidized OM. The increment on P also suggested the effective bacterial involvement in the soil P cycle. The significantly higher SO42- concentration seemed to no exert much effect on the soil bacterial diversity.

The bioremediation in BS after one year also showed a low richness. Although a reduced fluorescence was detected in this microcosms, the relative PAH and OM fluorescence contribution did not change.

The coupled technology studied was suitable for elimination of PAHs with the recovery of microbial diversity associated to the metabolism of oxidized OM. The multifaceted approach were useful for understanding the global process in a chronical-contaminated soil.