REMTECHEXPO

HuTTE

L'innovazione per la transizione giusta

A cura di
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con le Prefazioni
del Ministro Gilberto Pichetto Fratin
del Viceministro Vannia Gava
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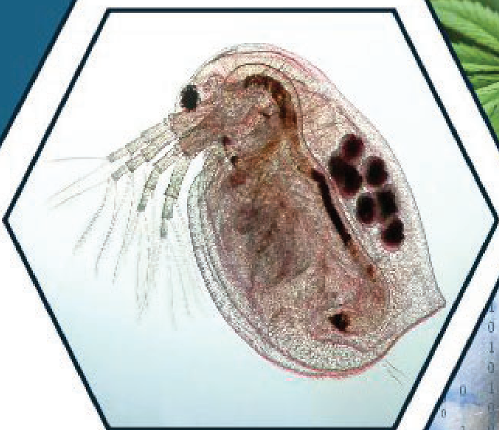

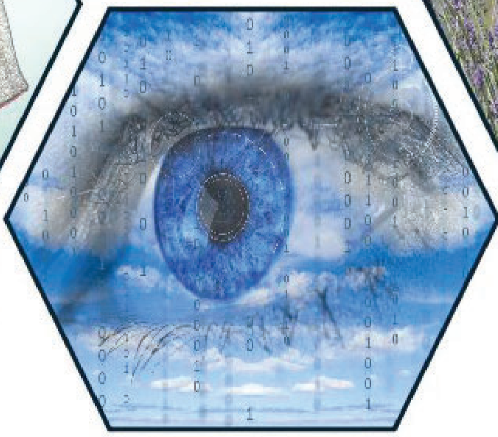

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Microbial Electrochemical Snorkels to boost anaerobic oxidation of petroleum hydrocarbons

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Abstract

Soil and groundwater contamination by hydrocarbons poses significant risks to human health and the environment. Current remediation methods range from physical and chemical treatments to biological approaches. In-situ bioremediation techniques like biostimulation and bioaugmentation are increasingly favored for their environmental friendliness. However, a frequent limitation to bioremediation is the availability of electron acceptors, the addition of which to the soil can be both energy and cost-intensive.

Microbial Electrochemical Technologies (METs), utilizing solid-state electrodes as electron sources or sinks, offer a promising option to stimulate microbial metabolism, reducing reliance on externally provided chemicals and energy consumption. Among these, microbial electrochemical snorkels stand out as a simple yet effective technology, employing a single electrode strategically placed to facilitate electron transfer between different redox zones.

This laboratory-scale study aims to evaluate the efficacy of METs in remediating hydrocarbon-contaminated soil. The study consisted of two sequential steps: first, enhancing the development of the electroactive community in the soil and on graphite felt electrodes, and second, assessing hydrocarbon degradation by previously acclimated microbial communities. Three different types of saturated hydrocarbon-contaminated soil columns were set up in duplicate, to simulate different in-situ treatments: i) Snorkel treatments (S1, S2), ii) Microbial Fuel Cell treatments (MFC1, MFC2), and iii) control treatments (C1, C2) with no electrodes.

The soil columns were incubated in the dark at a controlled temperature of 17 ± 1 °C, with regular monitoring of Oxidation Reduction Potential (ORP), Electrical conductivity, pH values. Acetate was replenished periodically in the first phase to prevent substrate rate-limiting conditions for the anodic reaction, whereas nitrate was introduced as the terminal electron acceptor for the cathodic reaction. In the second step, hydrocarbons served as

carbon sources and electron donors at the anode, whereas nitrate in the circulating groundwater served as the electron acceptor at the cathode.
At fixed times, the water and soil in the different treatments were sampled for hydrocarbon analysis (total petroleum hydrocarbons (TPH) by GC–MS and analyses of the microbiome composition and key functional genes quantification. At the end of the tests, the microbial characterization was carried out on the electrodes, too.
Preliminary results from the acclimation phase indicate that acetate promotes the formation of electroactive communities on MFC anodes. All systems showed a decrease in nitrate concentration, with BES treatments exhibiting higher nitrate removal efficiency compared to controls. Additionally, both MFC treatments displayed measurable current values due to the presence of electroactive biofilms on the anodes. Soil chemical analyses for hydrocarbon concentration and microbial characterization of soil and electrode-attached biofilms are ongoing.

Keywords: (Up to 5 keywords) Microbial Electrochemical Technologies (METs), Petroleum hydrocarbon biodegradation, Microbial electrochemical snorkels, Soil electroactive microbial communities.

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