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metabolism, overcoming the limitations imposed by the lack of appropriate chemical sources in some WW. Although positive results have been achieved in the removal of organic matter (OM), the same was not found for other compounds such as ammonium or nitrate, probably because the equilibrium potentials of the electrodes are not favorable for bacterial activity. The aim of this study was to enhance the removal efficiency of nitrogenous species and OM from WW treated with BW with external application of electrical energy. This new approach attempts to optimize the electrode potential to stimulate bacteria growth, increasing their activity and improving the efficacy of the treatment process. Scaled BW consists of columns measuring 110 mm in diameter and 60 cm in height, filled with gravel and coke (conductive material). These systems were fed downflow with sewage WW (SW). Four treatments were carried out in duplicate: two with external electrical energy application to set different voltage differences (ΔE) between the electrodes of 800 mV and 1400 mV, targeting potential values favorable for bacterial activity, a set of control systems with unconnected electrodes (open circuit-OC) and the remaining set with connected electrodes but without electrical energy application (closed circuit-CC). Samples were collected at the inlet and outlet of all columns to measure chemical oxygen demand (COD), nitrate and ammonium concentrations, pH and turbidity. While pH remained constant in all systems, a considerable reduction of COD was achieved for ΔE800 mV, ΔE1400 mV, CC, and CA treatments, decreasing from 159.67 to 14.68, 28.00, 19.67, and 44.67 $mgO_2.L^{-1}$, respectively. Total N concentration also decreased, from 45.75 to 20.51, 12.91, 20.31, and 20.51 $mg.L^{-1}$ in ΔE800 mV, ΔE1400 mV, CC, and OC, respectively. A similar trend was observed in turbidity. Although the differences between treatments with current application compared to CC or OC were not statistically significant, greater removals of OM and nitrogenous compounds were observed in the first ones. Current values (1.37 mA for ΔE800 mV and 3.71 mA for ΔE1400 mV) were much lower than the theoretical maximum that the systems could provide considering full bioelectrochemical treatment of the contaminants in the inflow (10.72 mA), suggesting the existence of deficiencies in electrode configuration and conductivity. Current efforts are directed towards improving the design and conductivity of the electrodes to further explore the potential of this promising strategy.

BB17

SEQUENTIAL OXIDATION-COMPOSTING-PHYTOREMEDIATION TREATMENT FOR THE MANAGEMENT OF OILY SLUDGE FROM PETROLEUM REFINERIES - AN ECOLOGICAL APPROACH

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The oil industry generates huge amounts of sludge during the different stages of crude oil treatment: exploitation, transportation, storage, and refining. These oily sludges are complex in nature, containing water, petroleum hydrocarbons, heavy metals, and solid particles in a stable water-oil emulsion. They are classified as hazardous organic waste, and regulations in our country require treatment before final disposal.

The use of combined approaches is a viable option for the treatment of matrices contaminated with hydrocarbons. In this context, the extent of a laboratory-scale sequential remediation treatment of oily sludge was investigated, applying chemical oxidation, followed by composting, and phytoremediation.

The total hydrocarbon concentration (THC) of the sludge was 18% (IR). The aliphatic hydrocarbon concentration by GC-FID was 4714 ppm, with no aromatic hydrocarbons

detected. Iron was the most abundant heavy metal quantified, followed by Ni and V. Generalist and PAH-degrading bacterial populations were quantified by qPCR obtaining $1.62.10^{10}$ and $2.11.10^{7}$ gene copy number/g. The 16S rRNA diversity analysis revealed that Gammaproteobacteria was the most abundant class (57%).

The oxidative treatment with 3% activated persulfate produced a THC elimination of 31% and a three-log reduction of the generalist bacterial population.

The next application of composting did not produce additional removal of THC after one year of treatment. But reduction in the total dissolved carbon (TDC) and increase in the E4/E6 ratio were verified in oxidized microcosms, along with an increase in the generalist population.

Phytoremediation was carried out by sowing ryegrass seeds in the substrate resulting from the previous composting (composted sludge or composted-oxidized sludge). Non-vegetated controls for both conditions were also performed. The biomass of the ryegrass in the composted-oxidized substrate was 67% higher than in the composted-non-oxidized substrate. Regardless of initial sludge oxidation, no hydrocarbon elimination was recorded by IR or GC-FID after phytoremediation. Nevertheless, compared to their non-planted controls, a greater increase in the TDC and E4/E6 ratio was observed in oxidized microcosms. In addition, both the hydrolase and dehydrogenase activities evidenced the effect of the plant.

A beta diversity analysis was performed to compare the effect of biological treatments on the bacterial communities of oxidized and non-oxidized microcosms, evidencing that the treatment phase could have significant effects on the structure of the bacterial community.

The results obtained showed that the proposed sequential treatment significantly reduced THC levels, resulting in a plant growth-promoting substrate. However, the techniques used in this study did not allow for revealing the hydrocarbon transformations produced by the biological treatments. A subsequent analysis using FT-IR spectrophotometry will allow us to delve into these changes.

BB18

EXPLORING MULTIFUNCTIONAL BACILLUS BACTERIA FOR ENHANCED LEGUME CROP GROWTH AND ANTIFUNGAL PROTECTION: A SUSTAINABLE APPROACH

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Modern agriculture needs sustainable and efficient solutions to enhance productivity. In this context, the strategic application of bacteria has emerged as a promising ecological practice. Particularly, the genus *Rhizobium*, distinguished for its atmospheric nitrogen fixation capacity, establishes a beneficial symbiosis with leguminous plants by inducing root nodule formation. On the other hand, bacteria of the *Bacillus* genus have demonstrated multifunctionality, stimulating plant growth and countering pathogens.

In our laboratory, we isolated several strains from industrial residues, and some of them were identified as *Bacillus* sp. Taking into account that some species of *Bacillus* genus are known to have plant growth promoting activity, we conducted a comprehensive analysis of these strains to evaluate relevant enzymatic activities. Moreover, considering that to enhance legume crops, a common practice is bacterial co-inoculation, this was evaluated together with *Bradyrhyzobium japonicum* E109.

The results obtained demonstrated that all strains assayed exhibited a diverse enzymatic profile. We evaluated amylase, cellulase, phospholipase and protease activity, surfactant, siderophore and auxins production. These activities are essential for plant growth promotion and development. Additionally, we observed strong antifungal activity (40-86%) against