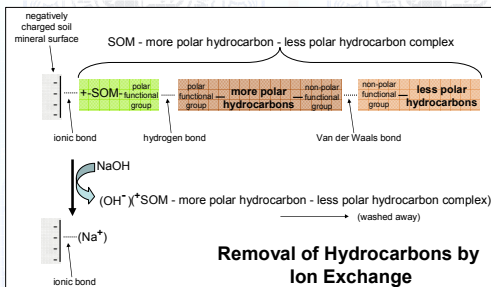
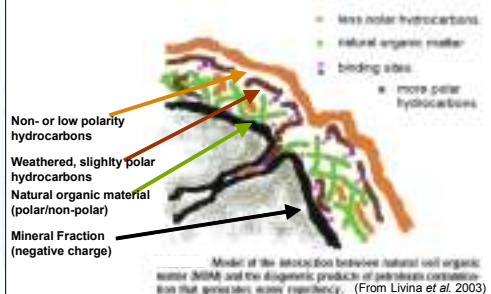


Restoration of Hydrocarbon Contaminated Water-Repellent Soil: Novel Alkaline Desorption-Organic Amendment Treatment Process

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Model for Soil Water Repellency



- 1.5 x 1.5 m plot was treated with 0.1 N NaOH (2Kg/m³) in two 15 cm lifts (30 cm depth) at 15 day intervals, with manual mixing (shovel).
- After 15 days, 4 % (w/w) partially composted sugar cane filter cake waste (cachasse) was added.
- After 1 month planted with Humidicola grass by stolons gathered from a nearby, uncontaminated area.
- Monitoring for 1 year: water repellency, field capacity, pH, salinity and pasture growth.
- After 1 year the water drop penetration time (WDPT) for dry soil was reduced eight orders of magnitude.
- Average field moisture was double that of untreated soil.
- Final pH of the treated soil was similar to background levels (5.9 vs. 5.7) and salinity was very low (0.7 dS/m).
- Soil at risk from water repellency was reduced by 5 months, from 290 to 140 days.
- Treated soil was moist and firm to a depth of >80cm, but untreated soil was dis-aggregated below 2 cm.
- Good growth of forage pasture which prior to treatment was not able to grow in the contaminated soil.

CONCLUSIONS

- The novel process was shown to be effective for the restoration of fertility to water repellent hydrocarbon contaminated soil.
- Average field humidity was doubled and water repellency was reduced eight orders of magnitude.
- This allowed the soil to be moistened to a depth of over 80 cm, and the establishment of a vigorous vegetative cover.
- Greater pasture production and increased forage quality.
- May be used in conjunction with other soil remediation methods, as a final step in soil restoration.

INTRODUCTION

- Heavy crude and weathered hydrocarbons interfere with normal soil-water interactions and cause water repellency.
- These weathered hydrocarbons act as chemical bridges between the soil organic matter and the low polarity, more abundant hydrocarbons, forming a hydrocarbon layer on soil particles.
- Effected soils present problems with the availability of water necessary for the growth of vegetation and microbial activity.
- Soil erosion and overall poor productivity may result.

CHEMICAL BASIS OF NOVEL PROCESS

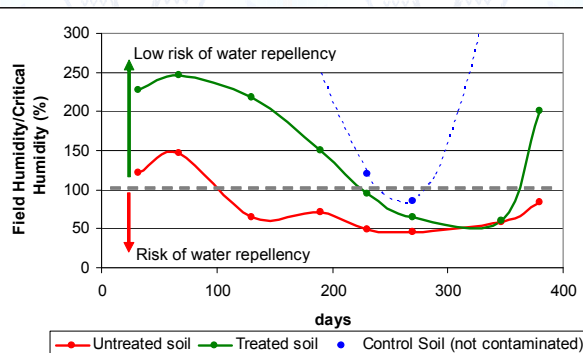
- Hydrocarbon layers on soil particles are removed by ion exchange.
- The positive charges in the soil organic matter (SOM) are substituted with mineral cations (Na⁺ and/or Ca⁺⁺).
- The negative soil surfaces which bind the soil organic matter are substituted with hydroxide anions.
- The mineral surface – soil organic matter bond is broken and the SOM-hydrocarbon complex is washed away.
- Natural precipitation or irrigation is used to wash out excess alkalinity and sodium.
- Subsequently, fresh, uncontaminated organic amendment is added to the soil to replace the SOM.

STUDY AREA

- Sandy soil contaminated by inadequately treated water from separation battery.
- A fire occurred in this site in 1982, further weathering the spilled hydrocarbons.
- In 2000 the soil was treated by bioremediation. This resulted in:
 - low TPH concentration (~500 – 1500 ppm, EPA method 1664A)
 - but still severe water repellency:
 - Molar Ethanol Drop (MED) value = 4.5
 - theoretical Water Drop Penetration Time (WDPT) of 10^{10.3} seconds.
- In unaffected areas Humidicola grass (*Bracharia humidicola*) is used as pasture.
- In affected area only Alicia grass (*Cynodon dactylon*), is able to grow: produces much less pasture and of poor quality.
- Additionally, some areas are completely devoid of vegetation and suffer severe erosion.
- This site is in the southern Gulf of Mexico and has a tropical monsoon climate, but even after heavy rains the contaminated soil is only moistened to a depth of 2 mm.
- Uncontaminated soil in the same site maintains a vigorous vegetative growth.



FIELD TRIAL



Growth of Humidicola Grass in Treated Soil

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