Remtech Engineer's News Flash

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Remtech is committed to providing quality and cost-effective emergency response and site remediation products and services. Remtech's goal is to minimize environmental damage and claims by applying innovative engineering technologies to preserve the world's resources for future generations. Remtech publishes this newsletter on a periodic basis to keep clients and friends informed. For current information on Remtech's turnkey site remediation products and services visit our website at www.remtech-eng.com.

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What's New?

New Equipment Additions

A mobile wastewater and groundwater treatment system was added to Remtech's fleet of site remediation equipment. This system is capable of treating 30,000 gallons per day and consists of an oil/water separator, free product removal system, twin diffused air strippers, and liquid phase granular activated carbon filters.

Remtech designed and built a 20-foot bioremediation trailer for an international bottling company. Remtech's HC-2000 technology is slated for treatment of PCE, TCE, and petroleum hydrocarbon contaminated soil and groundwater sites in the northeast.

Remtech Mobile Treatment System

Bioremediation Trailer

HC-2000 Developments

Bench-scale tests demonstrate that Remtech's HC-2000 degrades PCB's. The most highly chlorinated species Arochlor 1260 was degraded 85 percent in 60 days in both slurry and soil aerobic reactors which simulate soil and groundwater environments. This adds to the list of HC-2000 biodegradable contaminants which include; TCE, PCE, transformer oil, hydraulic oil, lube oil, mineral oil, motor oil, jet fuel, kerosene, gasoline, and diesel fuel.

Recent Projects Completed

Wastewater Cleanup

Remtech's all terrain vacuum tankers were deployed on a wastewater discharge with a high pH and COD at a specialty chemical company. The release flowed into a wooded wetland area with a topographic relief of over 30 feet. Over 25,000 gallons of wastewater were recovered and transferred into an onsite wastewater pretreatment facility.

Remtech All Terrain Vacuum Tankers

Tank Reaction at Major Food Products Company

An above ground storage tank underwent an exothermic reaction when a non-compatible material (4,000 gallons of choline chloride) was inadvertently transferred into a 6,500 gallon poly tank containing sodium chlorite. Temperatures exceeding 180 ^{O}F caused a partial tank roof collapse and vapor cloud release. The fire department applied water to the exterior of the tank to prevent it from collapsing.

Remtech pumped product from the tank through a site fabricated chiller (two coiled chemical hoses passing through 200 pound ice baths) into a lined tanker. Temperatures were reduced below 120 ^{O}F which stabilized the product for transport.

Collapsed Roof on Sodium Chlorite Tank


Product Stabilization Operations

Feature Article

Enhanced Bioremediation with HC-2000

PURPOSE AND BACKGROUND

Native heterotrophs dominate soil and groundwater in aerobic, facultative, and anaerobic environments. Heterotrophs have been demonstrated to be effective degraders of a variety of hazardous wastes including petroleum hydrocarbons, chlorinated solvents, and other pollutants. A myriad of degradation data was acquired in the 1980's during research on land farming of hazardous wastes (1). Ross McKinney in his book *Microbiology for Sanitary Engineers* states "….the best source of microorganisms is soil. The soil can furnish all the microorganisms ever needed in waste disposal. My advice to all sanitary bacteriologists who seek a special culture is to look under their feet; the supply is inexhaustible." (2)

Heterotrophs require nutrients, enzymes, biosurfactants, and the proper environmental conditions to accelerate biochemical reactions. The monitoring of natural attenuation can be very costly. Natural attenuation can take years and generally reaches plateau concentrations due to insufficient nutrients or inadequate environmental conditions. Application of HC-2000 reduces the degradation time of petroleum hydrocarbon contamination to several months and from six months to a year (in many cases) for chlorinated solvents.

Remtech developed HC-2000 which is a proprietary mixture of food quality plant enzymes, nutrients, enzyme cofactors, and biosurfactants. HC-2000 has been approved by regulatory authorities for; application on surface waters to eliminate sheens, to desorb and degrade petroleum hydrocarbons on banks and sediment, application to soil releases to degrade fuels in place, and injection into the vadose and saturated zones for bioremediation of petroleum hydrocarbons and chlorinated solvents.

Regulatory authorities frequently favor (and quickly approve) the acceleration of natural processes as apposed to injection of foreign materials into the environment. Stimulating natural biochemical processes reduces the possibility toxic byproduct formation and allows multiple species (operating under a variety of environmental conditions) to reduce contaminates to minimum levels. When the acceleration period is over, native conditions are restored. HC-2000 has

been approved by Georgia, Florida, and Illinois for the treatment of soil and groundwater on a case-by-case basis. Federal EPA On-Scene Coordinators and National Park Service officials have approved HC-2000 for projects in National Parks, navigatable water ways, lakes, and soil and groundwater environments.

OVERCOMING TECHNOLOGY DELIVERY CHALLENGES

Insitu treatment is limited by mass transfer, nutrients, and electron donors. Treatment technologies must first come in contact or mix with contaminants to be effective. The ability to communicate with soils and groundwater three dimensionally is required to achieve uniform site treatment. The design of delivery systems is a major factor that controls the success or failure of effective site remediation. Soil adsorption and contaminants bound in soil pores are also limiting factors. Passive insitu technologies rely on advection (bulk groundwater flow) and dispersion to disseminate reactants. Aggressive pulsed (air and/or reagent) injection enhances mixing and transport and generally achieves more rapid and uniform results.

Remtech's HC-2000 has the following characteristics which address these technology limiting factors:

- Biosurfactants desorb contaminates from soils and soil pores (increasing contaminant availability for microbial degradation) and increase the mobility of HC-2000 by lowering surface tension;
- HC-2000 may be injected as a liquid or foam to increase contact with pollutants;
- HC-2000 is an aerobically fermented product that converts nutrients, enzymes, and cofactors into readily assimulated forms that eliminates lag reaction periods;
- HC-2000 accelerates biochemical reactions in aerobic, facultative, fermentative, and anaerobic environments. Environmental conditions may be changed to complete the degradation of primary and secondary by-products, (for example degradation of PCE is initiated in an anaerobic mode followed by facultative, fermentative, and aerobic states to complete degradation);
- HC-2000 can be applied under various environmental conditions and consequently, a greater number of contaminants can be remediated;
- Pulsed injection of HC-2000 through sparge tips (along with water, air, and/or other reactants) increases contact and mixing by the formation and collapse of reaction distribution channels; and
- HC-2000 is applied at weekly intervals to create an explosion in heterotrophic plate counts. Between doses, native microbes and HC-2000 components attack contaminants directly or cometabolically.

HC-2000 APPLICATION SYSTEMS

For surface water or soil applications, a HC-2000 and water mixture may be applied by a diaphragm, roller, or centrifugal pump with a fire nozzle. Trace quantities of pulp may clog finer nozzles (especially pressure washers). Best results are achieved when surface soils are tilled with the initial application and several times during the treatment period.

For subsurface soil applications, HC-2000 may be applied through infiltration galleries, horizontal or vertical biovent systems or reaction trenches/fences. HC-2000 may be applied as foam to enhance movement through and contact with soil. Soil moisture should be maintained at 70% of field holding capacity.

For subsurface groundwater application, HC-2000 may be applied through horizontal or vertical biosparge systems or reaction trenches/fences. For insitu soil and groundwater applications, reaction zones are generally defined by areas where 10% of the applied air pressure is observed at response points. Radius of influence or reaction zone tests should be performed to determine injection grid layouts. Application of HC-2000 during high water table conditions will avoid contamination desorption from the smear zone located above the water table.

SUGGESTED MONITORING & DOSAGE RATES

Optimal degradation conditions are present when total heterotrophic plate concentrations are elevated and maintained during the treatment period. Elevated plate counts indicate that sufficient nutrients, moisture, and environmental conditions are present. Secondary parameters that may be monitored include respiration by-products, moisture, dissolved oxygen, pH, and redox potential. Monitoring the reduction of the contaminants of concern determines when treatment is complete.

Dosage rates are site and contaminate(s) specific. Dosage "rules of thumb" range from three (3) to ten (10) cubic yards of contaminated media (soil, groundwater, railroad ballast, etc.) per gallon of concentrate. Concentrate dilution ratios of one part of HC-2000 to sixteen parts of water is recommended for soil applications. Groundwater dosage rates vary from 1:16 to 1:30 (HC-2000 to water mixture). Always add HC-2000 concentrate to water to avoid excessive foaming.

CASE HISTORIES

Over fifty (50) sites have been remediated using HC-2000. Five (5) case histories are presented below to illustrate the effectiveness of HC-2000.

Hartsfield International Airport Jet Fuel Remediation

The drive train on a tanker carrying 10,000 gallons of Jet A exploded and punctured the shell releasing 8,000 gallons of fuel on a perimeter road. Fuel was released on asphalt pavement and migrated overland into a stormwater drainage ditch. 6,500 gallons of fuel were recovered from a one-mile section of stream utilizing skimmers,vacuum trucks, wash down pumps, and a polypropylene rope mop.

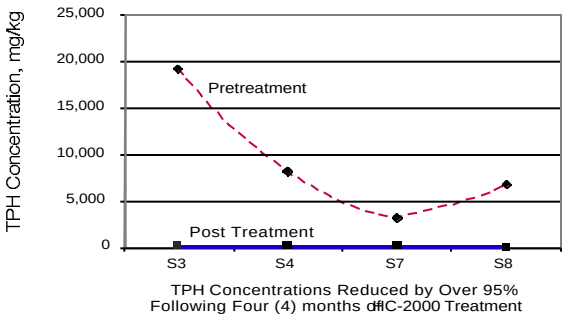
Ditch line Soil Removed to Biobed

An estimated 1,000 gallons of fuel migrated into 600 cubic yards of soils at the accident site. 350 cubic yards of soils were excavated from the bottom of the drainage ditch and placed on a one-foot deep biobed. Soil was treated with HC-2000 and cultivated with a disc/harrow.

The remaining 250 cubic yards of bank soils were remediated in place with three (3) horizontal aeration/enzyme injection manifolds aerated by a regenerative blower. Ten (10) gallons of HC-2000 (diluted with 16 gallons of water) were injected on a weekly basis into the bank and bed bioremediations systems. An automated sprinkler system was installed to maintain moisture levels at both locations. Remtech trained airport personal to operate the bioremediation systems.

Insitu Bank Treatment

Total petroleum hydrocarbon (TPH) concentrations were reduced below 200 mg/kg in 16 weeks. Total heterotrophic plate counts were elevated from 6,000,000 to over 100,000,000 CFU/gm and up to 99% total petroleum hydrocarbon reductions were achieved.



TPH Concentrations Reduced by Over 95% Following Four (4) months of HC-2000 Treatment

Bioremediation Bed

Major Tank Truck Company JP-8 Remediation

A tanker carrying 8,000 gallons of JP-8 on a major interstate highway rolled down an embankment releasing 2,600 gallons of jet fuel (JP-8) into a wetland area adjacent to a stream feeding a major recreational lake in North Atlanta. The fuel infiltrated a marshy area and migrated into an underground gravel streambed. Remtech was engaged by the insurance company to remediate the site.

JP-8 Tanker Rollover

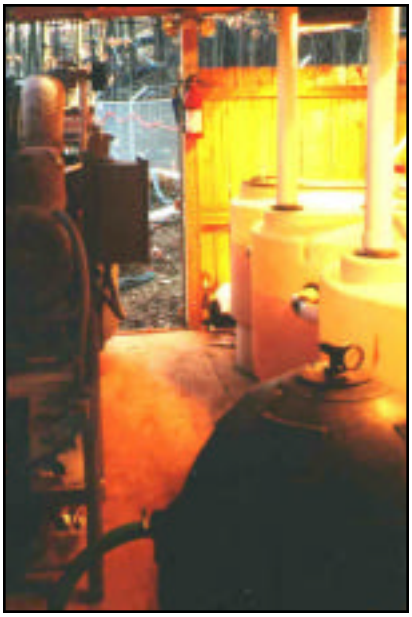
A series of interceptor trenches were installed to collect free product. The interceptor trenches were also designed to serve as biosparge and biovent systems. HC-2000 (a native micro-organism bioremediation accelerator) was applied to enhance the biodegradation of jet fuel in the vadose and saturated zones.

During the first month of operation, 700 gallons of free product were recovered from the interceptor trenches (using recovery well pumps) and oxbow using a polypropylene rope mop. Leachates were pumped to a Remtech treatment system consisting of an oil/water separator, twin LPAS (Low-Profile Air Strippers), and aqueous phase activated carbon filters.

BioSparge/Vent System

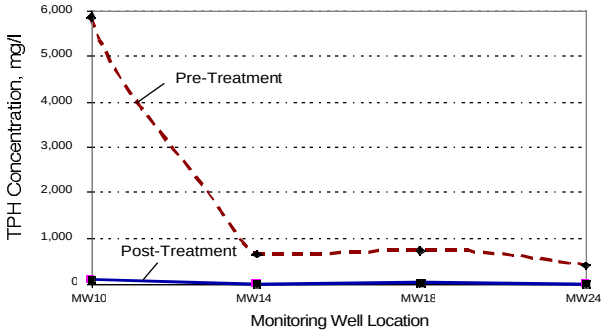
Following removal of the mobile free product phase, surface and groundwater HC-2000 injection was initiated. The inter-ceptor trenches were utilized to sparge the groundwater and elevate groundwater dissolved oxygen levels from 0.5 mg/l to over 3.5 mg/l. Total groundwater heterotrophic plate counts increased from 10,000 CFUs/ml to over 1,000,000 CFUs/ml during the first month. Solution phase total petroleum hydrocarbons (TPH via EPA method 418.1) were reduced by over 83% and soil TPH concentrations were reduced by over 70% during the first 30 days of treatment.

Over a 4 - month period, soil TPH concentrations were reduced over 91% and groundwater TPH concentrations by over 94%. Benzene groundwater concentrations were reduced from 125 ppb to below detection limits.



Enzyme Bioconcentrator

Insitu enhanced bioremediation was selected over other remedial strategies due to limited site access and significant cost savings over other methods, i.e. less than 50% of site excavation and restoration costs.



Groundwater TPH Concentrations reduced by over 94% Following HC-2000 BioSparging.

Water Main Diesel Fuel Remediation

A diesel tanker rollover occurred at an intersection with 75-year-old 30 to 48-inch ductile iron water mains. Concern for structural damage to the old water mains required that contaminated soils be treated in place.

The insurance company for a major transportation firm engaged Remtech to remediate the site. Remtech employed its proprietary HC-2000 biofoam injection process to treat the soils in place while minimizing impact to the water lines. After four months of treatment, more than 94% of the petroleum hydrocarbons had been degraded.

HC-2000 Injection Around Water Mains

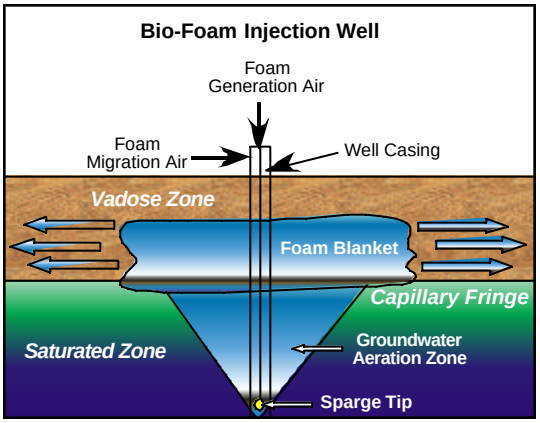
Georgia GUST FUND Gasoline Remediation

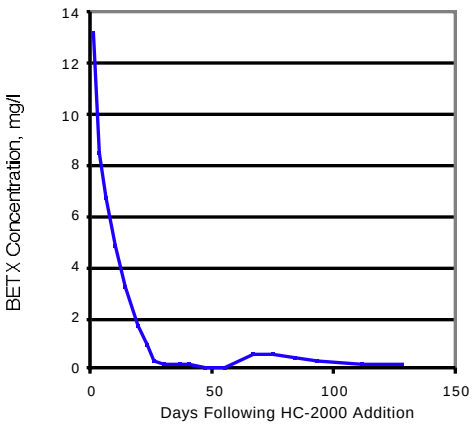
Seven (7) existing recovery wells at a beverage distribution facility LUST site were converted into enzyme injection bio-foam wells. Remtech's HC-2000 (natural bioremediation biofoam accelerator) was injected over a six (6) month period.

Remtech's bio-foam injection wells were utilized to increase mass transport of HC-2000 to the saturated and unsaturated zones. High pressure air is used to generate micro-bubbles of foam. High volume/low pressure air is used to move the foam blanket through the unsaturated zone and capillary fringe.

BioSparge/Vent System at Beverage Facility

Free product was eliminated during the first month of treatment.BTEX concentrations in the heart of the groundwater plume were reduced by over 94% and TPH concentrations were reduced by over 96% during the treatment period.





BETX Degradation Curve

Enzyme/Air Injection Well Head

Gasoline Bioremediation at Freight Distribution Center

Remtech was engaged to remediate a UST tank pit contaminated with gasoline in the saturated zone at a freight terminal located in Chicago, Illinois.

Remtech installed a biosparge injection grid system consisting of sixteen (16) injection probes. Sparge lances consisted of 1/2-inch steel pipe (10 feet long) with Remtech's air and enzyme delivery tips. Injection lances were driven into the ground with an electric jackhammer.

Low pressure air and HC-2000 was fed into the saturated zone with Remtech's automated biosparge system. Dissolved oxygen levels were raised to over 3.5 mg/l and total heterotrophic plate counts were raised to several million CFU's/ml.

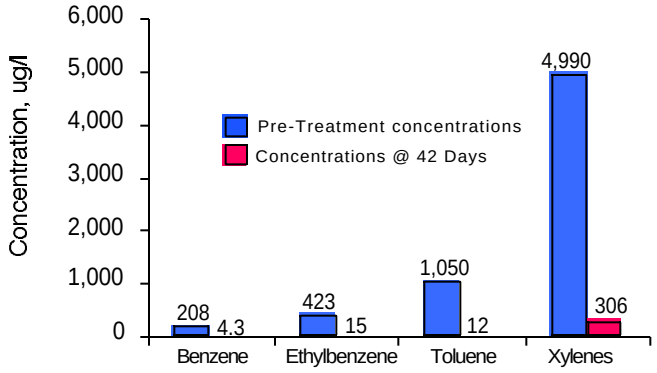
Treatment confirmation sampling points were installed between injection points. At the end of a six (6) week treatment period, BETX constituents were reduced by 98% for benzene, 96% for ethylbenzene, 99% for toluene, and 94% for total xylenes. Total BETX was degraded by over 95%.

The insitu groundwater remediation program is anticipated to be completed in eight (8) to twelve (12) weeks.

Automated BioSparge System

Sparge Tip Installation

BioSparge Injection Grid



SUMMARY AND HC-2000 BENEFITS

Other remedial technologies may leave residual contaminants that requires further treatment. These technologies include; pump and treat, soil venting and air sparging, and total fluids extraction. Why not start with a technology that can finish the job?

Site remediation costs with HC-2000 range from $15 to $225/cy of contaminated media. Costs are site specific and are affected by the type of contamination, local geology, project size, and contaminant location. HC-2000 performs best in formations where adequate communication and mixing can be established.

Other HC-2000 benefits include:

- HC-2000 is non-toxic, non-allergenic, and consists of food quality ingredients.
- Accelerating the natural degradation process with HC-2000 is generally received favorably by regulatory authorities and the general public.
- Heterotrophs are already acclimated and distributed in the environment. All that is required is to deliver HC-2000 to the degraders.

- HC-2000 goes right to work by energizing native heterotrophs. Chemical oxidization with permanganate, peroxide, and ozone frequently oxidize materials other than target contaminants, i.e., a significant mass of reagents are wasted. Chemical oxidization may form toxic by-products that are not normally associated with native biochemical reactions.

- Oxygen and hydrogen release compounds generally rely on passive slow release mechanisms and depend on advection and dispersion to transport the reagent to the contaminant. Limiting nutrient deficiencies are not addressed. Adsorbed and soil pore bound contaminates are only addressed by sufficient concentration gradients to draw reactants to contaminants. HC-2000 provides contaminant desorption with biosurfactants that is generally more effective than concentration gradients. Aggressive pulsed reagent injection (used with HC- 2000) generally provides better mass transfer and mixing.

- HC-2000 is easily assimilated by native bacteria without a lag time. Commercial fertilizers and surfactants may initially inhibit microbial degradation. Nutrient and carbon sources such as molasses, sugars, and vegetable oil need to be broken down further prior to assimilation by microbes.

- Organic nitrogen and proteins (contained in HC-2000) are a preferred source of nitrogen over nitrates, ammonia, and other compounds containing nitrogen.

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About the Authors

Mark D. Ryckman is Principal Engineer and Founder of Remtech Engineers. He is a licensed engineer in ten (10) states and possesses specialty certifications as a Diplomat in Hazardous Waste Management and Water and Wastewater Treatment from the American Academy of Environmental Engineers. He possesses undergrad degrees in Mathematics, and Civil Engineering and a Masters in Environmental Systems Engineering from Clemson University. He has served as project principal on over 2,500 hazardous material incidents during the past 25 years.

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