

# Environmental Bio-Systems, Inc. 1

## TECH MEMO #104: REDUCTION OF FREE PRODUCT USING FENTON'S REAGENT IN GROUNDWATER

By Jim Jacobs, CHG, 415-381-5195

**THE FREE PRODUCT PROBLEM:** Diesel has a density of 0.827 g/ml, as compared to water with a density of 0.998 g/ml. Therefore, the lighter contaminants, such as diesel, tend to float as a pancake layer on the water table once full saturation is reached.

**PAST REMEDIATION OPTIONS:** Groundwater pump and treat systems have been the main method to remove floating product from the top of the water table. Pneumatic product-only pumps with hydrophilic membranes have been used successfully for free product removal. A major concern with pump and treat systems are the generally large budgets needed for equipment procurement, operations and on-going maintenance.

**NEW REMEDIATION APPROACH:** Hydrogen peroxide can chemically oxidize diesel forming carbon dioxide and water as end products in a reaction that usually lasts seconds to minutes, with the longest reactions lasting hours. ENVIRONMENTAL BIO-SYSTEMS uses both a direct push method as well as a specialized lance system for the delivery of treatment chemicals. In-situ oxidation uses contact chemistry of the oxidizing agent to react with volatile organic compounds. A common oxidizer used in soil and groundwater remediation is hydrogen peroxide and the hydroxyl radical. Hydrogen peroxide when in contact with a metal catalyst such as iron (II), which is commonly known as Fenton's reagent, forms the more powerful oxidizer, the hydroxyl radical. The metal catalyst can be usually provided by iron oxides within the soil or fill, or added separately as iron sulfate. Fenton's reagent has been well documented for over 100 years and has been in use in water treatment plants for well over 50 years.



### RESEARCH AND CASE STUDY:

OAKLAND, CALIFORNIA; FORMER VEHICLE MAINTENANCE FACILITY: ENVIRONMENTAL BIO-SYSTEMS provided the delivery system for chemical oxidation of diesel. Prior to the treatment, 1.5 cm of diesel free product was noted in a well in the treatment area. The soil was generally low permeability materials: predominantly silty clay. The treatment depth was 0 to 4 m, and 400 m<sup>3</sup> was the volume of soil to be treated.

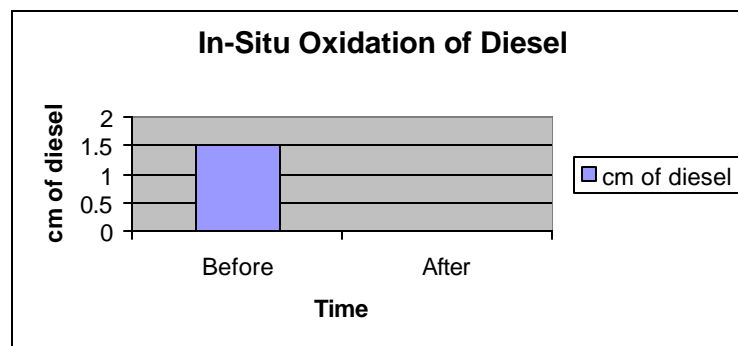
← Direct push rig using electric logging to evaluate subsurface conditions.

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ENVIRONMENTAL BIO-SYSTEMS treated the soil with up to 10% hydrogen peroxide. The natural iron content in the soil was sufficient for Fenton's Reagent and creating the hydroxyl radical. A low concentration of acetic acid was used to lower the subsurface pH. ENVIRONMENTAL BIO-SYSTEMS injected 40 ports on 2.5 foot spacing with up to 100 gallons of treatment chemicals. The 1.5 cm of diesel free product was oxidized during the one treatment event. Client reference: SEACOR International.



ITEM	DESCRIPTION
Contaminants	diesel
Medium	Soil and Groundwater
Volume	400 m <sup>3</sup>
Depth	0 to 6 meters
Treatment Solutions	Hydrogen Peroxide and Acetic Acid
Location	Oakland, California
Client	SECOR International, Inc. (2000)

**RECOMMENDED PLAN:** The existing physical and chemical data, including pH, permeability, lithology, and water depth, concentrations of VOCs, alkalinity is reviewed prior to a simple laboratory bench test (5 to 10 working days). A pilot-scale in-situ remediation project can occur within a days after the bench test results are available. After a pilot-scale project is performed, a large-scale full remediation program can be developed. In some cases, the pilot-scale size project may be enough to treat a lingering hot spot. For hydrocarbon-impacted sites, the hydrogen peroxide reaction will liberate large amount of free oxygen, allowing for a second treatment phase using aerobic bioremediation of the contaminants.

**COMPANY BACKGROUND:** Since 1990, ENVIRONMENTAL BIO-SYSTEMS has been a leader in in-situ remediation. The company has developed proprietary injection remediation

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technologies, allowing for successful remediations of metals, hydrocarbons, and chlorinated solvents.