**A TEST TO ILLUSTRATE THE EFFECTS OF
BIOSOLVE® ON THE MOBILITY
OF CONTAMINATED SOILS**

February 22 - March 5, 1999

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Abstract

Mountain States BioSolve[®] manufactures products for insitu bioremediation projects; their BioSolve[®] product desorbs and emulsifies hydrocarbons in a contaminated substrate.

BioSolve[®] is a blend of water-based, biodegradable surfactants which were engineered as a clean-up and mitigation agent for hydrocarbon products. Its basic mechanism is to emulsify the hydrocarbon into small encapsulated particles in a water/oxygen-bearing solution, desorbing hydrocarbon molecules from soil particles. This allows bacteria to more effectively metabolize the contaminate.

During desorption, Total Petroleum Hydrocarbons (TPH) levels may increase shortly after application. This is due to the removal of contaminate from soil particles which increases the total recoverable hydrocarbon. This allows the hydrocarbon, in the pump and treat process, to become mobile, and carried with the water to the recovery wells where it can be removed. This testing does not address pump and treat technology but only the increased surface area for bioremediation enhancement.

Introduction

Mountain States BioSolve[®] of Cheyenne, Wyoming contracted with the Rocky Mountain Oilfield Testing Center (RMOTC) of Casper, Wyoming to conduct a bench test. The test was intended to illustrate the increased mobility of crude oil in soils on which BioSolve[®] was applied as a surfactant to enhance the bioremediation of hydrocarbons.

The data presented in this report was collected from February 22, 1999 to March 5, 1999. This report will detail the materials and methods used to conduct the test, test procedures, laboratory results, and conclusions.

Materials and Methods Experimental Design

The procedures detailed in this report were based on earlier bench testing conducted by RMOTC at Naval Petroleum Reserve No. 3 (NPR-3).

To simulate the flow of water through the soil, constructed tubes were used to hold columns of soil.

Each tube was constructed from a 36 inch length of 4 inch diameter clear Schedule 40 PVC pipe. One-half inch holes were drilled at six inch intervals along each length of pipe; one-half inch pipe plugs were installed in the holes. A one-half inch outlet valve was inserted at the bottom of each tube. The tubes were set into specially constructed stands and loaded with eight inches of medium grain clean sand covered with twenty-four inches of clean sandy-loam dirt. Four inches of head space was left at the top to allow addition of oil, water and BioSolve[®]. A 1,000 milliliter glass jar was placed below the outlet valve of each tube.

Unrefined sweet crude oil (36^o API) was collected from an onsite battery at NPR-3. This oil and the soil-filled tubes were allowed to stand overnight to reach ambient room temperature.

Experimental Procedure

The two constructed tubes, a control tube (#1) and a test tube (#2) were used in the bench test. The general procedure was to add an equal amount of oil and water to each tube and to add BioSolve[®] to Tube #2. The output fluid was collected from both tubes, and the tubes were allowed to rest before the half-inch plugs were removed to recover soil samples. The experiment was divided into Phase I and Phase II. During Phase I, a 20% solution of BioSolve[®] was tested; in Phase II the solution strength was 10%.

Phase I, February 22, 1999

Tube #1

Soil temperature was 75°F prior to the addition of oil; temperature of the unrefined crude oil was 71°F. 200 milliliters of unrefined crude oil were added to the tube, followed by 1,000 milliliters of tap water at 120°F. The water was absorbed in less than one hour; during this time leachate began draining from the valve at the base of the tube. An additional 1,000 milliliters of tap water at 120°F were added one and one-half hours after the test began; this water was completely absorbed within one hour. Within seven hours, a total of 1,270 milliliters of leachate had been collected; 1,230 milliliters of leachate were analyzed for TPH content using EPA Method 418.1. The sample contained <1.0 mg/L.

Tube #2

Soil temperature was 76°F prior to the addition of oil; temperature of the unrefined crude oil was 71°F. 200 milliliters of unrefined crude oil were added to the tube, followed by a mixture of 1,000 milliliters of tap water at 123°F and 250 milliliters of BioSolve[®]. The water-BioSolve[®] mixture was not absorbed as rapidly as the plain water of Tube#1. An additional 640 milliliters of tap water at 120°F were added one and one-half hours after the test began. Six hours later the remaining 360 milliliters of water (at 120°F) were added to the tube. No leachate was collected from Tube#2 on the first day of the Phase I test. By the end of the second day, 550 milliliters of leachate had been collected and an additional 400 milliliters of leachate was recovered the morning of the third day. An 860 milliliter leachate sample was analyzed for TPH content. The sample contained <1.0 mg/L.

Soil Samples

Four days after the test began, the plugs were removed from both tubes to obtain soil samples. Samples were taken from the top and each six inch interval thereafter. The samples were analyzed for total petroleum hydrocarbons.

The results of Phase I testing are shown in Table 1.

Phase II, March 1, 1999

Tube #1

Soil temperature was 73°F prior to the addition of oil; temperature of the unrefined crude oil was 71°F. 200 milliliters of unrefined crude oil were added to the tube, followed by 1,000 milliliters of 140°F tap water. All of the water was absorbed in less than one hour and leachate began draining from the tube. An additional 1000 milliliters of tap water at 138°F were added one and one-half hours after the test began.; this water was completely absorbed within one hour. Less than seven hours later, a total of 1190 milliliters of leachate had been collected; a 930 milliliter portion was analyzed for TPH content. The sample contained <1.0 mg/L.

Tube #2

Soil temperature was 73°F prior to the addition of oil; temperature of the unrefined crude oil was 71°F. 200 milliliters of unrefined crude oil were added to the tube, followed by a mixture of 1,000 milliliters of 141°F tap water and 120 milliliters of BioSolve®. This water-BioSolve® mixture was absorbed within the first hour. An additional 950 milliliters of 140°F tap water were added one and one-half hours after the test began. Three hours later approximately 200 milliliters of leachate had been generated. An hour later the remaining 50 milliliters of tap water were added to the column. A total of 929 milliliters of fluid was collected by the following morning; an 860 milliliter leachate sample was analyzed for TPH content.

Soil Samples

Four days after the test began, the plugs were removed from both tubes to obtain soil samples. Samples were taken from the top and from each six inch interval, and analyzed for total petroleum hydrocarbons.

The results of Phase II testing are shown in Table 2.

Conclusions

A BioSolve® solution was tested at 10% concentration and at 20% concentration on hydrocarbon-contaminated soils. Both Phase I and Phase II tests demonstrated that the presence of BioSolve® retarded the rate of saturation and fluid movement through the soil columns as compared to fluid flow rates in the untreated columns.

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PHASE I, February 22, 1999: 20% BioSolve Solution			
Leachate	Volume, m/L		TPH, mg/L
Tube #1	1,230		<1.0
Tube #2	860		<1.0
Soil	Volume, m/L	Weight, g	TPH, mg/L
Tube #1			
Top	100	10	29,900
24"	100	10	43,300
18"	100	10	10,600
12"	100	10	34
6"	100	10	41
Bottom	100	10	34
Tube #2			
Top	100	10	25,900
24"	100	10	10,300
18"	100	10	20,300
12"	100	10	18,600
6"	100	10	1,220
Bottom	100	10	42

Table 1

PHASE II, March 1, 1999: 10% BioSolve Solution			
Leachate	Volume, m/L		TPH, mg/L
Tube #1	930		<1.0
Tube #2	910		<1.0
Soil	Volume, m/L	Weight, g	TPH, mg/L
Tube #1			
Top	100	10	64,800
24"	100	10	42,000
18"	100	10	8,100
12"	100	10	30
6"	100	10	<10
Bottom	100	10	<10
Tube #2			
Top	100	10	74,900
24"	100	10	64,600
18"	100	10	19,500
12"	100	10	14,100
6"	100	10	<10
Bottom	100	10	<10

Table 2