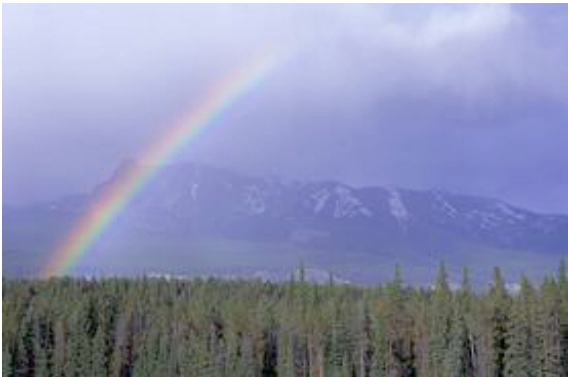


BioAugmentation - a detailed report

First, some background on the nature of hydrocarbon spills. The entire world runs on fossil fuels (crude oil) and has run on them for quite a while. Hydrocarbons are the world's primary energy source. With the demand for oil so high, and the human factor involved in the production, refining, transportation, and end use of petroleum hydrocarbons, spills are inevitable. The question is how best to clean up the spills after they occur. Nature has this down to a science. Wherever there is a natural oil seepage on the earth, nature has placed oil degrading microorganisms (microbes). These microbes use the oil as an food source, breaking it down into its component parts, making a potentially harmful substance harmless, even beneficial.



Nature is able to clean up after itself, but it takes time. It's a slow, natural healing process---nature's own pollution control. The problem is that mankind now puts far more hydrocarbon pollution into the environment than nature can remove in the amount of time that man wants to allow . Science has devised ways of speeding nature up. By adding certain materials to a contaminated environment we can speed up the rate of natural degradation. If the proper microbes are not present, the remediation will be delayed. Microbes, adapt, over lengthy periods of time, to be able to use whatever the most prominent energy source is.

Therefore, if you spill petroleum at a site that has seen numerous similar spills over a period of years, there may well be a population of petroleum degrading microbes present. If, on the other hand, the spill occurs at a site that has not experienced numerous petroleum hydrocarbon spills there will not be suitable starting microbial populations.

This speeding up of the natural degradation process, generally referred to as bioremediation, is splintered into different factions and techniques, depending upon what "materials" are added to the site. It's true that in general microbes are ubiquitous, however, only a small percentage of the indigenous microbes may have the ability to create hydrocarbon degrading enzymes. This usually comes down to an issue of BioStimulation versus BioAugmentation.

Proponents of BioStimulation believe that, since microbes are ubiquitous, the indigenous microbes at the site will take care of the pollution and all that is necessary is the addition of fertilizers and nutrients to speed up the growth of that indigenous microbial population. Proponents of BioAugmentation believe that the way to clean up the pollution is to inoculate the site with a consortia of specific contaminant targeted microbes in high densities. In both techniques, the environment must be carefully controlled and monitored for optimal microbial growth and some engineering of the site may be needed.

In either case, the BioStimulation method of adding fertilizers and nutrients may or may not have a desirable affect. It's a gamble. Fertilizer added to soils or water will be used competitively by all microbes that have food sources available. There is no guarantee that any hydrocarbon degrading microbes present will out compete the other microbes for available space.

Therefore, the BioStimulation method may have questionable results and, even if it does work, the

densities of the needed microbes are often so low that the treatment time is lengthy.

Whichever approach is used, BioStimulation or BioAugmentation, there is one unalterable fact. In order to have hyper-degradation (faster than normal) occur there must be a minimum of 1,000,000 oil degrading microbes per gram of contaminant to override the indigenous population of microbes. Anything less and the bioremediation process becomes a very slow one, if it works at all. So it all boils down to a numbers game. In this case, the more hydrocarbon degrading microbes present at the site of the spill, the faster and more efficient the remediation process.

Using BioAugmentation, instead, the site is inoculated with a proven and already tested, highly concentrated consortia of hydrocarbon degrading microbes. The only lab test required is a simple, quick, and inexpensive biocompatibility test to determine if there are any substances present that would be toxic to the microbes, thus preventing them from doing their job. Once the site is inoculated, the microbes quickly adapt to their new environment and begin the break down of the pollutant. The speed with which this occurs is relative to the density of the needed microbe population.

In the case of The Oppenheimer Formula, that amounts to well over 100,000,000,000 microbes per gram of product and since growth of the microbes is exponential, the pollutant is quickly and efficiently degraded, resulting in a faster closure of the site. This means that heavy equipment, if needed at all, is on site for a shorter period of time. Labor is needed for a shorter period of time. All of this translates into money saved and equipment and labor that, rather than being tied up on job 1, are ready to begin job 2. In both cost and time, the savings are considerable.

Over the years, studies have been published (some by prestigious universities) that purport that, across the board, there is no difference between BioStimulation and BioAugmentation. They indicate that, all things being equal, the results achieved are the same. The problem with these studies is that, as any working engineer or field personnel will tell you, all things are seldom, if ever, equal. Read these studies carefully. Was the soil being used representative of average soils or was it chosen specifically from a site known to have

a very high indigenous population of just the right microbes for the task? Were the inoculation levels of the exogenous microbes kept artificially low to allow unfair advantage to the indigenous microbial population being studied? If the study purports to compare various products, was each product applied meticulously following the individual manufacturer's specific instructions, including the application of manufacturer specified nutrients packages and biocatalysts?

BioAugmentation is the quickest and best way to clean up petroleum contaminated sites. BioStimulation may also clean up a site, but at a greater cost and much more time. There are a great number of things in this world that might work for a given job. But when your reputation, money, and time are on the line, don't you want the very best tool for the job? BioAugmentation is that tool and Oppenheimer Biotechnology can show you how to use it to save money, reduce the length of remediation and at the same time have successful results.