Bioscience, Inc.
Environmental Products and Services

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Bioscience Technical Services
Oil Spill Article

Bioaugmentation and the Gulf of Mexico Oil Spill

Bioscience, Inc. has had many inquiries as to the feasibility of bacterial cleanup of the Gulf oil spill. Bioscience, Inc. has several field proven microbial products for these types of applications (For example, MICROCAT® – SK and XRCP for floating oil, BioBags for oil sheens, MICROCAT – XBS for oil on a beach or in a marsh, MICROCAT – SMPL for oil on a hard surfaces or in the open ocean, MICROCAT – XRT for boat bilges, and MICROCAT - NPN and NPC nutrients for all these.) However, as with any bioremediation application, the particular growth requirements of the bacteria to be used and the physical and chemical characteristics of the environment (the seawater, marshes, sediments and beaches) must be considered.

Bacteria need a food and energy source (the oil, present in abundance), nutrients (such as nitrogen, phosphorus, iron and other minerals), oxygen and (depending on the species of bacteria) certain pH ranges, salt concentrations and temperatures. The sea pH is slightly alkaline and generally favorable to bacteria. Many species of petroleum degrading bacteria tolerate or thrive in the salt concentration of the sea or the brackish water of estuaries and marshes. The temperature of Gulf waters is also highly favorable for bacteria. The two factors that limit the rate of bioremediation of oil spills are dissolved oxygen and nutrient availability.

To biodegrade a large amount of oil, you need a large amount of bacterial biomass. Bacteria consume a fraction of their own weight every day; thus to consume tons of oil per day you need tens of tons of bacteria. Bacteria populations in the sea are comparatively small and rapid growth is needed. For bacteria to grow rapidly and biodegrade the oil there must be a balance of carbon, nitrogen, phosphorus and other nutrients. Part of the oil is converted to carbon dioxide and water while a substantial portion is partially oxidized and converted into bacterial cell mass.

Nutrients such as nitrogen, phosphorus and iron are typically present in very low concentrations in oil and are present at low concentrations in seawater. The rule of thumb for estimating nutrient requirements is a carbon to nitrogen to phosphorus ratio of 100 to 5 to 1; thus, for every 5000 barrels of oil (low estimate of daily leakage) about 90 tons of a good fertilizer will be required for degradation. While this addition of nutrients is possible, it is also necessary that the nutrients remain in the same area as the oil. Most fertilizers are water soluble and once dissolved in the seawater, they can easily diffuse away from the oil or be transported away by wind and water currents. Experiments conducted after the Exxon Valdez oil spill in Alaska found that special organic forms of fertilizer that dissolved in the oil were effective in maintaining the nutrient concentrations in the contamination zone and allowed bioremediation to occur without contributing nutrients unnecessarily to uncontaminated seawater (thus encouraging algae growth).

Oxygen is a severe limitation for biodegrading large amounts of oil. Oxygen from the air dissolves in seawater at the air/sea interface but oxygen diffuses very slowly within the water column. At the surface, wave action creates favorable conditions to dissolve oxygen from the atmosphere into seawater. However, below the surface, water that has been saturated with oxygen only contains about 8 mg/L and bacteria will use 2-3 mg of oxygen to degrade 1 mg of oil. Thus, a small amount of oil degradation will consume all of the available oxygen and degradation will stop (and other sea life that depends on available oxygen will die). It is predicted that large dead zones (areas with no oxygen) will be created as natural biodegradation occurs even at low rates.

Is Bioremediation/ Bioaugmentation Feasible?

Bioscience answers yes, but in general we recommend that care be taken to choose the right product formulation and that it be applied under conditions conducive to its effectiveness. Surface slicks with thin layers of oil, contaminated beaches and marshes are prime sites where the addition of bacteria and nutrients will stimulate rapid bioremediation of oil spills without contributing to damage by using the available oxygen and killing wildlife. Contaminated sand and soils can be either actively or passively managed (depending on the degree of contamination) to promote bioremediation.

There is no magic bullet that will quickly mitigate the damage from an oil spill of this magnitude and all the alternatives are expensive and have possible negative effects. Dispersants may lessen the amount of oil that surfaces and potentially washes up on beaches, but may create large dead zones beneath the surface and the dispersants themselves may be toxic to various forms of marine life. Burning can only be carried out where the depth of oil is significant and wind and wave action is limited. Booms have been partially effective, again limited by wind and wave action. Recovery ships capture a portion of the oil and have weather limitations.

The best response possible is to use all appropriate remediation options including bioaugmentation with selected microbes intelligently to maximize the oil containment, recovery and degradation while minimizing cost and collateral damage. Bioscience, Inc. stands ready with several hundred thousand pounds of product inventory and production capacity along with the technical know-how and experience to respond and get results.

966 Postal Road • Suite 200 • Allentown, PA 18109 • (484) 245-5232 • (800) 627-3069 • Fax (484) 245-5236
E-mail: bioscience@bioscienceinc.com • Website: www.bioscienceinc.com