

Natural Biostimulants and Their Application to Bioremediation and Wastewater Treatment

BIODEGRADATION

Every micro-habitat in the natural environment is populated by large numbers of different species of interacting micro-organisms: bacteria and fungi. Micro-organisms feed on organic material as food sources breaking them down. The metabolites (waste) from one species are used as a food source by another species, eventually producing water, carbon dioxide, nitrogen and some salts. This process, called biodegradation, can be slow, because it relies upon the natural metabolism, growth

rates and diversification of species in a microbial population. Metabolic processes of micro-organisms are sensitive to environmental factors, including available food sources, temperature, moisture, nutrients, oxygen, etc.

The process of biodegradation is used to:

- Clean-up and remove organic pollutants, such as hydrocarbons from soil.
- Remove organic and ammoniacal compounds from wastewater and effluent in treatment plant.

BIOSTIMULANTS

Biostimulants are molecules which catalyse and accelerate metabolic processes within micro-organisms, under both aerobic and anaerobic conditions. They enable the micro-organisms to grow and reproduce more rapidly, therefore using up available food at increased rates.

The formulations of Global Advantech's products used in bioremediation, wastewater and effluent treatment include specific natural biostimulant molecules, which accelerate the

rate of biodegradation of organic pollutants. In addition to their proven powerful biostimulant properties, the molecules also catalyse cell defence mechanisms within micro-organisms. This enables the micro-organisms to detoxify and utilise harmful organic molecules as food, including polyaromatic hydrocarbons and quaternary ammonium compounds (biocides used for disinfection and as wood preservatives).

BIOREMEDIATION

Bioremediation is the use of biodegradation to clean-up organic pollution:

- Land – hydrocarbons and organic solvents from oil-spills, contaminated ground at old oil refineries and storage/distribution depots, engineering works, power stations, railway depots, former gasworks, etc.
- Water – oil-spills on surface water, contamination of aquifers by hydrocarbons and organic compounds.
- Concrete floors, docks, tank bunds – oil and hydrocarbon contamination at engineering works, ports, oil refineries and storage/distribution depots.

Bioremediation is the most cost effective method for the removal of low concentrations



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BIOREMEDIATION Cont/...

of oil, hydrocarbons and organic solvents (<5%), where the pollutants are widely dispersed across a site or are inaccessible, e.g. because they have migrated underneath buildings or other structures. The remediation process may be used alone or in combination with physical treatment methods to remove pollutants. Used alone, bioremediation may be carried out *in situ* or *ex situ*:

- *In situ* – a solution of biostimulants, nutrients and natural-derived surfactants is injected or sprayed over the ground at the site of the pollution.
- *Ex situ* – contaminated soil, sand, etc., is dug out and piled into windrows (long mounds) and a solution of biostimulants, nutrients and natural-derived surfactants sprayed over the windrows. Water is collected from the base of the windrows, treated and re-applied with biostimulants over the windrows.

Combined bioremediation and physical treatment methods include:

- Mobilisation of hydrocarbons in the ground using "pump and treat", where water containing biostimulants, is pumped out through boreholes, treated in aerobic biological plants, then re-injected.
- Adjustment of local hydrogeology gradients (flow of groundwater) by digging out pits to below the water table, pumping water out from these pits. Treating the water in aerobic biological plants, then adding biostimulants then re-injecting.
- Bioremediation of heavy hydrocarbon contaminated sand and soil in windrows after it has been washed to further reduce remaining hydrocarbon levels, e.g. 0.5% to 0.003%

Building upon experience gained over the past 16 years, Global Advantech has developed a range of products for improving bioremediation treatment to biodegrade hydrocarbons and other organic pollutants, containing:

- Biostimulants derived from natural plant materials.



- Nutrients to support accelerated microbial activity, including nitrogen, phosphorous, potassium and trace elements.
- Natural-derived surfactants to reduce surface tension between water and non-aqueous pollutants increasing contact area and their availability as food for micro-organisms. The surfactants also release pollutants trapped within soil particles, concrete pores, etc., dispersing them into water as small droplets. (Micro-organisms live in water/moisture and feed on non-aqueous pollutants at the water/pollutant interface.)
- Water-soluble electron donors, which permit halogen respiring micro-organisms to use chlorinated/halogenated hydrocarbons as electron acceptors enabling their reductive dehalogenation and biodegradation.



Global Advantech's products contain no micro-organisms (bacteria, fungi, etc.) and no enzymes, which rapidly degrade in aqueous solution and are deactivated by many chemicals and pollutants.

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BIOREMEDIATION Cont/...

The following GCMS traces show the effect of using biostimulants to accelerate the biodegradation of hydrocarbons after an oil spill



WASTEWATER AND EFFLUENT TREATMENT

Biological treatment plants are used to remove organic and ammoniacal compounds, including sewage, animal and vegetable fats, oils and greases, and dissolved and emulsified hydrocarbons, from wastewater and effluent prior to discharge into the environment.

Biostimulants have been proven to substantially improve the performance of biological wastewater and effluent treatment plants. Global Advantech has formulated a number of products for use in treatment plants. They are dosed into wastewater immediately prior to it entering aerobic biological treatment processes, e.g. oxidation tanks, trickle filters, rotating biological contactors, etc.

The benefits of using Global Advantech's biostimulant products in wastewater and effluent treatment are:

- Improve municipal wastewater treatment plants to efficiently handle sewage loads beyond their original design capacities.
- Enable food processing companies to increase production capacity without having to immediately invest in the increase of capacity in their existing effluent treatment plants.
- Enable biological treatment plants at oil refineries and distribution depots to remove high levels of hydrocarbons and toxic organic compounds from process and ground water.



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APPLICATIONS BIOSTIMULANT PRODUCTS

| Application | <i>In situ</i> bioremediation of sand, soil, concrete, etc. | <i>Ex situ</i> bioremediation of sand, soil, etc., composting. | Bioremediation of water | Biological wastewater, effluent treatment | Anaerobic digestion |
|---|---|--|-------------------------|---|---------------------|
| OIL + GAS | | | | | |
| Drilling platform waste water, slops, etc. | | | | ✓ | |
| Environmental clean-up of well-sites, waste lagoons, etc. | ✓ | ✓ | ✓ | | |
| Oil + gas produced water, flowback water | | | | ✓ | |
| Refinery process, storage tank, ground water | | | | ✓ | |
| Distribution depots storage tank, ground water | | | | ✓ | |
| Oil-based mud drill cuttings (after washing) | | ✓ | | | |
| Production waste sludges, interceptor sludges, etc. | | ✓ | | | |
| Soil remediation at refineries, storage/distribution depots | ✓ | ✓ | | | |
| Remediation of concrete storage tank bunds, tanker loading/discharging stations, etc. | | ✓ | | | |
| Clean-up after oil-spills from transportation/storage | ✓ | ✓ | ✓ | | |
| Clean-up of beaches after oil-spills | ✓ | ✓ | | | |
| MUNICIPAL WASTEWATER AND EFFLUENT TREATMENT PLANT | | | | | |
| Aerobic plant stages | | | | ✓ | |
| Anaerobic digesters (methane production) | | | | | ✓ |
| MINING + MINERALS | | | | | |
| Treatment of quarry lagoons | | | ✓ | | |
| METALS PROCESSING | | | | | |
| Cleaning oil from concrete floors in strip rolling mills, etc. | ✓ | | | | |
| Remediation of steelworks | ✓ | ✓ | | | |
| Treatment of process water and groundwater lagoons | ✓ | | | | |
| MARINE | | | | | |
| Tanker + ship bilge, ballast water | | | | ✓ | |
| Cruise liner wastewater | | | | ✓ | |
| Ports, harbours, quaysides, fuel bunkering | ✓ | | ✓ | ✓ | |
| TRANSPORT | | | | | |
| Road and rail refuelling stations | ✓ | | | ✓ | |
| Oil and chemical spills | ✓ | | | | |
| Railway track ballast | ✓ | | | | |
| Car parks, etc. | ✓ | | | | |
| WASTE MANAGEMENT | | | | | |
| Landfill leachate | | | | ✓ | ✓ |
| Intensive animal production | | | | ✓ | ✓ |
| Cleaning road interceptor waste | | ✓ | | | |
| AIRPORTS | | | | | |
| Aircraft refuelling stands | ✓ | | | | |
| Surface water collection lagoons | | | ✓ | ✓ | |