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REMEDIATION OF HYDROCARBON CONTAMINATED SOIL

BIOREMEDIATION

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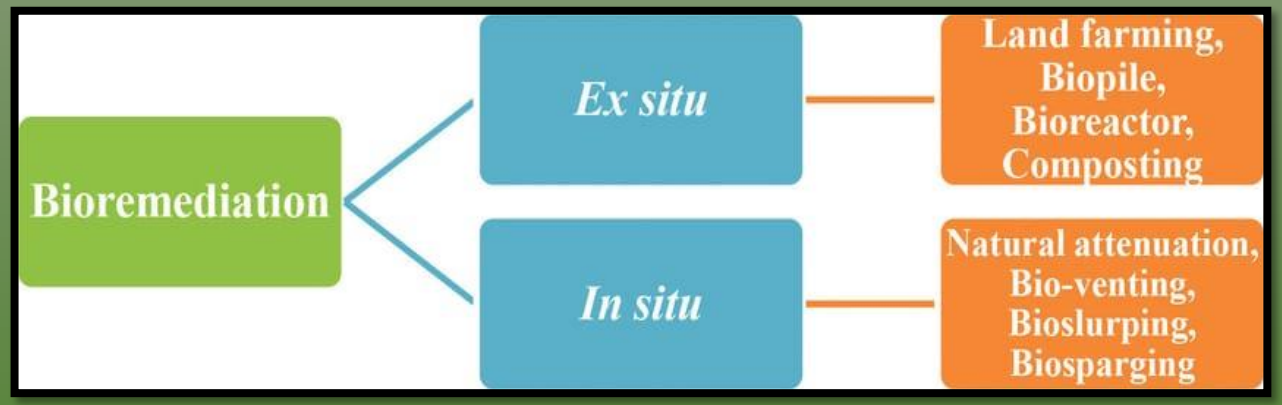
Bioremediation is the a biological degrading processes for the treatment of contaminated soils, groundwater and/or sediments, relying on microorganisms including bacteria and/or fungi to use the contaminant(s) as a food source with resulting degradation of the contaminant. Bioremediation is one of the most economic remedial techniques presently available for treating most organic fuel based contaminants such as coal tars and liquors, petroleum and other carcinogenic hydrocarbons such as benzene and naphthalene, and some inorganics. Hydrocarbon bioremediation and soil bioremediation are the most common services we provide of this type.



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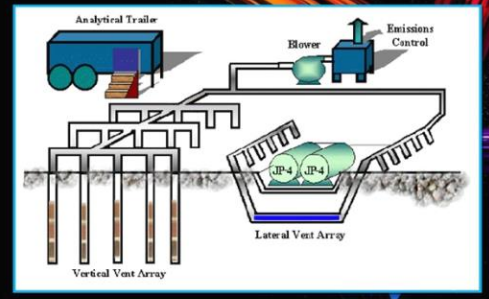
Bioremediation is widely used to remediate organic contaminants (e.g. fuel and fuel oils), in general bioremediation is a significantly more economic option to straight disposal, however it can take anything from 1 month to several months to carry out. Its suitability is based on the contaminants, site conditions, and target levels. If you want to find out if bioremediation is an option for your site then you should phone or e-mail us, we're always happy to discuss a site with you.
Bioremediation can be undertaken in-situ (i.e. with the soils / groundwater in the ground) or ex-situ (i.e. excavated soils or water pumped from the ground.

Methods in-situ

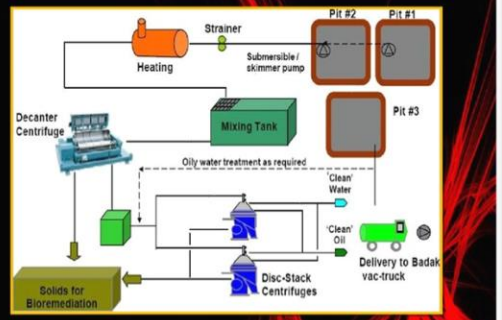
BIOVENTING

Bioventing is a technology that stimulates the natural in-situ biodegradation of any aerobically degradable compounds in NAPL within the soil by providing oxygen to existing soil microorganisms.



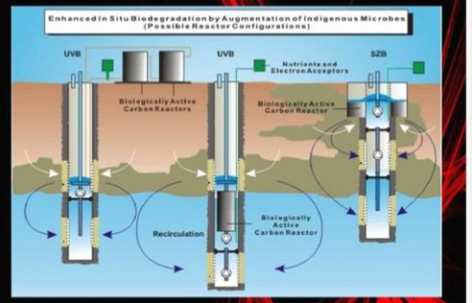
BIOPILING

Treatment is a full-scale technology in which excavated soils are mixed with soil amendments, placed on a treatment area and bioremediated using forced aeration.



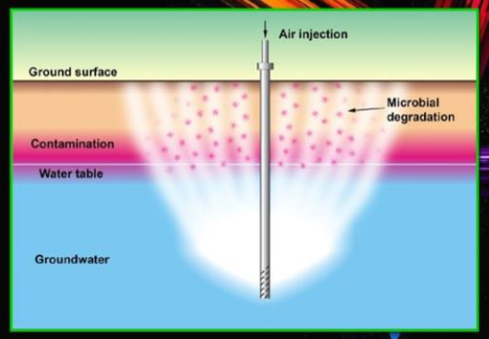
BIOAUGMENTATION

Is the introduction of a group of microbial strains to treat contaminated soil or water.



BIOSPARGING

Involves the injection of air under pressure below the water table to increase groundwater oxygen concentrations and enhance the rate of biological degradation of contaminants by naturally occurring bacteria.



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Methods in-situ

As a general rule all but the most homogenious of excavated soils require processing before bioremediation techniques can be successfully applied. There are a number of different techniques and formats to biological treatment however the basic principal of intruducing the correct soil oxygen, moisture and nutrient conditions prevails.

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Ex-situ bioremediation is a biological process in which excavated soil is placed in a lined above-ground treatment area and aerated following processing to enhance the degradation of organic contaminants by the indigenous microbial population. Under aerobic conditions, specific micro-organisms can utilise organic contaminants such as petroleum hydrocarbon mixtures, polycyclic aromatic hydrocarbons (PAH), phenols, cresols and some pesticides as a source of carbon and energy and degrade them ultimately to carbon dioxide and water. It is unusual to require the addition of microbial populations but usual to assess the nutrient requirement and amend the basic nutrients and organic substrate of the soil if any of these elements are deficient or absent. Oxygen (via the introduction of air) is essential to allow the microbial population to develop cultures capable of sustaining degradation.

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Ex-situ bioremediation can remediate a wide range of hydrocarbon contaminants including but not limited to:

- General hydrocarbons
- Kerosene
- Phenols
- Cresols Polycyclic aromatic hydrocarbons
- Semi-volatile organic compounds
- Diesel range hydrocarbons
- Lubricating oils
- Straight chain aliphatics

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Land farming

The simplest form of bioremediation, contaminated soil is excavated and spread out in layers approximately 0.3m in thickness on a lined treatment area. Bioremediation can be enhanced by periodic turning of the bed and addition of nutrients. Due to the limiting thickness of soil layers (0.3m) land farming techniques require large areas and are not generally suitable for small sites, but can be the cheapest and most basic form of bioremediation.

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Turned Windrows

The excavated soil is placed into a shaped pile up to between 1.5 and 2m height and up to 6m wide in a lined area, the pile is aerated by periodical turning of the windrows by specialised machinery which can be excavator mounted or self propelled. Soil organic amendments and nutrients can be easily added to the windrows during turning to improve aeration and soil characteristics as required. This is often the most cost effective method of ex-situ biological treatment.

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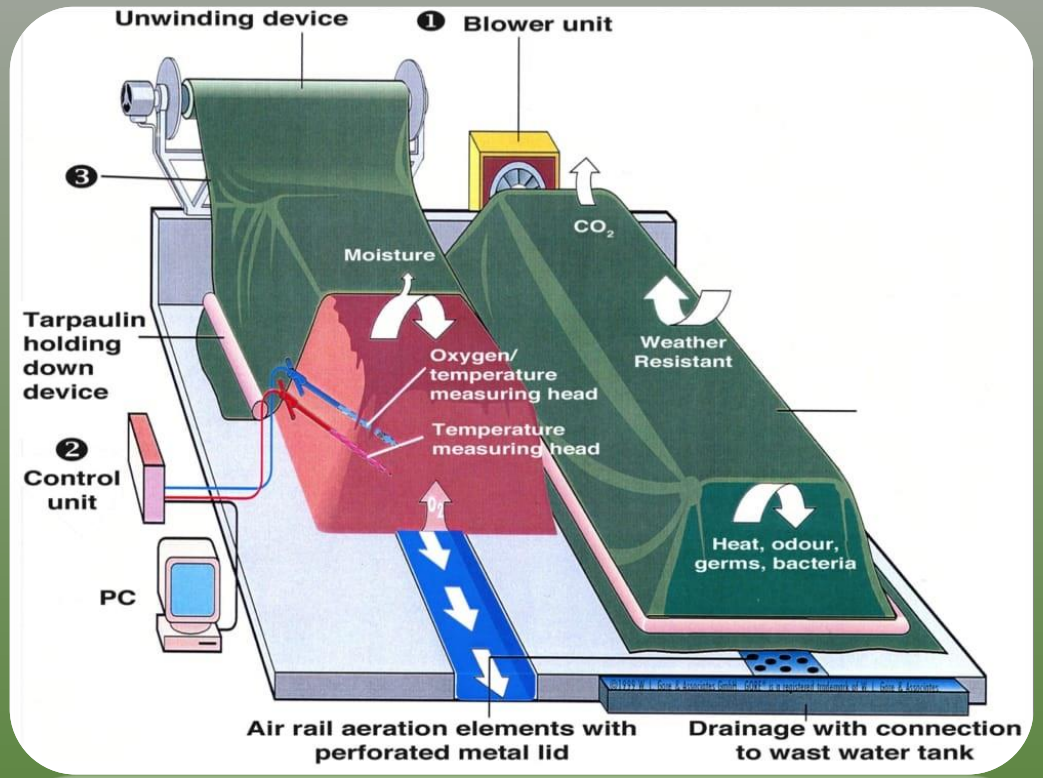
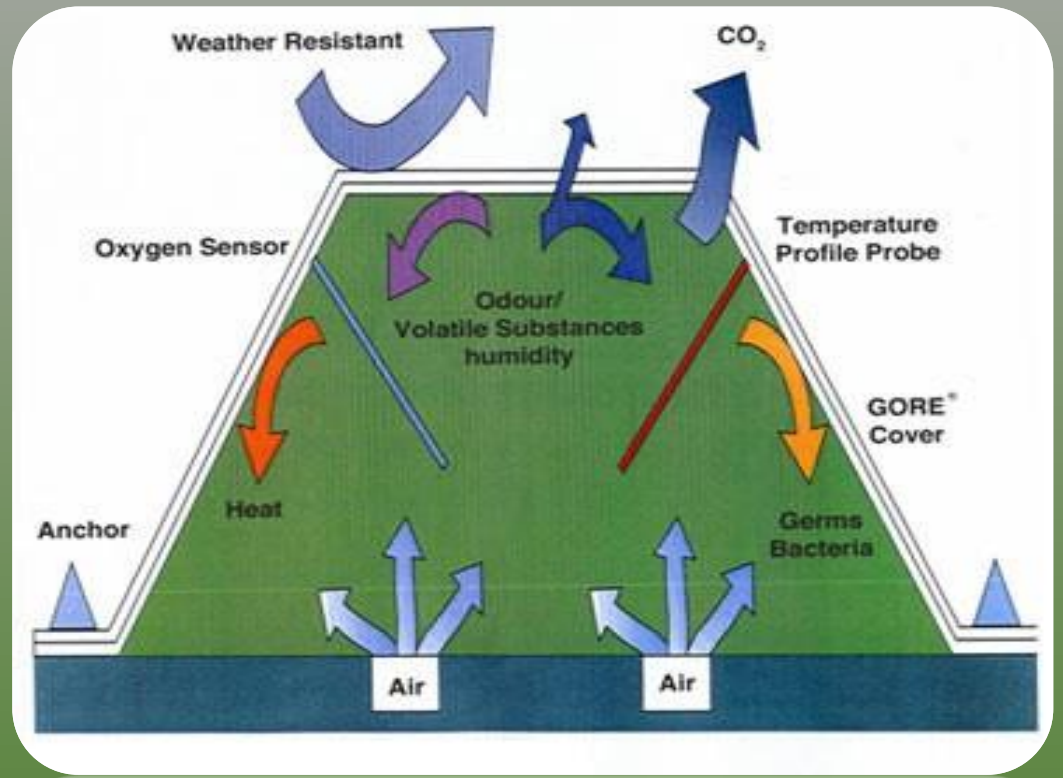
The treatment process used will be aeration in covered heaps, the aim being to treat the soil contaminated with hydrocarbons (1-7% TPH), so as to ensure its reuse in a minimum percentage of 80-90% as required in the documents provided by the Contractor/Beneficiary. The bioremediation process starts on the intensive bioremediation area by applying this technology. The contaminated soil is transported from the delivery area and is placed in piles of 500-1000 cubic meters by truck.





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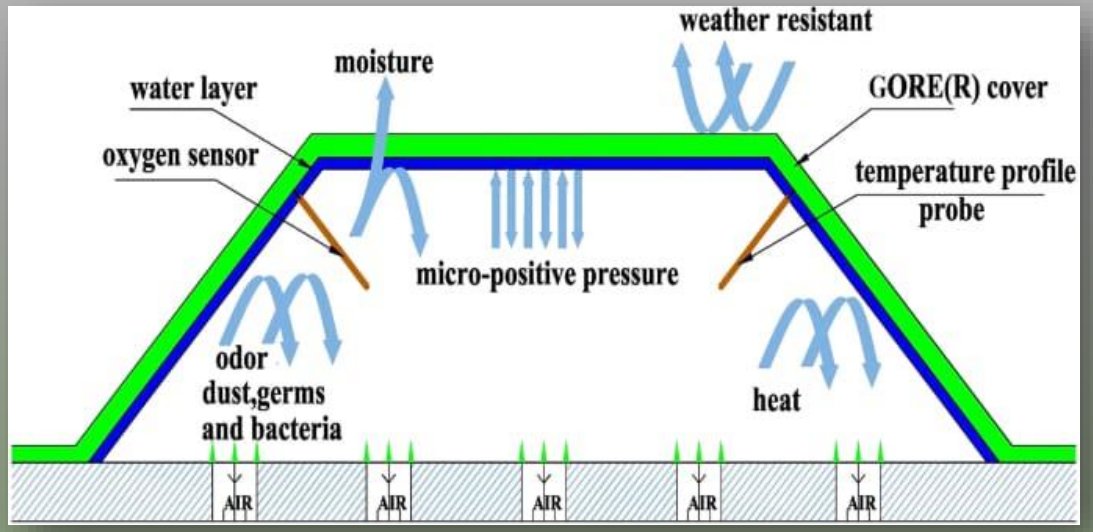
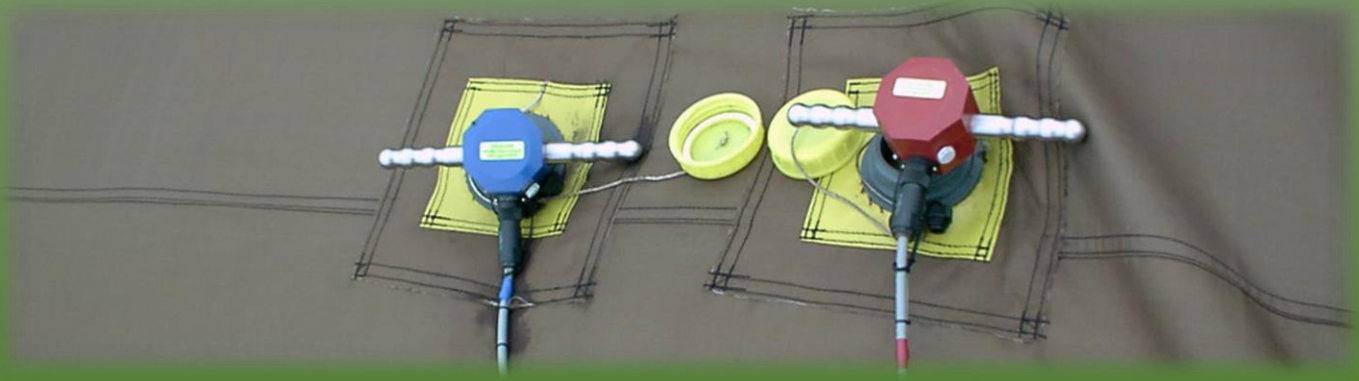
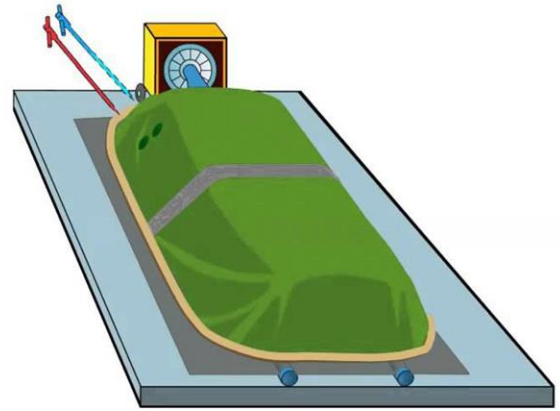
In the intense decomposition phase, the contaminated soil piles are covered with a membrane and forcibly aerated without moving or remixing the material. This bioremediation system works by forcibly introducing air into the contaminated soil mass, and an essential condition for optimal operation is the creation of a sealed environment, the membranes must be fixed on the sides. The model performs composting by forcibly aerating the material and covering it with a semi-permeable membrane. Each area on which the piles are built has a concrete wall at the end to allow the blowers (fans) and control panel to be fixed.







temperature and oxygen probes placed in composting material

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Under each pile there are two air channels, which are used to introduce air into the material and to collect the leachate. Each area on which the pile is built is equipped with a fan (25 m3/h) to blow air through perforated pipes / ducts of HDPE Dn 160 mm. The entire bioremediation area is a well compacted surface, and has slopes that allow water and leachate to collect in the specially designed channels.

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The membrane, together with the aeration system, optimises the bioremediation process. Moisture control is achieved by protecting against rainwater and sunlight while limiting moisture loss from the interior through the membrane. The aeration system maintains pressure under the membrane, ensuring even distribution of air (oxygen) through the material. After forming the pile, the membrane is laid on top using a membrane handling machine (winding machine). After the membrane is positioned over the material, temperature, humidity, pH and oxygen sensors are installed. The fans are controlled by PLC (Programmable Logic Controller) to optimise the bioremediation process, using data sent by sensors. Intensive bioremediation lasts on average 4(four) weeks after which the membranes are tightened and the bioremediated soil is moved to the maturing area.

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For active process management to complete the bioremediation of the soil from the intensive treatment area, the maturing piles are remixed with the front loader or with a type furrow tiller to:

- avoid compaction of the pile.
- improve air exchange.
- bring the material from the inside to the surface of the pile and insert the material from the surface into the pile.
- Introduction of NPK constituents to improve soil quality.
- Release to the atmosphere of light volatile hydrocarbon constituents remaining in the soil mass.

The maturing period will be 2(two) weeks and the piles will be turned once a day.

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The bioremediation process which lasts in principle 6 (six) weeks is completed when the biological activity of the material transferred from the area of intense decomposition has ended and laboratory tests show TPH values accepted by the Contractor/Beneficiary. The liquid residues in the biological treatment area represent removed seepage water and impure rainwater. The amount of seepage water is much lower than in compacted landfills and is characterized by biodegradable load and high salt content and will be treated either by settling or by reintroduction into the decomposition process, i.e. by spraying the piles in the maturing area.

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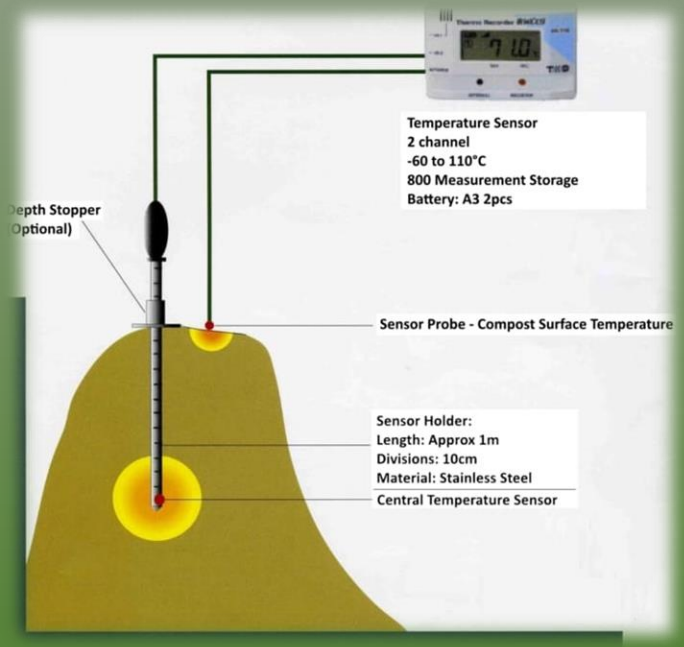
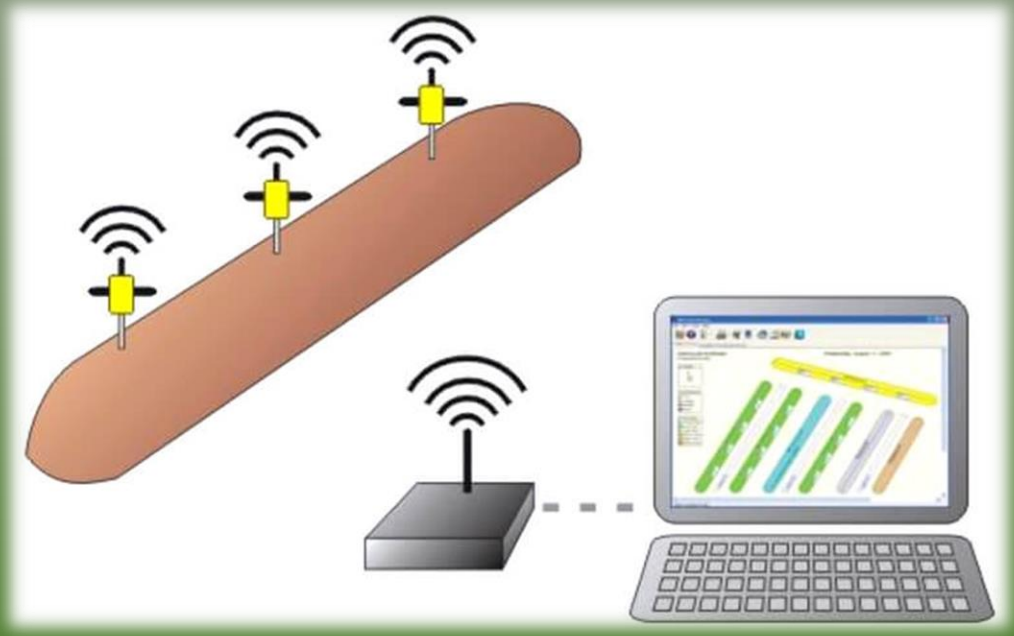
Principles of the biological process used:

Biological processes are based on the action of microorganisms that have the ability to transform organic pollutants mainly into CO2, water and biomass, or to immobilise pollutants by binding in the humic fraction of the soil.

Degradation takes place, in our case, under aerobic conditions. In order to make the process more efficient, we introduced the optimization of the conditions for the growth of microorganisms (oxygen supply, pH regulation, water content, etc.).

Stimulation of biological activity will be achieved by active aeration, humidification or drying, heating, addition of nutrients (NPK) and inoculation with microorganisms (fungi and mucilage).





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In addition to accelerating degradation, bioaeration has the side effect of moving volatile pollutants through the activated soil.

The main advantages of ex-situ technologies are optimized working conditions, better process control, simpler and more accurate monitoring, in addition, the addition of specialized microorganisms and the biodegradation of certain contaminants is easier and safer. As soil remediation and soil remediation biotechnologies exist in the air stream, air leaving the soil can be treated to remove or destroy CO2 before discharge to the atmosphere, making the technology applicable in the short term.

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Advantages:

Proven track record on contaminated sites Suitable for a wide range of contaminants Suitability relatively simple to assess from site investigation data Flexible with respect to volumes (treated in excess of 250,000 tonnes in one season on some sites)

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The rate of bioremediation is based on 4 factors- oxygen, food, temperature, and moisture (not necessarily in that order).

Here are 5 ways to optimize bioremediation on excavated soils (in-situ remediation is also possible):

1.Aerate the soils- the more air you can get in to the soils, the greater the rate bacteria can respire and the greater the rate of contaminant degradation. Physical 'turning' also results in physical attrition of contaminants, another benefit in reducing contaminant concentrations.

2.Balance the nutrients – the main food source is the contamination you're trying to treat, however hydrocarbon degrading bacteria require Nitrogen, Phosphorous, and Potassium (NPK) to be able to degrade contamination. Producing the right balance of nutrients will speed up the remediation process.

3.Balance moisture- Bacteria require moisture to do their job, too much moisture and you starve them of oxygen, not enough and you don't get the most out of them.

4.Warm the soils – maintaining a working temperature in the soils can be approached several ways, bioremediating in large piles (bio-piles) gives an insulating effect which keeps the core of the bio-pile warm. Sheeting the pile with 'fleeces' keep the warmth (and the moisture) in the bio-pile. Probably the easiest approach is to do the work in the summer months, and avoiding the freezing winter months.

5.Add contaminant specific bacteria – I am always a little cautious about this approach, sometimes it works and sometimes it doesn't. Culturing the native bacteria gets results every time. Adding new bacteria can produce great results, assuming they survive. Soil conditions have so many variables including pH, and metal mixtures, and few bacteria can stand up to the test of being introduced to a new soil, so this approach can be hit or miss regarding speeding up the remediation process.

LIST OF REFFERENCE

Client`s Name	Scope of Service
ALGHANIM INTERNATIONAL	Oil sludge treatment in ARAMCO area Excavation and transportation contaminated soil KOC AHMADI area Feed pipelines for new refinery project (NRP) KOC
PRO AIR CLEAN SA SRL	Financing, construction and commissioning of the **Waste to Energy Plant** through **waste incineration** - capacity 30,000 tonnes/year. Project co-funded by the Environmental Fund Administration
RO ECOLOGIC ALTERNATIVE FUEL S.R.L	Design, financing, construction and operation of plants for the production of alternative fuels from waste and co-generation in cement plants belonging to **Carpatcement Romania S.A.**
Vivani Salubritate S.A.	Design, financing, construction and operation of **the "Ialomita county non-hazardous waste conforming landfill"**. Project co-financed by the Environmental Fund Administration.
Vivani Salubritate S.A.	Design, financing, construction and operation of the **hazardous waste landfill** - capacity 110,000 tonnes. Project co-financed by the Environment Fund Administration Purchase, financing and operation of the waste sorting plant, located on the site of the "Conforming landfill for non-hazardous waste of the county of Ialomita" Project co-financed by the Administration of the Environment Fund.
Vivani Salubritate S.A.	Design, financing, construction and operation of bioremediation and composting plants for contaminated soils and biodegradable waste. Design, financing, construction and operation of transfer stations for municipal and assimilable waste in place. Fetești, Urziceni, Balaciu from Ialomita county.
PETROTEL-LUKOIL S.A.	Greening of the settler and restoration of the natural environment of the settler NDS 212 Contract no. 393/18.10.2011
PETROTEL-LUKOIL S.A.	Greening of the settler and restoration of the natural environment of the settler NDS 211 Contract no. 384/18.10.2011
PETROTEL-LUKOIL S.A.	Final disposal of oil residues from the NDS 196 settler Contract no. 445/11.09.2012 / 021/12.01.2011
ARCELOR MITTAL HUNEDOARA	Draining and cleaning of the tar lake at the slag heap site Contract No 100000/110/02.03.2009
OMV PETROM S.A.	Processing of existing sludge in 6 oil residue deposits located in the eastern and north-eastern part of Romania, lot 4 (belonging to the Independenta-Oprisenesti and Moinesti-Lucacesti-Dofteana deposit groups) Contract No 8460010149/08.10.2009
OMV PETROM S.A.	Processing of existing sludge in 20 oil residue deposits located in the central and southern part of Romania lot 3 (belonging to the following groups of deposits: Moreni-Gura Ocnitei-Razvad, Strambu-Cobia-Leordeni-Ludesti and Runcu-Tintea Boldesti-Paraul Sarari and Burcioaia Barbuncesti) Contract no. 8460010148/08.10.2009
OMV PETROM S.A.	Existing sludge processing in 13 oil residue landfills located in the central and southern part of Romania lot 2 (belonging to the following landfill groups: Bradesti, Ticleni, Ileana-Cartojani-Bolintin, Videle-Vadu Lat, Preajba Nord-Sud, Mamu-Otesti and Valcele Slatioare). Contract no. 8460011901/17.06.2010
OMV PETROM S.A.	Processing of existing sludge in 5 oil residue/settler deposits located in the western part of Romania lot 1 (belonging to the Suplac and Arad groups of deposits) and Addition no. 7 "Closure and restoration of the settler in order to return it to the natural circuit-Batal Abramut" Contract no. 8460010147/08.10.2009
FCC Construcction SA Barcelona	Decontamination of soil that contains oil products, slams, heavy metals - bioremediation
Astaldi- FCC- Salcef- Thales LOT 2A	Decontamination of soil that contains oil products, sludge, heavy metals
OMV Petrom S.A.	Industrial cleaning of technological installations in the oil industry Remediations and bioremediation of soil products

THANK YOU !

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