



Pembina Bio-Mulch®

as a Substrate in Degrading Hydrocarbon Contaminated Soil

By: Arif Sheena, Ph.D. Microbiology and Kirstin Castro-Wunsch, P.Eng. Environmental

Mulch and Mulching

Mulch is a product that can be produced through mulching, which is a mechanical process intended to reduce the particle size of plant materials such as leaves, grass, coarse compost, shredded bark, hardwood, straw, and wood chips. Mulching is similar to composting, but the plant materials are degraded to a specified level of microbiologically mediated decomposition. In this respect, mulch cannot reach the degradable criteria normally attributed to stable compost.

Pembina Bio-Mulch® interferes with weed growth, retains moisture in the soil, maintains constant temperature for the soil, and prevents/reduces soil erosion. It is thus a useful organic matter to cover the soil in gardening, landscaping and golf course.

Wood chips and other wood residuals are also used as mulch products. One of their main applications is to restore the roads due to their effectual erosion control, specifically added to stabilize dirt roads, industrial parking, and other non-paved surfaces that are used for transportation.

The bioremediation of soils contaminated with hydrocarbons, can be remediated using aged mulch. Aged mulch contains microorganisms and intermediate compounds that are produced due to the microbial activity during the aging period. Pembina Bio-mulch® is shown in Figure 1.



Figure 1

Bioremediation

Bioremediation is the use of microorganisms to convert pollutants that are hazardous and environmentally unacceptable to less/non-toxic products. There are very large numbers of microorganisms (fungi and bacteria) that are involved in biodegrading the complex organic compounds of plants into much smaller and simpler products such as H₂O and CO₂.

The biodegradation occurs when certain microorganisms produce specific enzyme(s) to attack the substrate such as lignin and cellulose in plants. Most of these fungi and bacteria are also capable of degrading petroleum hydrocarbons either directly or through cometabolism (a simultaneous metabolism of two compounds).

Generally, there are indigenous populations of microorganisms that are found with the organic substrates and in the soils at the site. These microbes play a major role in the processes of mulching, composting, and bioremediation. White-rot fungi produce extracellular enzymes that can degrade lignin and other organic compounds. There is also a broad range of mesophilic and thermophilic bacteria that significantly contributes to these processes through their enzymatic activities via the metabolic pathways.

To optimize the microbial activity during any of these processes, it is very critical to consider the following factors:

1. Presence of appropriate microorganisms with considerable concentration in soil or the site.
2. Availability of nutrients and moisture.
3. Appropriate temperature and pH.
4. Availability of oxygen (aerobic respiration)
5. Mechanical manipulation of the treated materials.



Pembina Bio-Mulch®

as a Substrate in Degrading Hydrocarbon Contaminated Soil

Petroleum Hydrocarbons

Petroleum hydrocarbons are naturally occurring chemicals with great importance for our daily needs and use. Some examples of petroleum hydrocarbons are crude oil, fuel oil, diesel, gasoline, and polycyclic aromatic hydrocarbons (PAHs). The environment and ecosystem can be negatively affected if these complex chemical compounds are mishandled or improperly managed during their production and processing, such as in the unfortunate event of oil spills and petroleum hydrocarbon contamination. Therefore, bioremediation must be considered when environmental incidents occur and threaten ecosystem.

Crude oil as well as Gasoline and its components benzene, toluene, ethylbenzene and, xylene (collectively known as BTEX) are easily bioremediated. This is due to the fact that BTEX is comparatively soluble and degrades at a faster rate. The aerobic condition also facilitates the growth of microorganisms, which in turn speeds up bioremediation.

The process of bioremediation can fulfill the requirement of *Canada-Wide Standard for Petroleum Hydrocarbons in Soil*. It is a document by *Canadian Council of Ministers of the Environment (CCME)*, which refers to the four petroleum fractions (F1 through F4). The fractions should be determined analytically, to find out which final land use the contaminated site can be bioremediated to.

The CCME has referred to the *Method Detection Limits (MDL)* for each fraction of fine grained agricultural soil as follows:

1. F1, C 6 to C 10 hydrocarbons	260 mg/kg
2. F2, C10 to C16 hydrocarbons	900 mg/ kg
3. F3, C16 to C50 hydrocarbons	800 mg/kg
4. F4, C34-C50	5600 mg/Kg

KC Environmental Group, Ltd.

KC Environmental Group, Ltd. in Edmonton, and Drayton Valley, Alberta, Canada, intends to study the feasibility of using mulch and some wood products (Figure 2) as substrate for petroleum contaminated soil/mud at the oil well site. It is known that well aged mulch contains reasonably large microbial biomass that can contribute to a more efficient bioremediation process at contaminated sites. Pembina Bio-Mulch® also contains organic matter as nutrient for the indigenous microorganisms of the contaminated site. In addition, the size of individual particle of mulch is large enough to facilitate diffusion of oxygen into the mixture of contaminated soil.



Figure 2

Another advantage of mulch is that it acts as an absorbent to the contaminant. It has a similar mechanism of action to the cellulose-fiber or cotton-based commercial products available.

Researchers are currently engaged in similar research involving the addition of fresh manure with wood chips or saw dust to contaminated mud, in attempt to reduce the level of petroleum contamination. However, there is less success with these methods when compared to aged mulch, due to the lack of healthy and stabilized microbial populations in sawdust and manure.

In order to have a cost effective operation, the bioremediation site, must be engineered and managed to optimize its biological efficiency.

In-situ bioremediation with Pembina Bio-mulch® has the following advantages:

1. The contaminated soil will stay in place, so will limit transportation cost.
2. Integrate the use of nutrients and microorganisms natural to the site.
3. There is minimum disturbance to the site.
4. Mulch amendment is in a concentrated form versus wood chip. The ratio of microorganisms per unit of mulch is higher.
5. It drastically reduces the project cost (landfill costs in Alberta are approximately \$30, while the costs of this method is approximately \$ 15 per tonne).

For more information contact

(780) 488-7926 or
1-877-774-5678



**ENGINEERING SOLUTIONS FOR
BUSINESS AND ENVIRONMENT**

Environmental Assessments • Environmental Management • Compost Consulting • Integrated Waste Management • Cleanit Greenit Composting Systems Inc.

KC ENVIRONMENTAL GROUP LTD.

www.cleanitgreenit.net 15619-112 Avenue, Edmonton, Alberta T5M 2V8 Phone: (780) 488-7926 Fax: (780) 452-8284 kcgroup@cleanitgreenit.net