Bioremediation of Wastes with Saion Biotechnology

(Municipal & Industrial, Hazardous & Non-Hazardous)

(Dr. Saito Ari)

Introduction

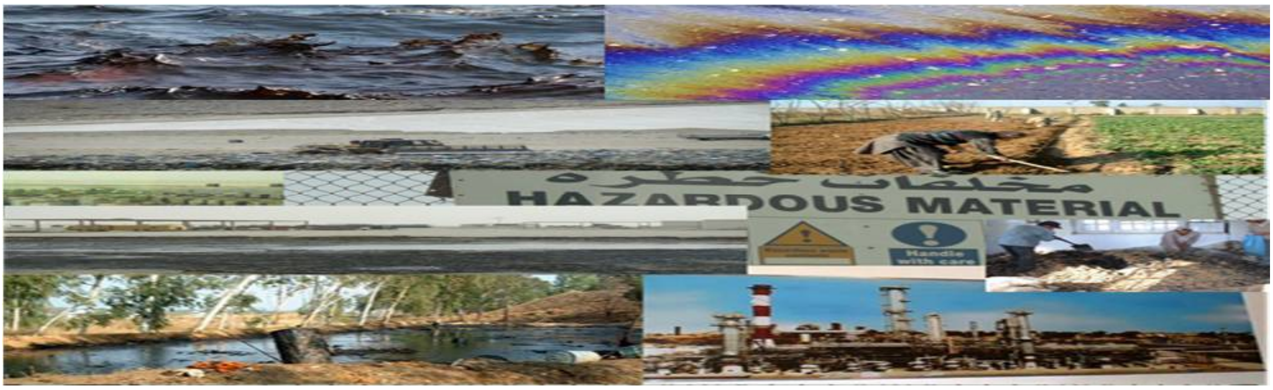
Bioremediation of Hydrocarbons (TPH), Heavy Metals, Polychlorinated biphenyls (PCB) Spent Caustic, Phenol, Sulfur, MTBE, BTEX, NORM, Dioxins, NOx, SOx and other contaminants are everyday topics of petroleum and petrochemical industries. Chemical, Non-chemical, mechanical, and biological approaches are adopted world-wide to tackle these environmental issues. However, secondary contamination and treatments for secondary wastes are a sky high challenge for industries; environment protection agencies and environmentalists, where a huge cost and time is dumped. Man-made developments, resulting environmental problems, limitations to solve these problems, have lead us to considering going back to NATURE and find hints and solutions to fix these man-made problems. Biological treatments recently have been of full interest in all sectors, due to their efficiency, low cost and high performances.

Saion Biotechnology is one of those result oriented proven technologies. This technology was developed in late 70's in Japan. It is different from other technologies due its composition of aerobic and anaerobic microorganisms and their applications. Normally, aerobic and anaerobic microorganisms cannot exist together in the same environment, but Saion Biotechnology has made it possible where both survive on each other and complement each other for co-existence and prosperity. There is no genetically modification in this technology, all microorganisms are isolated from nature, and most of them are food-grade and exist in almost all environments. Therefore, the formulas are environmentally friendly, easy to handle, cost-effective with high performance. These isolated microorganisms are capable to guarantee the existence and performance of those microorganisms which are essential and beneficial in bioremediation, as given in Table 1.

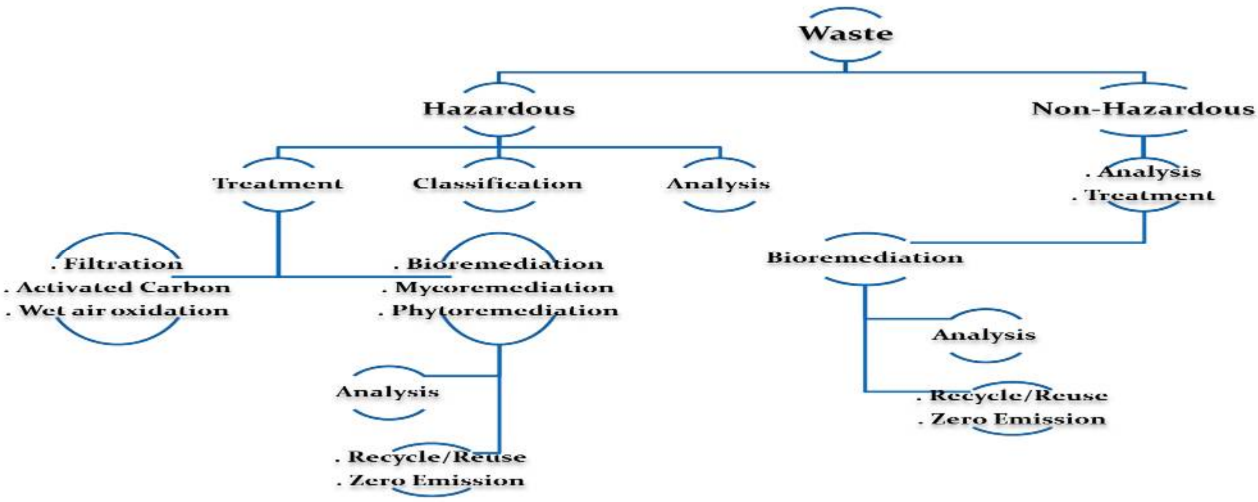
Saion Biotechnology works under a harmony and combination of different methods, i.e. biological degradation, phytoremediation, mycoremediation, wet air oxidation, redox, fermentation, activated carbon filtration, to achieve maximum performance of bioremediation.

Microorganisms recognize hydrocarbons, their constituent by bio-surfactants and bio-emulsifiers, attack them and use as source of energy and carbon. At the same time produce enzymes which attack hydrocarbon molecules. Enzymatic redox reaction reduces heavy metals as part of metabolic process both in aerobic and anaerobic condition. Hydrogen releasing compounds such as lactic acid, through biological interaction, provide carbon source, undergo biological transformations and generate hydrogen, and enzymatically the reduction in heavy metal occurs. In other words, microorganisms can catalyze redox reactions by a combination of several mechanisms; including enzymatic extra-cellular reduction, non-metabolic reduction by bacterial surfaces and intra-cellular reduction and precipitation. Both eukaryotic and prokaryotic cells can actively transport heavy metals across their cell membrane to reduce heavy metals.

For example, *Cryptanaerobacter phenolicus* produces benzoate from phenol via 4-hydroxybenzoate. *Rhodococcus phenolicus* is able to degrade phenol as sole carbon source. *Tyrosinase* enzyme is fast in oxidation of phenol. Microorganisms can neutralize toxins by converting the halogens to harmless compounds like salts. Microorganisms enhance bio-augmentation which enhances bioremediation process. Microorganisms oxidize sulfides and mercaptans to sulfates through wet air oxidation. Microorganisms deodorize VOCs, reduce COD, BOD, TOC, phenols, oils and polymers and breakdown toxic hydrocarbons. Anaerobic microorganisms use other electron acceptors like nitrate, iron or sulfate to yield energy and continue bioremediation process.



Procedure:



Mechanism:

During the bioremediation of wastes ; microorganisms synthesize and release useful substances, such as :

- organic acids (amino acids, nucleic acid, citric acids, acetic acids, lactic acids) alcohols, ethers, aldehydes
- bioactive substances (vitamins, enzymes; such as protease & lipase, hormones) sugars, polysaccharides,
- enhance the release of phosphates, fixed atmospheric N
- break down highly complex and resistant compounds (cellulose, starch, gums, lignins, carbohydrates)
- release antibiotics (streptomycin, actinomycin, neomycin)
- produce humus (fluvic acid, humic acids, humic)
- And other products (fatty acids, chelates) from the effluents and wastes.
- These microorganisms produce electron donor organic acids, enzymes and catalysts; which convert hazardous elements to non-hazardous elements. Nutrients provided during bioremediation, enhance the degradation process and act as catalyst. Enzymatic redox reaction reduces heavy metals and other contaminants as part of metabolic process both in aerobic and anaerobic conditions. Both eukaryotic and prokaryotic cells can actively transport heavy metals across their cell membrane to reduce heavy metals and other contaminants.
- In other words, microorganisms can catalyze redox reactions by a combination of several mechanisms; including enzymatic extra-cellular reduction, non-metabolic reduction by bacterial surfaces and intra-cellular reduction and precipitation.
- Similar to human metabolic system, combination of microorganism surfactants, emulsifiers, and enzymes breakdown hydrocarbons into carbon dioxide, water, fatty acids, and humic material. Microorganisms produce electron donor organic acids, enzymes, and catalysts; such as humic acid, fulvic acid, amino acids, etc. which convert hazardous elements to non-hazardous elements.
- Macronutrients provided during bioremediation of hydrocarbons; enhance the degradation process and act as catalyst. The optimum nutrient balance for hydrocarbon remediation is 100:10:4. The nutrient requirement of carbon to nitrogen is 10:1 and carbon to phosphorous is 30:1. Nitrogen makes up 15% of the molecular composition of bacteria cell, is utilized by bacteria to produce its cell walls, nucleic acid and proteins. A 4 pond of oxygen is required for a 1 pound of hydrocarbon remediation. Addition of nutrients bio-stimulates electron acceptors, whereas oxygen stimulates bioremediation. Saion formula can tolerate more than 15% of sodium.

Conclusion

Similar to human metabolic system, combination of microorganism surfactants, emulsifiers, and enzymes breakdown hydrocarbons into carbon dioxide, water, fatty acids, and humic material. Microorganisms produce electron donor organic acids, enzymes, and catalysts; such as humic acid, fulvic acid, amino acids, etc. which convert hazardous elements to non-hazardous elements. Microorganisms deodorize VOCs; reduce COD, BOD, TOC, phenols, oils and polymers and breakdown toxic hydrocarbons. Microorganisms can catalyze redox reactions by a combination of several mechanisms; including enzymatic extra-cellular reduction, non-metabolic reduction by bacterial surfaces and intra-cellular reduction and precipitation. Both eukaryotic and prokaryotic cells can actively transport heavy metals across their cell membrane to reduce heavy metals. With the adaptation of Saion Biotechnology, following objectives can be achieved:

An effective treatment of Petroleum/Petrochemical waste, reduction in concentration of heavy metals, neutralization of toxic hydrocarbons, bioremediation of hazardous contaminants, environmentally friendly safe disposal with ISO-14000 compliance, in cost-effective manner.

Biological treatments have been proven effective in reducing concentrations of nearly all the constituents of petroleum and petrochemical products typically found at contaminated sites.

Hazardous & toxic wastes can be converted into a beneficial byproduct through bioremediation process cost-effectively.

Saion Treatments are easy to adopt and can be introduced to any existing treatment system or treatment plant, to avoid an extra installation cost of equipment. A little modification can not only lead to a better and cost-effective treatment and safe disposal but also to Zero Emission.

Result oriented proven approaches; practiced in Japan can also fix the environmental problems faced by the Kingdom.

"An environmentally friendly safe disposal with ISO-14000 compliance".