ROLE OF BIOREMEDIATION TO COMBAT POLLUTION HAZARD

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I. INTRODUCTION

The term technology refers to the application of knowledge for practical purposes. Green technology is the application of the environmental science to conserve the natural environment and resources and to curb the negative impacts of human involvement. The field of green technology encompasses a continuously evolving group of methods and materials from techniques for generating energy to non-toxic cleaning products. The goals that inform development in this rapidly growing field include:

- ***A.*** ***Sustainability:*** meeting the needs of society without damaging or depleting natural resources.
- ***B.*** ***Cradle to cradle design:*** ending the cradle to grave cycle of manufactured products by creating products that can be fully reused.
- ***C.*** ***Source reduction:*** reducing waste and pollution by changing patterns of production and consumption.
- ***D.*** ***Innovation:*** developing alternatives to technologies that have been demonstrated to damage health and the environment.
- ***E.*** ***Viability:*** creating a centre for ecological activity around technologies and products that benefit the environment and speeding their implementation.

II. METHODOLOGY

Biological process vary in their methods of removal. Depending upon the location of the contamination, green technology can either be applied to the surface and sub-surface or require above ground removal. Surface and sub-surface technology deals with contaminated soil down to 12 inches below ground level. In this technology water and nutrients are added in addition to tilling to the soil, in order to optimise bacterial growth and begin the biological process. In oppose to technology that are directly applied to surface and sub-surface contamination, above ground technology involves treatment of soils out of the given area. Such treatment used in above ground technology, include that of slurry-phase and solid-phase remediation. Slurry-phase involves the initial combination of water with the contaminated soil and later treatment involves the degradation in a bioreactor. Solid-phase treatment achieves the similar goal of the former treatment. Yet in this process the contaminated soil is placed in a bed and nourished with nutrients, moisture and oxygen in hopes that decomposition will occur.

III. BASIC CONCEPTS OF GREEN TECHNOLOGY

A. ***Recycling***
B. ***Water purification***
C. ***Air purification***
D. ***Sewage treatment***
E. ***Environmental remediation***
F. ***Solid waste management***
G. ***Renewable energy***
H. ***eGain forecasting***
I. ***Energy conservation etc.***

IV. ENVIRONMENNTAL REMEDIATION OR BIOREMEDIATION

Microbes and microbial processes have served the need of mankind since time immemorial and now occupy an enviable position in the core of the new biotechnology revolution. Out of many branches of this biotechnology revolution, a very important area of global concern that has emerged in the last decade is "bioremediation".

The term bioremediation can be defined as any process that uses living organisms to return the natural environment altered by contaminants to its original condition. Indeed, bioremediation is not a magic to control pollution, but all the available evidences suggest that it can be an effective additional bio-weapon on the pollution front. The OECD (Organization for Economic Co-operation and Development) has been sponsoring meetings and workshops of scientists and government representatives from USA, Canada, Japan and West European countries since 1991, and recognises bioremediation as an effective measure to combat the pollution hazard.

Some examples of bioremediation technology are:

A. ***Bio-venting***: It is the in-situ remediation technology that uses microbes to biodegrade organic matters absorbed in soil in the unsaturated zone. It involves the induction of air to provide oxygen to promote biodegradation of the organic matter. It is used in the cleaning of petroleum products- gasoline, jet fuels, kerosene and diesel.
B. ***Land-farming***: It is the process that is performed in the upper soil zone or in bio-treatment cells. Contaminated soils, sediments or sledges are incorporated into the soil surface and periodically turned over to aerate the mixture. It is used in the cleaning of oil sledge, petroleum.
C. ***Bio-reactor:*** It is a device that supports a biologically active environment meant to grow cells or tissues in the context of cell culture designed to treat sewage and wastewater.
D. ***Composting:*** It involves the aerobic decomposition of organic matters- plant and animal matters. The method requires carbon, oxygen, nitrogen, water which can destroy pathogen or unwanted seeds. Microbial pesticide in compost destroy pathogens.
E. ***Bio-augmentation:*** It involves the breakdown of contaminants via the addition of matched microbe strains to the medium to enhance the resident microbe population's ability.
F. ***Rhizo-filtration:*** It is a process using mycelia to filter toxic waste and micro-organisms from water in soil. The mycelium secrets extracellular enzymes and acids that breakdown lignin and cellulose, the two main building blocks of plant fibre. These are organic compounds composed of long chains of carbon and hydrogen, similar to many organic pollutants.
G. ***Bio-stimulation:*** It involves the addition of fertilizers to increase the bioavailability within the medium.
H. ***Phyto-remediation:*** In this technology, plants play their role. Natural plants or transgenic plants are able to bio-accumulate toxins which are not easily absorbed by organisms- heavy metals like cadmium, lead, mercury etc., in their above ground parts, which are then harvested for removal. The heavy metals in the harvested biomass may be further concentrated by incineration or even recycled for industrial use.

V. GENETIC ENGINEERING APPROACH

The use of genetic engineering to create organisms specifically designed for bioremediation has great potential. The bacteria involved are gluttonous microbes placed within the contaminated site immediately start breaking down the organic constituents. These break up the carbon chains until the contamination is eliminated. It results in the release of carbon dioxide and water with little fatty acid. pH for bacterial growth is 7. Bacteria requires carbon source (carbon dioxide from air) for growth and nitrogen and phosphorus as energy source to sustain their metabolic process.

In early 1980s, little knowledge was available about how toxic wastes interact with the hydrosphere. But with the changing time the researchers acquired the maximum possible utility of these tiny organisms to degrade a wide range of pollutants. There is also a search of microbes that could grow under extreme environmental conditions.

Researchers have also been using genetic engineering to develop new microbial strains with novel bio-degradable capabilities. Adding genes that code for enzymes, that breakdown toxic chemicals, to microbes and are able to survive and grow in much disturbed and harsh environments would greatly extend the range of compounds that might be treated with bioremediation.

Many examples in this concern are available out of which the most striking research work of Japanese research team is the isolation of a species of *Pseudomonas* that can grow in solvent containing more than 50% tolune, a condition that kills most organism through disruption of cell membrane.

Similarly, many instances of oil tanker leakages in oceans had caused massive devastation of flora and fauna in the past. No doubt, there were methods to neutralise these oil spills, but the most effective and safe measure is the use of biological treatment. These microbes are sprayed on the surface which mix with the oil, emulsify it and disperse it throughout the water body so thinly that it no longer remain hazardous. Professor Anand Chakraborty, a hydrocarbon biotechnologist, working at the University of Llinois Medical Centre, Chicago, USA has developed very efficient oil-eating bacterium "SUPERBUG" using species of *Pseudomonas* through recombination DNA technology.

With the first emerging trends for bioremediation, it is difficult to cite many examples, but broadly three different foci of research and development for bioremediation research are emerging worldwide and these are:

- ***A. European upgrading of traditional waste and water treatment systems:*** Using this technology, European countries particularly Germany, Netherland, Belgium Austria and Italy are producing biogas from solid wastes, removing inorganic compounds of water aerobically to reduce BOD, removing toxic chemicals from industrial wastewater, developing biological gas treatment systems to treat air pollutants, etc.
- ***B. American focus on on-site specific clean up:*** In the United States, the Environmental Protection Agency includes more than 1200 locations, where this method of bioremediation is extensively used to combat the menace of pollution. This technology is being used to treat sites contaminated with complex organic pollutants including petroleum products in oil spills and sites contaminated with heavy metals or radio-nuclides.
- ***C. Japanese Global Application of bioremediation technology:*** This formula of Japanese bioremediation is also working on replacement of petrochemicals, reducing global warming, biodegradable plastics etc.

The above account shows that bioremediation has promising future with several potential applications to clean-up the polluted environment and treat wastes. It can be used as a "Bio-weapon."

VI. REFERENCES

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