TECHNOLOGIES FOR BIOREMEDIATION OF SOILS CONTAMINATED WITH PETROLEUM PRODUCTS

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Abstract: *Biological methods for remediation of soils is based on the degradation of pollutants due to activity of microorganisms (bacteria, fungi). Effectiveness of biological decontamination of soils depends on the following factors: biodegradation of pollutants, type of microorganisms used, choice of oxidant and nutrient and subject to clean up environmental characteristics. Ex situ techniques for bioremediation of soils polluted are: composting (static / mechanical agitation), land farming and biopiles. Techniques in situ bioremediation of soils polluted are: bioventingul, biospargingul and biostimulation – bioaugumentarea.*

Key words: soils, polluted, technologies, bioremediation

1.Introduction

Biological methods for remediation of soils is based on the degradation of pollutants due to activity of microorganisms (bacteria, fungi). Biodegradation is a natural phenomenon, because the soil, subsoil and groundwater is normally living environment for many microorganisms (bacteria *Pseudomonas, Bacillus, Arthrobacter and Flovorbacterium and fungi Trichoderma, Penicillium and Asperigillus*), having an action on degraded organic pollutants. This type of decontamination is suitable for petroleum hydrocarbons (diesel, light fuel oil, gasoline, kerosene, mineral oils, benzene, toluene, xylene). Effectiveness of biological decontamination of soils depends on the following factors:

- ***biodegradation of pollutants*** - their ability to degrade under the action of microorganisms.
- ***type of microorganisms used*** - indigenous microflora of the polluted area may be necessary decontamination of microorganisms, but microorganisms can also use "specialized", which are developed on a mineral support (zeolites, carbonates, composites) and mixed with the contaminated environment.
- ***choice of oxidant and nutrient*** - oxygen administration in contaminated environment, as air, pure oxygen, ozone, hydrogen peroxide and nitrogen trioxide, following the introduction of oxygen and oxygen compounds in a reducing metal oxidation conditions are created (cross-Fe2 + in Fe3 +) and hydroxide flocculation, organic nutrients most commonly used processes biodecontaminare are methane, propane, molasses, inert organic material (bark and straw) and surfactants.
- ***subject to clean up environmental characteristics*** - pH, temperature, humidity, physical parameters

2. Ex situ techniques for bioremediation of soils polluted

- ex situ bioremediation = biodegradation in bulk = methods for solids used for the remediation of contaminated soils on-site organic products, is the excavation of polluted soil and its disposal in the vicinity of the excavation site, the technical conditions that promote natural aerobic biodegradation

- source of microorganisms derived from bacterial flora present in the soil
- biodepoluare most important methods are:

2.1. Composting (static / mechanical agitation)

- the oldest and simplest technique for biodegradation in bulk soil contaminated
- contaminated soil is excavated and additive (mixed) with blowing agents (coarse organic materials, straw, hay, bark scraps, manure), which fulfill a nutritional role and encourage air circulation and water, essential to aerobic microbial metabolism
- the resulting mixture is deposited on the soil surrounding the piles regularly, with a circumference of several meters and a height of one meter
- providing basic conditions accelerate the degradation process is aeration, moisture and nutrient intake
- **composting** = biotechnology requires thermophilic conditions (55-60 ° C), favoring activities biodegradative
- **technologies are**:

a. *static plie composting* (piles are aerated by blowers or pumps)
b. *mechanically agitated in vessel composting* (contaminated soil is placed in machines which made mixing and aeration)
c. *windrow composting* (placement in long mounds, mixed periodically with specific eguipment

2.2. Land farming

- treatment of contaminated soil, the execution of specific agricultural work
- after excavation, soil pollution is deposited on a flat surface in a layer several centimeters thick and treated with fertilizer or manure (fertilizer intake improves nutrient balance - carbon source (pollution), and if manure increases the amount of microorganisms available
- technique is farming land excavation, display on a platform that allows fluid drainage collection, mixing and monitoring = technology for bioremediation of soil contaminated by wetting, aeration, nutrients and blowing agents to promote aeration and circulation of fluids in to increase the rate of microbial degradation of contaminants (fig.1)

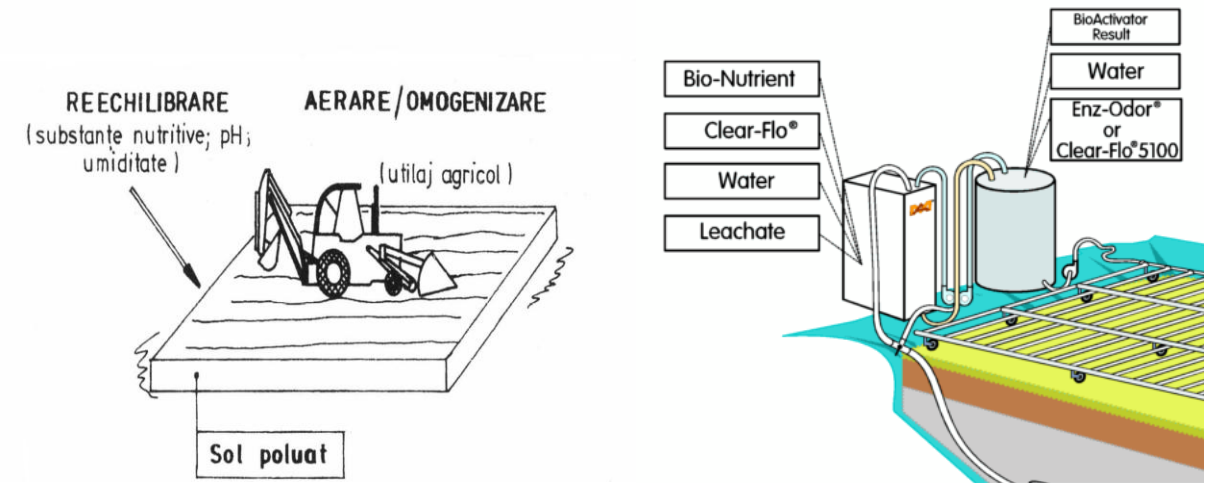

Fig. 1. *Land farming technology for bioremediation of soils polluted*

2.3. Biopiles

- apply to clean up the soil with high content of volatile substances
- involves excavation of polluted soil and deposit it in the pile, and to prevent migration of pollutants into the environment gaseous and liquid present in contaminated soil, entrances and exits gas and liquid phases are controlled by the deposit of contaminated soil on a slope and located impervious cover pile of soil contaminated with a membrane that retains the gas in the enclosure *biopic*
- above the stack, as waterproof membrane is installed agricultural spraying device for moistening the soil and nutrient management and micro-organisms around the stack, at its base, is provided a gutter which is intended to collect liquid waste out of lot (because of the sloping site, the effluent is recovered and pumped into a pool and administered by sprinkling over the stack
- exploiting the "biopic" requires continuous monitoring and appropriate adjustment of parameters: pH, temperature, humidity, pollutants contained in exhaust gases of the atmosphere
- *biopic* = biotechnology derived from Land Farming method, based on increasing the contaminated soil mounds several meters high, ensuring aeration and humidity + intake of nutrients, contaminants are reduced to CO2 and H2O, within 3-6 months (fig. 2)

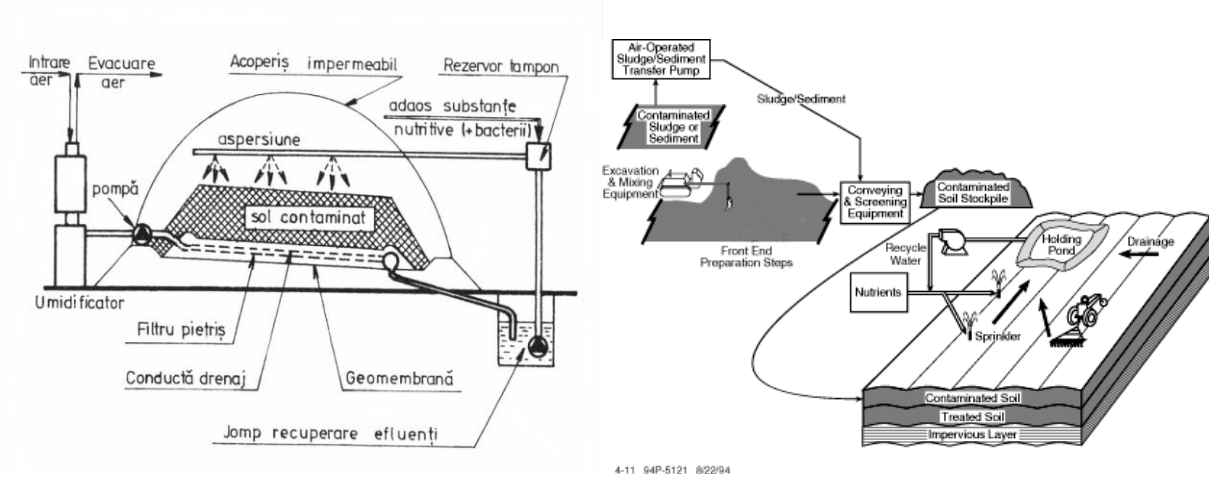

Fig. 2. *Biopiles technology for bioremediation of soils polluted*

3. Techniques in situ bioremediation of soils polluted

- biodegradation in situ = application biodecontaminare operations directly affected by pollution in the environment (soil, subsoil, water table), without the need for excavation of soil or water pump, is recommended for major extensions of pollution, in depth and laterally, and and remediation of soil below the building
- principle is the introduction of the contaminated area of nutrients and oxygen, to create favorable conditions for biodegradation of organic pollutants
- provides the classic underground water injection are dissolved phosphorus, nitrogen and oxygen, which accelerates the annihilation reaction for aerobic pollutant, can be applied to two distinct systems for in situ biodegradation: the passive and active system

a. Passive system - means taking the solution with nutrients and oxygen spray, over the contaminated area and injection wells or wells, installed upstream of the contaminated area, if the pollutant floating on the groundwater table, taking nutritional solution is by spraying, for this pollutant solution to quickly reach and contact with it to make the greatest possible surface (fig.3)

b. Active system - is based on management solution with nutrients and oxygen through wells or wells located upstream of the air, is provided in addition to drilling wells and pumping water downstream of the contaminated area (fig. 4.); system is based on recirculated water before being reinjected the soil is decontaminated in a specialized unit, use the active system allows for in situ biodegradation of remediation yields better than when applying the passive system, the positive effects of the active system due convection is the movement of contaminated ground water, leading to a pronounced stimulation of biodegradation of pollutants

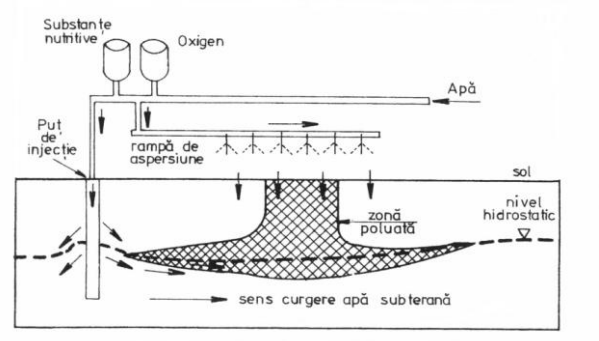

Fig. 3. *Passive system layout*

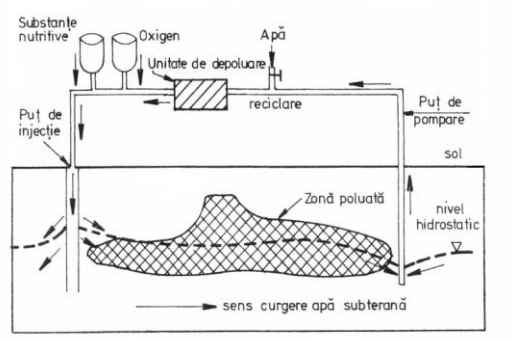

Fig. 4. *Active system scheme*

3.1. Bioventingul

- forced aeration is contaminated environment to stimulate mobilization of volatile pollutants and degradation processes based on biomass development in the basement
- rebalancing report carbon - nitrogen - phosphorus in contaminated environment is achieved by adequate intake of nutrients in water dosed and administered by sprinkling the ground or through injection wells applied upstream of the contaminated
- vacuum extraction is volatile pollutants by creating a current of air that favor biodegradation; recover gas from the underground is possible with a drain located near the surface and connected to a ventilator
- is a biotechnology based on the stimulation of degradation of contaminants in the soil, by injection of atmospheric air and nutrients (nitrogen, phosphorus) is for in situ decontamination of POLs (petroleum, oils, lubricants)
- factors that limit the application of this technology are: poor soil aeration, soil water saturation, low percentages of nutrients (nitrogen and phosphorus), reduced aerobic biodegradation by cometabolism or anaerobic, low temperature (fig.5)

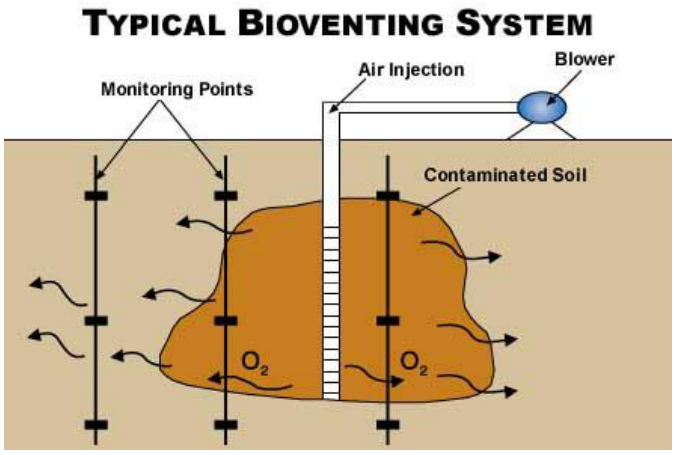

Fig. 5. *Application technology bioventing site the remediation of soil*

3.2. Biospargingul

- air injection is performed in air, using a network of special drills, air pollutants vaporize injected dissolved or retained by the capillary pores, mobilizing them to the surface, on their way upward, finely dispersed pollutants are degraded by biomass stimulated by aeration and nutrient intake
- in fig.6 is played biosparging principle method for simultaneous remediation of unsaturated zone and saturated zone

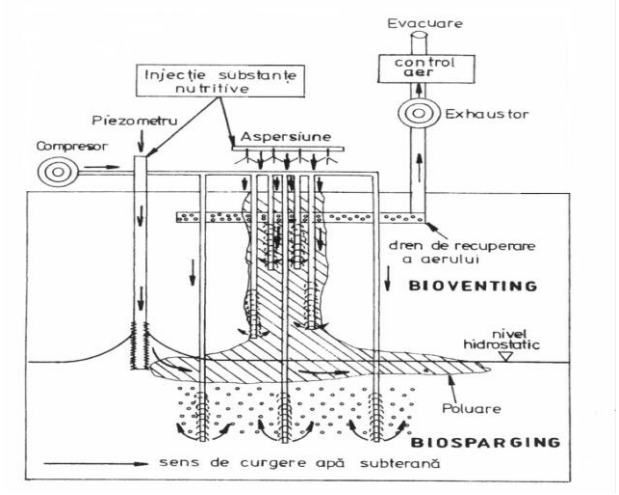

Fig. 6. *Application technology biosparging site the remediation of soil*

- bioremediation of soils can be achieved by injection of hydrogen peroxide in sites with petroleum hydrocarbon pollution constant, volatile organic compounds, halogenated compounds, metal ions
- effects are: stimulating existing microbiota, increasing the speed of bioremediation by soil water movement, aerobic metabolism of pollutants, their declorurarea, in situ immobilization of metals dissolved by the intake of O2

Fig. 7. *Soil remediation technology injection of hydrogen peroxide*

3.3. Biostimulation and bioaugumentarea

- biotechnology is a growth rate of biodegradation of soil contaminated with nutrients and oxygen dissolved in water for injection
- microbial activity is stimulated by movement of water, supplemented with inoculum (aerobic or anaerobic process) (fig.8)

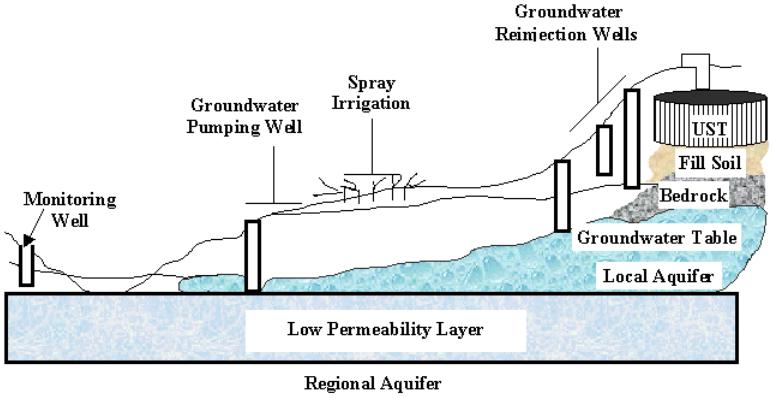

Fig. 8. *Technology biostimulation and bioaugumentare polluted soil*

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