THEORETICAL CONSIDERATION REGARDING THE CONTAMINATED SOIL

Mihaiela Andoni[1]*, Georgeta-Maria Simu[1], Germaine Savoiu-Balint[1], Anca Dragomirescu[1], Oana Raluca Pop[1]

[1]Faculty of Pharmacy, University of Medicine and Pharmacy "Victor Babeş" Timişoara, 3000040 Timişoara. P-ţa Eftimie Murgu nr.2, România
e-mail: andoni.mihaiela@umft.ro

Abstract
This artice represent a small review of the main methods for decontamination of soil infected with toxic chemicals. Are presented several methods such as: isolation of contaminated area, separation methods, electrochemical methods, phytoremediation and photocatalytic remediation of soil contaminated with toxic chemicals.

Introduction
It is known that many inorganic chemicals and organic especially are very toxic to the environment and human body[1]. Inorganic combinations are eliminated from the body, but some affect internal organs such as the liver and kidneys, but the organic compounds mostly cannot be removed[2]. They accumulate in the body and their cumulative effect becomes obvious after a few years. Therefore, there are studies on the mechanisms of action of toxic compounds. It is important to establish environmental remediation processes because they found a growing accumulation of toxic compounds, which represent a real risk factor[3]

Experimental
There are several general methods of environmental remediation that we review:
a. *Isolation of contaminated area*
Isolation can be done using barriers of steel, cement, bentonite and plastered walls that can be placed both horizontally and vertically. This insulation of contaminated areas is done to reduce infiltration of contaminated water in areas where perhaps it cannot yet penetrate. Contaminated soil solidification technologies are pretty much used. Solidification is the physical encapsulation of toxic compounds into a solid matrix, solidification being preceded by chemical reactions that reduce mobility of contaminants[4].
b. Method of separation
Mechanical separation is necessary for the classification of soil particles based on their size. To achieve such separations are used: cyclones which separates particles larger than 10-20 μm by centrifugal force from the particles smaller, separation through a fluidized bed in which the particles smaller than 50 μm are found at the top of the fluidized bed and are extracted in countercurrent in a column upright, gravity *separation* by *flotation* process which is based on separating under the action of terrestrial gravitational field, of the particles with average density lower than water, *magnetseparation* is based on the magnetic properties of metals and can be used for the separation of ferrous materials.
Pyrometallurgical separation using high temperature furnaces where toxic compounds are volatilized from contaminated soil. This process is applicable to soil with high concentrations of toxic compounds. These compounds are then recovered.
Chemical separation is applied either for detoxification or to reduce ion mobility. The method is usually used for wastewater. Ions are subject to reduction processes.
Separation using additives is a method used for the separation of toxic compounds. You can use natural zeolites that form an important class of natural aluminosilicate. They have great ability to remove highly toxic compounds.

c. Electrochemical separation

Electrochemical process involves passing a current of low intensity between an anode and a cathode implanted in contaminated soil. Ions and small particles loaded together with ground water are transported between the electrodes. An applied potential difference between the electrodes initiates the process. When current passes directly through the ground, ions migrate towards the electrodes, cations to cathode and anions to anode. This effect is used in electrochemical remediation If using an ion exchange membrane the process is called electrodialysis[5]. The principle of the method is shown in Figure 1

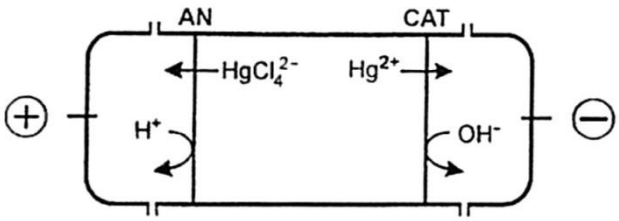

Figure 1. The principle of mercury contaminated soil remediation by electrodialysis
AN = anion exchange membrane; CAT = cation exchange membrane

d. Photocatalytic remediation

It was taken as example to remedy such wastewater with a high content of mercury. Heterogeneous photocatalysis is a promising method for remediation of wastewater with a high content of mercur.TiO_2 is known as a photocatalyst by means of which mercury is removed from aqueous solutions. All remediation processes in the presence of TiO_2 are carried out in the absence of oxygen[6]. The reaction mechanism is as follows:

$$TiO_2 + h\nu \rightarrow 2e^- + 2h^+$$

$$Hg^{2+}(aq) \leftrightarrow Hg^{2+}(ads)$$

$$Hg^{2+}(ads) + 2e^- \rightarrow Hg^0(ads)$$

$$2H_2O \leftrightarrow 2H^+ + 2OH^-$$

$$2OH^- + 2h^+ \rightarrow H_2O + \tfrac{1}{2} O_2$$

Total reaction: $Hg^{2+}(aq) + H_2O \xrightarrow[TiO_2]{h\nu} Hg^0(ads) + 2H^+ + \tfrac{1}{2} O_2$

e. Remediation by biochemical processes

Metals extraction techniques include microorganisms' bioextraction, biosorbtion and processes of oxidation / reduction. *Bioextraction* is via microorganisms such as *Aspergillus niger* fungus that can produce citric acid and gluconic acid. They can function both as acids and adjusts the pH as well as complexing agents for mercury. *Biosorbtion* represents a biological treatment in which the adsorption of mercury in biomass represented by algae and bacterial cells that can be dead or alive *The processes of oxidation/reduction* .are also made by microorganisms. For the mercury exist sulfate-reducing bacteria (SRB) forming insoluble mercuric sulfide, according to the reactions:

$$CH_3COOH + SO_4^{2-} \rightarrow 2HCO_3 + HS^- + H^+$$

$$H_2S + Hg^{2+} \rightarrow HgS + 2H^+$$

f.Phytoremediation

Plants like *Thlaspi, Urtica, Chenopodium* are able to accumulate toxic compounds and may be considered as a method of treating contaminated soil. The method is suitable for soils that do not contain high concentrations of toxic substances. Schematic process (Figure 2):

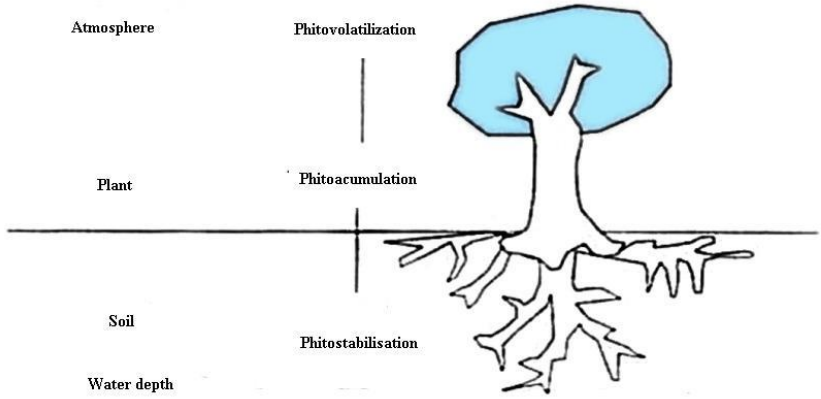

Figure 2. Schematic diagram of the process of phytoremediation of soils contaminated with mercury

g. Remediation of soil by washing with various agents

The solutions used for extraction is infiltrated into the ground using flooding from surface, sprinkler irrigation, pool infiltration etc. Use water with various additives. Process diagram is shown in Figure 3:

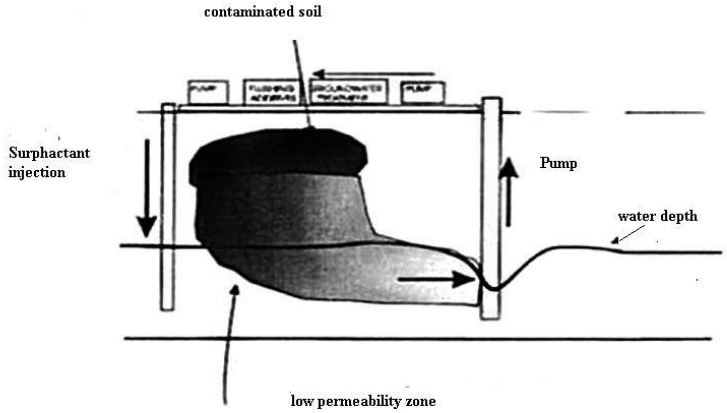

Figure 3. Remediation of soil by washing with various agents diagram

Results and discussion

For the isolation of contaminated area the vertical barrier reduce movement of deep waters contaminated with toxic substances or prevents deep penetration of contaminated water in contaminated areas. To prevent the transport of toxic compounds through this barrier it must be covered with a glue or a low permeability layer. If this barrier cannot be placed is required an extraction system of deep water to avoid toxic compounds passing through the barrier. Use mud walls, geomembranes and walls with multiple layers. Most used are mud walls because they are the most readily available and the cheapest. A horizontal barrier are not yet widely used and has not yet been demonstrated efficiency. In any case these barriers can be used as a horizontal dividing line for contaminated area so you do not need excavation Vitrification is a process of solidifying soil requiring thermal energy. Involves inserting electrodes into the ground. Through these electrodes must be able to pass electricity, and solidification occurs through cooling.

Mechanical separation methods are increasingly being used, especially as methods of

decontamination of soil run-up. They prepare the soil particles, it groups them classified so that it can be applied specific decontamination processes. Following the separation pyrometallurgically it forms a slag that contains heavy metals that can be recovered in this way. Sometimes it is necessary as a pretreatment to reduce the volume of soil to be subjected to pyrometallurgical separation.bChemical treatments can be made in situ by injecting reactants in deep waters, but there is a risk of introducing other contaminants.Experiments were performed on soils contaminated with mercury, and then treated with the zeolite. As a result of experiments and found that the treatment of the soil with zeolites reduces the amount of toxic compounds by up to 80%. Reducing the concentration of mercury is attributed zeolites ability to immobilize mercury ions acting as natural ion exchangersIf electrochemical remediation is an example in which the cations are H^+ and Hg^{2+} and OH^- anions are represented and $HgCl^{4-.}$ The contaminated soil is placed between anion exchange membrane and cation exchange membrane. Efficiency remedy depends on the current density electrodyalitic During the mercury ions move from one side of the contaminated soil to another forming an ion front. This procedure is applied mainly in sandy soilsIf photocatalytic remedy when presented for extracting mercury complexing agents may be employed for mercury, allowing its extraction and if present oxygen in solution. The reaction may occur even under sunlight.

Conclusion

We wanted to make a review of the main methods for decontamination of soil infected with toxic chemicals. Some methods have been applied to contaminated soils in different geographic areas with relatively successful results Attempts to develop new effective methods for decontaminating soil infected with toxic chemicals are done.

References

[1]. M. Andoni, A.. Dragomirescu, A.Iovi, I. Ursoiu, A. Negrea, L.Lupa, P.Negrea, M. Ciopec, Revista de chimie 60 (2009) 424

[2] M. Andoni, A.Iovi, P. Negrea, L.Lupa, A.Negrea, M. Ciopec, Revista de chimie 59 (2008)779

[3] M.Andoni, A.Iovi, P.Negrea, A.Negrea, L..Lupa, M. Ciopec, Revista de chimie 59 (2008) 653

[4] C. Borza, C.Oancea, R. Mateescu, G. Balint-Săvoiu, C. Cristescu, M.Andoni, G.M. Simu, M. Butur, C. Dehelean, E.A. Pauncu, Journal of Foof Agriculture&Environment 9 (2011) 175

[5] M. Andoni, J.M. Pătrașcu, C.A. Dehelean, G.M. Simu, C.Soica, D. Antal, R. Pop, Croatica Chemica Acta 88 (2015), 241

[6] M. Andoni, M. Medeleanu, M. Stefanut, A. Cata, I. Ienascu, C. Tanasie, R.Pop, Journal of Chemical Srbian Society 81 (2016) 177