WASHING TREATMENT OF SEDIMENTS CONTAMINATED WITH HEAVY METALS AND POLYCYCLIC AROMATIC HYDROCARBONS.

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Polluted sites exist in all industrialized countries. These contaminant sources are often present in such quantities that they constitute a danger for sediment and groundwater as well as for the users of these resources.

The aim of this project is focused on fundamental and applied aspects of washing treatment of river and seaport sediments contaminated with Polycyclic Aromatic Hydrocarbons (PAHs) and Heavy Metals (HMs).

PAHs are a family of neutral organic compounds, made up exclusively of carbon and hydrogen. The structure of these molecules includes at least two aromatic rings amalgamated in a linear, angular or bunch arrangements. The majority of PAHs are Hydrophobic (or liposolubles) non-volatile molecules. These properties mean that PAHs tend to be adsorbed to organic matter and soil/ sediment particles (Weissenfel et al. 1992).

HMs contamination has become a worldwide problem through disturbing the normal functions of rivers, lakes, and seaports. However, unlike organic pollutants, natural processes of decomposition do not remove heavy metals. In some conditions, more than 99% of heavy metals entering into river can be stored in river sediments in various forms (i.e. speciation), but HMs cannot be immobilized in sediment forever. Sediment, as the largest storage and sources of heavy metals, therefore plays a rather important role in metal mobility (Zoumis et al. 2000).

With the variation of the physical–chemical characteristics of interstitial water conditions (e.g. pH and redox), part of these fixed metals will re-enter the overlying water and become available to living organisms. Thus, sediment often acts as both carriers and potential sources for metals in aquatic environment. HMs usually possess significant toxicity to aquatic organisms, and then affect human health through food chain (Zoumis et al. 2000).

There are many treatment technologies for remediation of sediments contaminated with such contaminants. The selection depends on contaminant and site characteristics, regulatory requirements, costs, and time constraints. Since most remediation technologies are site specific, the selection of appropriate technologies is often a difficult, but extremely important, step in the successful remediation of a contaminated site. One of these treatment technologies is soil/sediment washing.

Soil/sediment washing is an *ex situ* treatment technology for remediation of contaminated soils and sediments. It is based on either physical separation, chemical leaching or a combination of both physical and chemical processes (Pearl et al., 2006). In particular physical separation consists of a volume reduction/waste minimization process in which the majority of the contamination in sediment is removed as a small fraction of the original sediment volume.

An *ex-situ* method that could simultaneously remove organic compounds and heavy metals from sediments would improve the remediation of hazardous waste sites, and reduce the cost of the technology, but the removal of PAHs and HMs concurrently is difficult due to differences in their physical-chemical properties.

Among the naturally occurring and readily available biomolecules, deoxyribonucleic acid (DNA) is known to exhibit a high affinity for toxic organic compounds such as PAHs (Boyland-Green, 1964, Lesko et al., 1968). In fact, the toxicity of such organics is often associated with their high affinity for DNA, which can induce mutations in

living systems (Lesko et al., 1968). Recently, utilization of DNA in the field of environmental cleanup has been studied (Navarro et al., 2007). Since the DNA is known to interact also with HMs (Duguid et al. 1993), the use of DNA solution to extract simultaneously PAHs and HMs is tested in order to assess any possible synergistic effect.

The main objective of this research is to develop a sediment washing process effective on both PAHs and HMs removal from polluted sediments. The technique that will be developed is a sediment washing process ensuring the mobilization of both organic and inorganic pollutants from sediment particles.

After sediment characterization, contaminants spiking of sediment was performed according to Sawada et al. (2004), and then an ageing treatment was designed according to Udovic and Lestan (2009).

After observing the interaction of DNA with HMs and PAHs compounds, several tests were done in order to optimize the operational conditions for the washing treatment in terms of sediment to washing solution ratio, time of contact, pH, temperature, and salts concentration. Figures 1.1 and 1.2 show the result of the tests at room temperature, with a sediments washing solution ratio of 1:20 at different contact times and different pH.

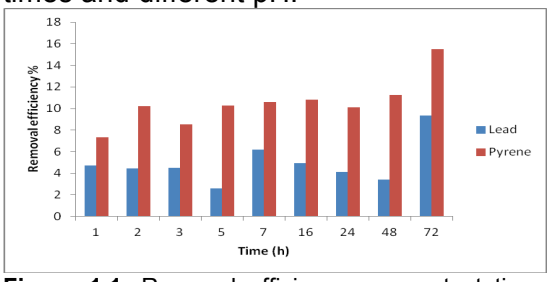

Figure 1.1. Removal efficiency vs. contact time. Washing solution: DNA 1%; Sediments washing solution ratio 1:20; pH 6.5.

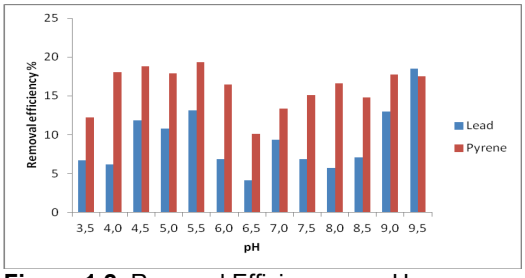

Figure 1.2. Removal Efficiency vs. pH. Washing solution: DNA 1%; Sediments washing solution ratio 1:20; contact time: 24h.

Next step is to investigate the relationships between the sediment matrix and the contaminants using an analytical procedure involving Sequential chemical extractions for the partitioning of particulate trace metals into different fractions.

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