

Original Article

Lead Extraction from Soil by Washing with Ethylenediamine Disuccinic Acid Trisodium Salt (Na_3EDDS)

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Abstract

In this paper are presented the research performed in order to establish the optimum conditions of lead extraction from soil by washing with ethylenediamine disuccinic acid trisodium salt (Na_3EDDS). Laboratory experiments were performed on soil samples taken from the Copșa Mică area, an area with highly polluted soil with Cu, Zn, Pb and Cd. Soil samples were subjected to washing with Na_3EDDS for 2, 4, 6, respectively 8 hours, the Na_3EDDS solution concentration was 0.4, 0.5 and 0.6 [%]. Sample mixing was made using a stirrer with platform and orbital oscillation-rotation movement, with the stirring speed of 200 oscillations/minute. Lead determination was made by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES). The experiments allowed determination of optimum parameters for washing, respectively the washing time and concentration of the washing solution, the best yield being of 85.54%.

Keywords: soil washing, lead, EDDS.

1. Introduction

Soil pollution with heavy metals is a problem of major importance because: metals are very toxic, have a low biodegradability, tend to accumulate and represent a threat for human health. [2]. Remedy of soils contaminated with metals can be achieved by several methods, including soil washing. Soil washing involves removing metals from the soil using water and different reagents (acids, oxidizing agents, chelating agents, etc.). EDDS ([S, S – ethylenediamine-disuccinic acid]) is, nowadays, among the most studied chelating agents, due to its ability of forming biodegradable complexes.

EDDS is a structural isomer of EDTA and only the [S,S]-ethylenediamine-disuccinic acid is biodegradable, being used as Na_3EDDS in the soil washing process. Soil washing with EDDS leads to formation of metal-chelant complexes through which metals are removed from the soil surface [1, 3]. Given this, EDDS is a chelating agent increasingly used for soil remediation.

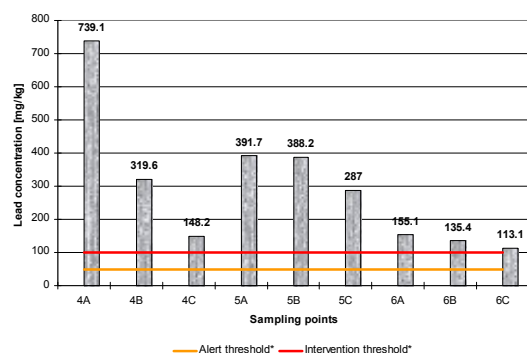
2. Material and Method

One of the most metal polluted areas in Romania is the Copșa Mică area. From this area we took samples of soil, from three sampling points and at three depths, as follows: 4A (at a depth of 0 - 10 cm), 4B (at a depth of 10 - 20 cm) and 4C (at a depth of 20 - 30 cm) at a distance of approximately 500 meters from SC Sometra; 5A (at a depth of 0 - 10 cm), 5B (at a depth of 10 - 20 cm) and 5C (at a depth of 20 - 30 cm) at a distance of approximately

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2 km from SC Sometra; 6A (at a depth of 0 - 10 cm), 6B (at a depth of 10 - 20 cm) and 6C (at a depth of 20 - 30 cm) at a distance of approximately 5 km from SC Sometra. Samples were taken according to STAS 7184/1-84 [4], and afterward they were subjected to analysis in order to determine the soil characteristics.

Determination of lead concentration from the soil samples was made by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES), obtained results being presented in fig. 1.



*According to Order 756/97 [5]

Figure 1. Lead concentration at the sampling points

As it can be noticed from fig. 1, the lead concentration exceeds the intervention threshold values in all the three sampling points and at all the three depths. Lead concentration in the soil decreases with the increase of the sampling depth and with the distance increase from the source. The highest value of lead concentration is in point 4, where at a depth of 0 - 10 cm the intervention threshold is exceeded of approximately 7 times.

Given that the highest value of lead concentration is in point 4A, experiments were conducted on the soil taken from this sample, soil characteristics from this point being presented in table 1. As regards the distribution of soil size particles, it is presented in fig. 2.

Table1. Soil characteristics

Characteristics	Value	
Soil reactivity (pH)	Value	7.08
	Interpretation	neutral
Humus (%)	Value	1.86
	Interpretation	small
Total nitrogen (%)	Value	0.146
	Interpretation	medium
Mobile phosphorus (mg/kg)	Value	63
	Interpretation	very high
Mobile potassium (mg/kg)	Value	275
	Interpretation	high

Lead extraction from the contaminated soil sample was made by soil washing, and as a washing method the chemical extraction was used, washing agent being water to which was added the ethylenediamine disuccinic acid trisodium salt, Na_3EDDS . In order to establish the optimum metal extraction parameters from the soil by washing with Na_3EDDS , there were prepared four sets of samples, four samples each set. The first set was subjected to 2 hours of stirring, the second was subjected to 4 hours of stirring, for the third the stirring lasted 6 hours and the fourth set was stirred for 8 hours.

The 4 samples were prepared as follows: in 4 Erlenmeyer glasses was added 5 g of soil onto which water was poured, using a solid:liquid ratio of 1 : 10.

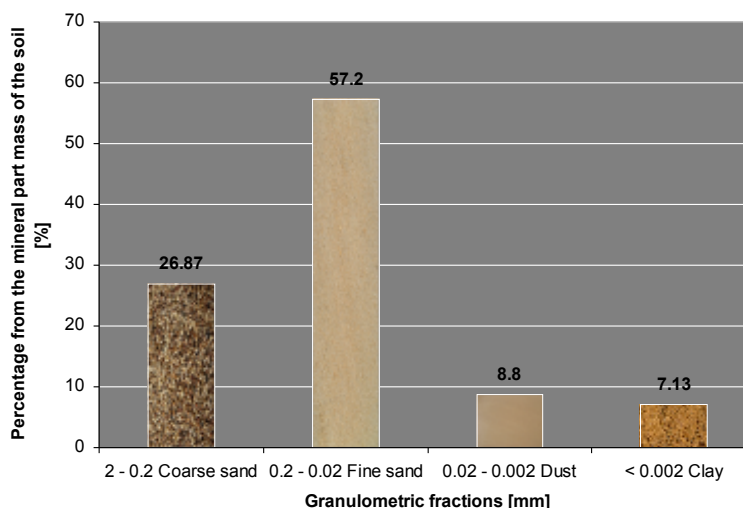


Figure 2. Distribution of particle size fractions

One of the samples was kept as control sample, Na_3EDDS being added for the other three with the following concentrations: 0.4; 0.5 and 0.6 %, respectively.

3.Results and Discussions

After preparing the samples, they were subjected to stirring in the VDRL 711/CT stirrer with platform and orbital oscillation-rotation movement.

The stirring was performed at room temperature and at a speed of 200 oscillations/minute. After the stirring operation, samples were filtered and then dried at room temperature.

Samples thus obtained were analyzed by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP - AES), in order to determine the metal concentration from the soil samples.

The results obtained from soil treatment by washing with Na_3EDDS are presented in the figures below.

As it can be seen in figs. 3 – 6, lead concentration in the soil decreases with the increasing concentration of the washing solution and of the washing time.

The best results were recorded for soil washing with the highest washing solution concentration, in this case even if soil washing time is 4 hours, the lead concentration falls under the alert threshold set by Order 756/97 [5].

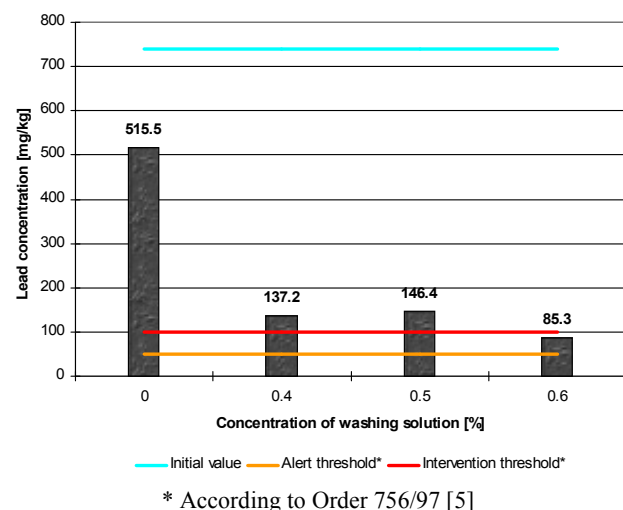


Figure 3. Lead concentration in the soil after Na_3EDDS treatment for 2 hours

As it can be seen from figure 5, on interval 2 – 4, the time variation curve for soil washing with water, there are no modifications of the lead concentration in the soil.

After this it is recorded a slight decrease of the lead concentration for the 6 hours washing, and in the case of 8 hours washing it is recorded a more significant decrease of lead in the soil.

For washing with water and Na_3EDDS , in all three cases the curve has approximately the same lie.

On the 2 – 4 hours interval there is a decrease of the lead concentration, after which on the 4 – 6 hours interval the curve presents an outage, followed by a decrease of lead concentration on the 6 – 8 hours interval of soil washing.

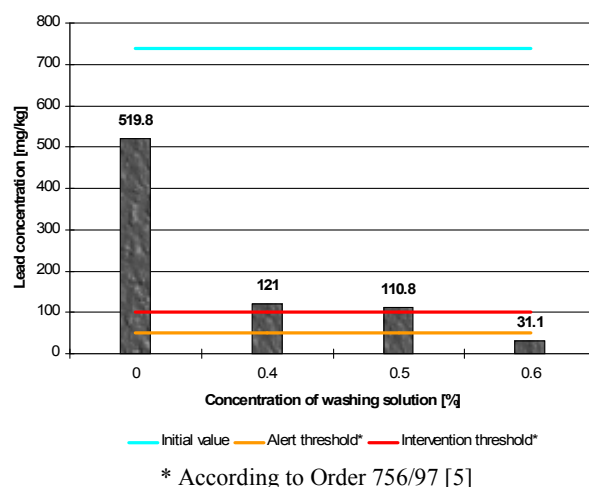


Figure 4. concentration in the soil after Na_3EDDS tr: Lead eatment for 4 hours

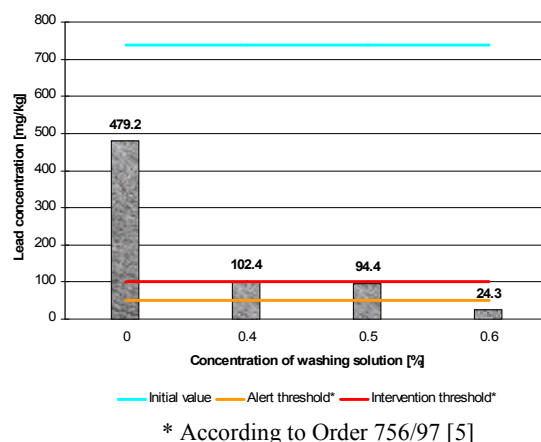
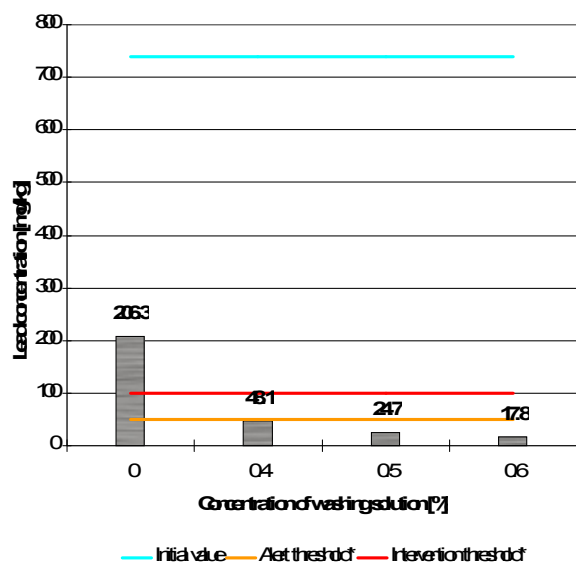


Figure 5. Lead concentration in the soil after Na_3EDDS treatment for 6 hours



* According to Order 756/97 [5]

Figure 6. Lead concentration in the soil after Na_3EDDS treatment for 8 hours

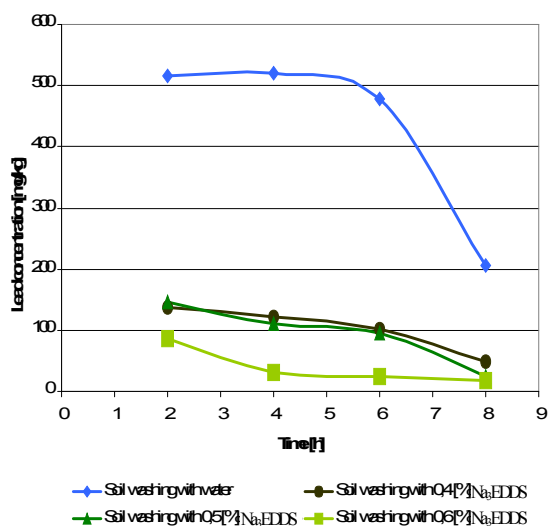


Figure 7. Time variation of the lead concentration in the soil after washing with Na_3EDDS

4. Conclusions

Soil washing with ethylenediamine disuccinic acid trisodium salt for lead extraction from contaminated soils proved to be a viable solution.

Washing solution concentration and time are important parameters in the washing process, observing the fact that with the increase of these parameters, the lead concentration in the soil decreases.

Therefore the highest yield of 85.54% was recorder for an 8 hour soil washing with a concentration of 0.6 % Na_3EDDS .

Given the obtained results and this washing agent's property to form biodegradable complexes with metals from the soil, it is preferable to use Na_3EDDS for remediation of soils contaminated with lead.

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