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Introduction

The efficiency of the electrokinetic remediation treatments on heavy metals contaminated soils is strongly limited by the chemical species of the different metals in the soil [1-2]. Thus, different results are obtained from electrokinetic treatments of soils applied to an actual contaminated site and a similar clean soil spiked in the laboratory. The changes of the metallic species during the electroremediation are also important. If the basic front generated by the electrode reactions at the cathode is not controlled, heavy metals may precipitate in the form of insoluble hydroxides, making the treatment inefficient. Therefore, in order to characterize all these processes, procedures of sequential extraction, such as BCR (Communitie Bureau of Reference), are used to split the total metal content in fractions with different mobility [3].

On the other hand, acid enhanced electrokinetic treatments have been one of the most accepted techniques for heavy metal electrokinetic remediation. Low pH is assured in the soil during the process, by the use of selective membranes or acidic substances, increasing the mobilization of the metals. Although the technique has shown high effectiveness, in the cases of soils with high buffer capacity the acid enhanced technique can be inefficient, since an enormous amount of electrical energy is necessary to obtain the aimed acid environment. Furthermore, the process can modify in a significant manner the physiology of the soil, and reduce or eliminate permanently the buffer capacity of the treated soil.

The use of specific extractant agents seems to be an interesting alternative to improve the mobilization of the contaminants. The main idea is to obtain a soluble compound, normally a complex ion, by means of a chemical reaction between the target heavy metal and the extractant agent. Thus, this technique not only improves the general efficiency of the removal, avoiding the side effects of the use of acids,

but also allows a selective mobilization of the contaminants which can be of interest for different purposes, such as the economical exploitation of the collected heavy metals. In addition to this, the use of extractant agents can be combined, in a sequential or in a simultaneous treatment, such as, for instance, the aforementioned acid enhanced technique.

In the present study, a procedure for the selection of the optimal extractant agent for a contaminated soil is described. In a first step, multi-species chemical equilibrium software is used for the identification of the best candidates to be useful extractant agents for a specific system. Subsequently, leaching experiments in a well stirred tank are performed, to verify the results of the theoretical equilibrium analysis, as well as to determine the feasibility of the process from the kinetic point of view.

The effectiveness of the selected extractant agents are verified in both flushing and/or electrokinetic treatment depending on the soil permeability.

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