OPTIMIZATION OF A HYDROCARBON POLLUTED SITE TREATMENT BY IN SITU CHEMICAL OXIDATION

S. del Reino,[1] M. Rodríguez[2], J. Bueno[1], J.L. Fernández[1], T. Schmid[2], R. Millán[2], O. Escolano[2]

[1]AITEMIN, Río Cabriel, s/n, Toledo, 45007, Spain
[2]CIEMAT, Avda. Complutense 40, Madrid, 28040 Madrid, Spain

E-mail: susana.del.reino@aitemin.es and olga.escolano@ciemat.es
(Author affiliations and contact information, centred, 12-point Times New Roman Italics)

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1. Purpose

The *in situ* chemical oxidation is a technique used for soil and underground water treatment, which consists in the injection in the subsoil of a chemical oxidant agent in order to transform pollutants in other less injurious species. Compared with other in situ treatments this technique has several advantages like: short execution times, high degradation yields and is possible to treat a broad range of pollutants.

For an effective treatment without environmental problems or security risks, the injection of oxidant agents in the medium requires a good knowledge of the subsoil and of the pollutants nature. As in the case of the site considered in this work, the heterogeneity of pollutants distribution, hydrogeochemical parameters and the nature of the different horizons or soils layers, can produce high inefficiencies of the applied treatment.

Previously to the injection on site, a detailed characterization of the site and the development of treatability laboratory tests, have allowed to optimize the design, and therefore, to increase significantly the effectiveness of the ISCO treatment.

2. Design

This work has been developed in an area of 1.5 ha. The pollution area state has its origin in hydrocarbon storage and hydrocarbon transport activities developed during several decades. The site has some features that make difficult the ISCO application: irregular distribution of pollutants, low depth of the freatic level (changeable along the year) and a low or invalid permeability at some depth, having the soils a remarkable vertical and horizontal heterogeneity related to ventilation, granulometry, calcium carbonate, soluble salts and organic matter conditions.

In order to ensure a maximum effectiveness on the ISCO system design a detailed characterization of the area to be treated has been performed, including:

- A compilation of the installation historical evolution (ortoimages, areas, geological maps).
- Topographic raising of the land in order to know the flow pattern.
- Identification and selection of pollution sources as target places for the injection.
- Detailed edaphology raising (25 soils samples with soil profiles description)
- Pumping tests in soils simples and pre-existing drillings for the determination of hydraulic parameters.
- Sampling and physico-chemical analysis of water and soils (115 samples).
- Pollutants identification (chromatographic analysis of organic compounds).
- Continuous monitoring of the underground water level evolution by the installation of automatic registration systems Diver type.

After the analysis of the information obtained, several samples where taken for the development of laboratory treatability tests based on the introduction in Teflon columns of different chemical reagents and soils samples combinations.

The pollutant content was analyzed in water and soil before and after the oxidation process.

The different combinations tested are summarized in table 1:

Table 1. Combinations tested in the teatrability tests.

Oxidant	Catalyst	Chelant agent
Hydrogen peroxide	$FeSO_4 \cdot 7H_2O$	Weak acid
Hydrogen peroxide	$FeSO_4 \cdot 7H_2O$	Cycled olygosaccharide
Persulphate	-	Weak acid
Persulphate	-	Cycled olygosaccharide

3. Results/Findings

The tasks above described have allowed optimizing the design of the ISCO injection system. The obtained results allow defining:

- The type and necessary volume of oxidant reagent and optimum chelant agent.
- The suitable oxidant/pollutant weight relationship.
- The oxidation intermediate products to be monitorized.
- The edaphic horizon and the suitable injection depth.
- The selection of localizations with the more suitable pollutants range for ISCO treatment.

4. Conclusions

The development of a detailed characterization of the polluted land and of laboratory treatability tests with real samples, allows increasing the efficiency of the application of a ISCO treatment in a polluted site with heterogenic features.

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