Remediation of Chromium and Naphthalene Wastes Using Bioremediation and Immobilization

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Abstract

Using bioremediation and solidification/stabilization (S/S) to treat naphthalene and chromium wastes was investigated in this study. Studies showed that a combination of $FeCl_2$ reduction and S/S was effective to reduce the leaching of Cr(VI) from Cr(VI)-contaminated soil by 95%. Biodegradation of naphthalene was inhibited when 500 mg/L of K_2CrO_4 was present.

1. Introduction

The use of chromium and naphthalene in industries such as steel production, chrome plating, leather tanning, wood treatment, coal, lubricants, motor fuels and oil refinery industries, has resulted in the contamination of soils and waters to a concentration as high as 130,000 mg/kg. Reports have indicated that chromium, especially Cr(VI), and naphthalene are toxic, mutagenic and carcinogenic. There is a great need to better manage naphthalene and chromium wastes to protect human health and environments.

2. Objective

The overall objective of this study is to investigate the effectiveness and limitations of S/S and bioremediation in treating naphthalene and chromium wastes. Specific objectives are (1) to investigate the limiting factors in each remedial technology; (2) to develop an integrated treatment train for Cr(VI)-contaminated soils; and (3) to investigate the involved mechanisms and products during the treatment with the aid of XRD.

3. Testing Program

Contaminants. Hexavalent chromium, Cr(VI), and naphthalene were the two target chemicals under investigation in this study. Contaminated soils up to a concentration of 25,000 mg/kg were prepared

Solidification/stabilization (S/S). Type I Portland cement was used as the binder for S/S treatment. Unconfined compressive strength (UCS) and Toxicity Characteristic Leaching Procedure (TCLP) were conduced on samples cured for 28 days. Factors such as contamination level, cement-to-soil ratio, site characteristics, and potential additives were investigated.

Bioremediation. Acclimated *Flavobacterium sp*., isolated from field samples, was used for biodegradation studies. Factors such as metal toxicity, contamination level, and soil characteristics

were investigated in continuously stirred batch bioreactors.

4. Results

Extraction of contaminant. Solutions of 0.28 M Na_2CO_3/0.5 N NaOH (96^{o}C) and methanol (100%) extracted more than 90% of Cr(VI) and naphthalene from contaminated soils.

Effect of Cr(VI) on biodegradation. Naphthalene (30 mg/L) was biodegraded to below 5 mg/L within 60 hours of operation depended on the Cr(VI) concentration. The biodegradation process was inhibited when 500 mg/L of K_2CrO_4 was added. Models were developed based on the biodegradation kinetics to quantify the metal inhibition effect.

S/S treatment. Cement-based S/S was effective in treating naphthalene wastes but failed to treat Cr(VI)-contaminated soils to meet TCLP limit of 5 mg/L. A combination of Fe(II) reduction and S/S was able to reduce the leaching of Cr(VI) by 95%.

5. Conclusions

(1) Cement-based S/S was effective to treat 500 mg/kg K_2CrO_4 contaminated clayey soil with less than 5 mg/L (TCLP limit) of Cr(VI) in the leaching solution.

(2) Naphthalene biodegradation was affected by the Cr(VI) concentration. The process was inhibited when more than 500 mg/L of K_2CrO_4 was added.

(3) The Freundlich isotherm represented the sorption of contaminants to the soil constituents.

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7. Reference

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