Remediation of highly saline petroleum and heavy metal contaminated fine textured soils

Majid, Abdul; Khan, A. Aziz; Xu, Jing G.; Sparks, Bryan D.

Publisher's version / Version de l'éditeur:

Proceedings. The 5th International Conference on the Biogeochemistry of Trace Elements 1999, 2, pp. 998-999, 1999

136

REMEDIATION OF HIGHLY SALINE PETROLEUM AND HEAVY METAL CONTAMINATED FINE TEXTURED SOILS

Abdul Majid[1], A. Aziz Khan[2], Jing G. Xu[2] and Bryan D. Sparks[1]

[1] National Research Council of Canada, ICPET, Ottawa, Ontario, K1A 0R6 Canada, abdul.majid@nrc.ca, bryan.sparks@nrc.ca
[2] Alberta Research Council Vegreville, Alberta, T9C 1T4 Canada, Aziz@AEC.ARC.AB.CA

1. Introduction

Existing technologies for the cleanup of contaminated soil are poorly suited for treating fine textured soils without adversely affecting the associated humic matter or soil mineralogy. The Institute for Chemical Process and Environmental Technology (ICPET), part of Canada's National Research Council (NRC), has developed a remediation process called Solvent Extraction Soil Remediation (SESR). SESR is the concurrent application of liquid phase agglomeration and solvent extraction of organic contaminants; heavy metals may be fixed concurrently by incorporating metal binding materials into the soil agglomerates as they form during solvent extraction of organic contaminants.

This presentation will discuss the results of recent tests on the application of SESR to the remediation of highly saline, fine textured, solid wastes containing both hydrocarbon and heavy metal contaminants. Plant growth studies on the remediated material will also be presented to show that the process is capable of producing material acceptable for use as topsoil.

2. Materials and Methods

The details regarding materials and experimental procedures has been reported elsewhere (Majid et al 1996, 1999).

3. Results and Discussion

Two highly saline, industrial soil samples, one contaminated with a heavy oil and several heavy metals and the other contaminated with diesel and lead were tested for remediation by NRC's SESR process. Concurrent removal of the hydrocarbon contaminant and fixation of heavy metals was achieved by incorporating metal binding agents such as peat, coal combustion ashes and phosphates into the soil agglomerates formed during processing. The efficiency of solid-solvent separation was greatly improved by selecting the agglomerate size in the 0.5-2 mm range. Over 90% of the oily contaminant was removed in the first stage of treatment. After five stages, close to 100% of the oily contaminant had been separated. Residual contaminant levels were close to the Ontario Ministry of the Environment and Energy (OMEE), guidelines for residential and recreational land use.

Dried agglomerates were leached with water, in a fixed bed system, to remove residual brine in order to meet OMEE, guidelines for soil conductivity. Agglomerated solids required less water and time to reach the conductivity guideline than unagglomerated soil extracted by conventional means.

After brine removal remediated material was evaluated for stability to plant enzymes by using it as soil in plant growth tests. Barley was used as the test species. A summary of the test results is shown in Table 1. These studies showed that the remediation process is capable of producing material suitable for use as topsoil. Analyses of lead in plant tissues suggests that only a small proportion of the lead absorbed by the plant roots was transported to the shoots. The additives used for the fixation of heavy metals were beneficial in reducing the bioavailability of lead to the plants. Biochemical activity, as a result of plant growth, did not render the fixed heavy metals leachable.

4. Conclusions

NRC's solvent extraction soil remediation process was successfully applied to the remediation of two highly saline industrial soil samples contaminated with both hydrocarbon and heavy metal contaminants. The remediated soil sample was demonstrated to be suitable for agriculture use by growing barley plants.

5. References

Majid, A.; Toll, F.; Boyko, V.J. and Sparks, B.D. (1996), "Fixation of lead in contaminated soils by co-agglomeration with metal binding agents", J.Environ.Sci.Health, A31(6), 1469-1485.

Majid, A.; Sparks, B.D.; Khan, A.A. and Xu, J.G. (1999), "Treatment of used diesel invert drilling mud to remove hydrocarbons, fix lead and leach brine", J. Soil Contamination (in press)

Table 1. Lead up-take by Barley Plants Grown on Remediated Soil

Sample ID	Pb up-take by plants (mg/kg, dry matter)		TCLP Pb (mg/L)	
	Shoots	Roots	Before plant growth	After plant growth
Blank, remediated	2 ± 0.1	950 ± 40	53	3.0
With Na_3PO_4	Not detected	460 ± 30	<1	<1
With $Ca_3(PO_4)_3$	10.4 ± 2.2	370 ± 20	4.7	1.9
With CCA 'FBA'	3.2 ± 0.2	140 ± 20	21.5	1.6
With CCA 'C'	7.3 ± 0.9	290 ± 20	31.3	<1
With CCA 'F'	16.5 ± 3	260 ± 10	43.7	<1
With Lignin	9.5 ± 1.0	140 ± 20	22.1	1.7
With Peat	8.2 ± 1.1	380 ± 20	20.7	<1

TCLP: EPA's Toxicity Characteristics Leaching Procedure; CCA: Coal combustion ashes