Laboratory Testing for Optimization of Lead Stabilization at a Former Oil Refinery

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BACKGROUND/OBJECTIVES

Stabilization can be used to prevent leaching of lead from soil. Different reagents are available which can stabilize lead, however different reagents required different cure times and addition of moisture, produce different amount of bulking, and produce material with different strengths, densities and other properties. The stabilization of lead must be optimized to suit the properties of the soil and the requirements of the site. A laboratory study can achieve this within a short time period and at low cost.

Lead is a highly poisonous metal, affecting almost every organ and system in the body. Soil impacted by lead is often present on industrial sites associated with oil refineries, smelters and other manufacturing. Impacted soil is usually excavated and disposed of. Soil from which lead leaches at greater than 5 mg/L as measured by the Toxicity Characteristic Leaching Procedure (TCLP) must be disposed of as hazardous however if leaching can be controlled it can be disposed of as non-hazardous material.

Solidifying agents and/or bulking agents are added to treat the soil. The solid matrix encapsulates any metals present within the solid matrix where they are no longer available and cannot leach out. In this way, the metals are immobilized and are no longer considered a risk.

Lead was detected in the soil at a former oil refinery in Texas at concentrations up to 84,500 mg/kg. The soil that exceeded regulatory requirements was excavated and disposed at an off-site landfill. A treatability study was performed to optimize treatment to meet the TCLP standard of 5 mg/L.

INITIAL CHARACTERIZATION

Parameters	Units	TCLP Lead criteria	Total Initial Lead (mg/kg)	Initial TCLP Lead (mg/L)
Low Lead	mg/L	5.00	8,610	47.8
Medium Lead	mg/L	5.00	20,000	95.8
High Lead	mg/L	5.00	41,000	229

APPROACH/ACTIVITIES

The objective of the treatability study was to evaluate potential treatment alternatives for the soils at the Site to prevent lead from leaching from the soils. Screening of many different solidification reagents including Portland cement, Fly Ash, and several proprietary products was performed to determine whether leaching of lead could be controlled. Different mixing times, mixing methods, moisture contents and curing times were also tested to optimize treatment to prevent leaching of lead.

Treatments that performed best where further tested to better simulate field conditions. The chosen reagents were slurried using the amount of water identified in the screening tests and then added to the soil in a mechanical mixer to replicate the process that would be used in the field.

SCREENING TESTS

150 g of soil were mixed with varying doses of reagents in a mechanical mixer and mixed for 5 mins.

After mixing, the mixtures were placed in molds and the molds were place in a high humidity chamber to cure.

Portland cement mixtures cured for 3 weeks and all other reagents were cured for 24 hours.

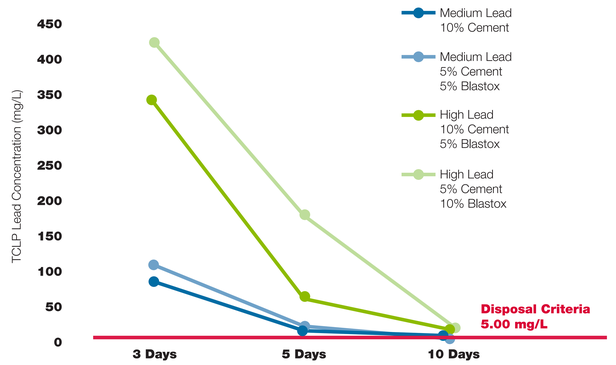
Reagents Tested:

- Portland Cement
- Portland Cement & Fly Ash
- Portland Cement & Blastox
- Enviroblend
- Terrabond TS

DOSE OPTIMIZATION TEST

150 g of soil were mixed with varying doses of Portland Cement, Portland Cement with Fly Ash, and Portland Cement with Blastox in a mechanical mixer and mixed for 5 mins. The reagents were added as a 1:1 reagent : DI water slurry.

TIME SERIES TEST



OPTIMIZATION TEST RESULTS

Parameters	Units	Control	10% Cement	5% Cement 10% Fly Ash	5% Cement 5% Blastox	20% Cement
Low Lead	mg/L	27.2	5.31	18.4	0.396	Not Tested
Medium Lead	mg/L	35.8	ND (0.05)	28.2	ND (0.05)	Not Tested
High Lead	mg/L	95.8	0.079	116	0.23	0.0651

**Notes: Green cells are below disposal criteria

Portland Cement and Portland Cement with Blastox were the most promising reagents.

SCREENING TESTS RESULTS

Parameters	Units	10% Cement	20% Cement	5% Cement 10% Fly Ash	10% Cement 10% Fly Ash	5% Cement 5% Blastox	10% Cement 10% Blastox	3% Enviroblend	5% Enviroblend	5% Enviroblend w/ water	3% Terrabond TS	5% Terrabond TS	8% Terrabond TS	8% Terrabond TS w/ water
Low Lead	mg/L	7.24	0.0732	0.0511	0.0386	0.00893	0.0413	9.53	6.42	6.42	1.56	0.56	0.296	0.265
Medium Lead	mg/L	0.079	0.122	0.00842	0.00076	0.0169	0.122	0.807	0.357	0.357	0.475	0.219	0.115	0.0785
High Lead	mg/L	0.0595	0.214	297	0.211	273	5.64	120	2.59	2.59	2.93	0.701	0.39	0.389

**Notes: Green cells are below disposal criteria

All reagents were effective in reducing leaching. Portland Cement, Portland Cement with Blastox, and Portland Cement with Fly Ash were most effective. These reagents were further tested.

SUMMARY FROM STUDY

- Portland cement and Portland cement with Blastox were the most effective reagents
- For samples with extremely high lead, if Portland Cement is used alone, up to 20% may be required
- The addition of 5% Blastox decreases the amount of Portland cement required to 5%
- When regular Portland Cement or Portland cement with Blastox is used, the minimum effective cure time is 14 days

RECOMMENDATIONS

- The use of 10% Portland Cement is recommended
- Cure time of at least 14 days is required
- Portland Cement should be added as a slurry
- Mixing should be as thorough as practically possible

RESULTS

The results of the study showed that laboratory treatability studies can be used to optimize all required parameters to maximize the treatment in the field. It is important to consider site specific requirements such as cure times and mixing methods in the laboratory testing in order to design a successful treatment. Portland cement was the most effective reagent. It was recommended that Portland cement solution be added as a slurry to a concentration of 10 percent by weight. A cure time of at least 14 days is required and the degree of mixing has an effect on the outcome so minimum mix times should be specified. The remedy was implemented as recommended and resulted in successful treatment with all soils passing TCLP.