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An Alternative Use for Bagasse: Stabilizing Agent for Lead Waste

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Abstract

Bagasse amounts to one-third of the cane ground, and supplies fuel for the generation of steam in raw factories; however, most factories have an excess of bagasse during regular grinding season. Another method for the utilization of bagasse was investigated using bagasse as a stabilizing agent for heavy metal waste solidified/stabilized in cement. Lead nitrate was used as the model heavy metal waste with a 10 or 15 per cent lead by weight to cement loading. Samples were cured for 7, 14, and 28 days at 24°C. Samples containing bagasse typically resulted in TCLP extract lead concentrations of approximately 0.5 mg/l of lead for all samples, while samples containing no bagasse had lead extract concentrations of approximately 5 mg/l for 10 per cent samples and 45 mg/l for 15 per cent. Results indicate that using bagasse as an additive to cement is effectively improving the solidification/stabilization of lead.

Introduction

The hazardous waste disposal problem is a major national concern. Because of the extremely large amounts of toxic chemicals that are being released into the environment, the federal government was forced to regulate the disposal and management of hazardous wastes. The Environmental Protection Agency (EPA) classifies a waste as hazardous

if it is nondegradable, toxic, may cause detrimental cumulative effects, or poses a substantial threat to human health or living organisms (U.S. Environmental Protection Agency, 1989). Some wastes are recycled, detoxified, or incinerated which decreases the amount of waste that must be disposed, but in almost all cases some residue still remains. One of the most cost-effective methods available for disposing of this residue along with other wastes not recycled or incinerated is placement in landfills. In 1984, the Hazardous and Solid Waste Amendments (HSWA, 1984) to the Resource Conservation and Recovery Act (RCRA, 1976) banned the placement of noncontainerized liquids in landfills. As a result, it became necessary that some form of solidification/stabilization (S/S) pretreatment be performed prior to landfilling. The process of solidification/stabilization is a recommended treatment alternative for many RCRA wastes (CERCLA, 1980).

The bulk of solidified/stabilized wastes in both radioactive waste and hazardous waste disposal consists of cementitious waste forms because cementitious materials are the least expensive. Selected materials such as Portland cement, fly ash, pozzolan, lime, etc. are used in the S/S process for binding the hazardous waste prior to landfilling. It is estimated that 16 million metric tons per year of waste could sustain S/S treatment

and landfilling (Conner, 1990). According to the Toxic Release Inventory for 1994, 289 million pounds of toxic wastes was disposed of in landfills in 1994 (Hanson, 1996). A significant portion of modern industrial waste is disposed by solidification in cements and slags each year. Approximately 40 per cent of all wastes that are disposed in landfills are pretreated by S/S processes. Solidification/stabilization of hazardous wastes is a widely used technology; therefore, it is crucial that its effectiveness be evaluated and make attempts to improve the technique. To be successful, a solidification/stabilization procedure must constrain waste to prevent leaching (migration of waste through the soil), especially by ground water. There has been a large interest in studies dealing with leaching of stabilized metals such as arsenic, cadmium, chromium, and lead from cement waste forms (Conner, 1990; Means *et al.*, 1995, Janusa, 2000). Immobilization by cement is effective for some metals and for some wastes, but not others. Since cement alone is not always effective, new and cheaper stabilizing agents are always sought for tailoring formulations when the need arises.

Our efforts are aimed at designing a matrix for solidification/stabilization of hazardous waste that will be effective while being economically feasible and safe to produce. The

absorbent used with cement to enhance the effectiveness of the cementitious system to contain heavy metal waste was lignin. The heavy metals will be stabilized by complexing with the large lignin molecule significantly reducing leach rates from wastes. To make the process economically feasible, the source of lignin came from the large excess of bagasse (\approx 1.8 million tons annually in Louisiana) produced each year from sugar cane processors. Bagasse is the byproduct or residue of milling or diffusing sugar cane. One of the components of bagasse is lignin, approximately 22 per cent by weight (Chen & Chow, 1993). Developing a better matrix to bind heavy metal waste was examined by using bagasse as an absorbent for lead prior to solidification with cement. Even though lead is usually stabilized by cement-pozzolan processes at low lead concen-

trations, it was chosen as the model waste to determine if using bagasse as an adsorbent improves performance even at high lead concentrations.

Materials and Methods

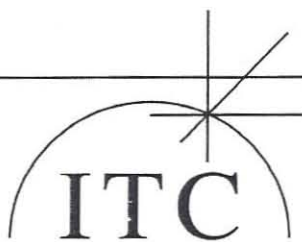
Bagasse Treatment

The bagasse was treated under acidic conditions. The purpose of the treatment is to eliminate cellulose fibers as much as possible and to liberate the lignin. All soluble sugars within the bagasse must be eliminated before the bagasse is added to the cement. Sugars in concentrations as low as 0.03 to 0.15 weight per cent in cement will retard the setting time and strength of cement (Herubin & Marotta, 1981). The bagasse was boiled with 0.1 M HCl for approximately 45 min, with the residue washed free of sugars and hydrolysis products. This procedure was repeated 3-4 times until the filtrate was virtually colorless. The

residual product was oven dried at 110°C overnight and ground to 200 μ fineness.

Sample Preparation

Each set of solidified samples was prepared from a bulk batch to eliminate homogeneity problems within any particular set of samples. Bulk batches typically contained 294 g of ordinary Portland cement type I, 47 g lead nitrate $[Pb(NO_3)_2]$, 15 g treated bagasse, and 162 g deionized water giving a composition of 10 per cent lead / 5 per cent bagasse by weight to cement and a water/cement ratio of 0.55. The batch was mixed in the following manner with the exception that control samples contained no bagasse: $Pb(NO_3)_2$ was dissolved in 120 ml of water by vigorously shaking the solution. The Bagasse and lead nitrate solution was placed in a nor-



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mal household blender and blended on low speed for 1-2 min making sure that all the bagasse was saturated. The solution beaker was rinsed with the remaining water and placed in the blender. This bagasse/lead nitrate solution soaked for approximately 1 h before proceeding. The cement was added to the blender and mixed with a stirring rod until all cement was moist. The mixture was blended on high speed for 5 min with periodic scraping of the sides of the blender. Approximately 20 g of the bulk batch was scooped into 20-ml borosilicate screw-cap vials. There were typically 4 samples made for each set of cure times (7, 14, 28

days) from a bulk batch. Care was taken to ensure that representative bulk samples from the top, middle, and bottom were obtained for each set of cure times. Once a set of samples were made, the borosilicate vials were capped, and samples were stored in a standard laboratory oven at 24°C until the appropriate time for the experiment. Curing temperature is a critical variable that must remain constant to ensure reproducibility (Janusa, Heard, *et al.*, 1998).

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Crushing

After the appropriate cure time, the samples were crushed in the following manner: A vial was placed into a wide-mouth plastic bottle, and the vial broken by striking it with a steel rod. The whole sample slug was removed from the glass. The entire sample was crushed with

TCLP Procedure

The EPA recommends the Toxicity Characteristic Leaching Procedure (TCLP0 (APHA, 1985; Federal Register, 1986) to determine the leachability of a solidified waste encountering typical acidic environ-

mental conditions. It is under these conditions that some solidified waste tends to leach. To each sample, a volume of TCLP leachant No. 2 (5.7 ml/l glacial acetic acid aqueous solution at pH 2.88) was added at a volume of 20 times the weight of the sample. The extraction period for the sample was 18 h under rotary agitation at 30 rpm. Subsequently, the sample was filtered using Grade GF/F 0.7-µm glass-fiber filter paper. The sample was filtered within 2 hours of the 18-hour extraction period to ensure reproducibility (Janusa, Bourgeois, *et al.*, 1998). The filtrate was acidified using concentrated nitric acid and analysis for lead was performed using a Perkin-Elmer Model 5000 atomic absorption spectrometer at 283.3 nm. Since the model waste used in this study was ACS reagent grade lead nitrate, the pretreatment extract concentration (approximately 5000 mg/l) can be safely calculated based on a 10 per cent lead loading. This procedure differs from the EPA TCLP (APHA, 1985; Federal Register, 1986) experiment in that one-tenth of the amount of sample was used (10 g instead of 100 g) and only particles between 8.0 and 9.5 mm were used.

Results and Discussion

Table 1 compares the average TCLP extract lead concentrations for samples containing 10 per cent lead and cured for 7, 14, and 28 days at 24°C. Samples containing bagasse typically had extract concentrations of less than 0.5 mg/l of lead

TABLE 1
TCLP Extract Lead Concentrations for 10% lead samples
(lead conc. in mg/l)

% bagasse by wt. to cement	7 days cure	14 days cure	28 days cure
0	6.7 ± 1.3	4.9 ± 1.2	3.8 ± 0.5
5	1.0 ± 0.1	<0.5	<0.5

mental conditions. It is under these conditions that some solidified waste tends to leach. To each sample, a volume of TCLP leachant No. 2 (5.7 ml/l glacial acetic acid aqueous solution at pH 2.88) was added at a volume of 20 times the weight of the sample. The extraction period for the sample was 18 h under rotary agitation at 30 rpm. Subsequently,

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(limit of sensitivity) for all cure times, while samples containing no bagasse had extract concentrations of approximately 7 mg/l (7 days cure), 5 mg/l (14 days cure), and 4 mg/l (28 days cure) of lead. There is a significant decrease in the amount of lead leached with those samples containing bagasse, compared to those that did not, for all cure times studied. All bagasse samples are well below the EPA leaching standard for

(0.73 mg/l). The bagasse samples were able to stabilize the increased amount of lead added in the 15 per cent lead samples. Samples containing 20 per cent lead by weight to cement were also analyzed. Lead extract concentrations for all samples (no bagasse and bagasse) were extremely high. The small amount of water used in comparison to the large amount of lead nitrate yielded a saturated solution. It is suspected

cost and a relatively safe treatment process. Bagasse is a byproduct or residue of milling or diffusing sugar cane, and there is approximately 1.8 million tons produced annually in Louisiana. As for the treatment process, it is simple and does not require careful control. There are no toxic or flammable chemicals involved in the treatment process as compared to other adsorbents. Sugar cane is the major crop of the Louisiana region and utilization of one of its major by-products would help make it a stronger and more viable one. This process accomplishes this task while at the same time help to provide a safe sound method of disposing heavy metal hazardous waste.

% bagasse by wt. to cement	14 days cure	28 days cure
0	45 ± 3	53 ± 8
5	0.73 ± 0.29	<0.5

lead of 5 mg/l (Federal Register, 1986) while the control samples (no bagasse) fail at 7 days cure and are borderline at 14 and 28 days cure.

Experiments were also conducted with a higher lead loading to determine if using bagasse as an absorbent improves performance even at high lead concentrations. Results for samples containing 15 per cent lead are shown in Table 2. Samples containing 15 per cent lead by weight to cement and no bagasse had extremely high TCLP lead extract concentrations (45 mg/l) compared to the bagasse samples

that the high concentration of lead nitrate affected the cement hydration process, which may have saturated the chelating sites on the bagasse and left much of the lead in its ionic form causing higher lead extract concentrations.

Our efforts were aimed at designing a better matrix for solidification/stabilization of hazardous waste that would be effective while being economically feasible and safe to produce. This was accomplished with the use of bagasse. Bagasse used with cement enhanced the effectiveness of the cementitious system to contain lead. Solidification of lead with the aid of bagasse as an adsorbent reduces the leachability of lead allowing cement matrices formed to easily pass the EPA TCLP test, often by a considerable margin. Results indicate that using bagasse as an additive to cement is effectively improving the S/S of lead. Other metals (Cd, Cr, Hg, Ni) are expected to be effectively immobilized by bagasse; however, the answer will come from future studies.

The advantages of bagasse are the

Acknowledgments

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References

- APHA (1985) *Standard methods for the examination of water and wastewater*. 16th edition, American Public Health Association, Washington, DC.
- CERCLA (1980). *Comprehensive Environmental Response, Compensation and Liability Act of 1980*. PL 96-510.
- Chen, J.C. & Chou, C.C. (1993). *Cane sugar handbook*, 12th edition, John Wiley & Sons: New York, 375-98.
- Conner, J.R. (1990). *Chemical fixation and solidification of hazardous wastes*, Van Nostrand Reinhold, New York.
- Federal Register (1986). *Environmental Protection Agency - 40*

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CFR Parts 261, 271, and 302, 51, 21562021692 (No. 114, Friday, June 13, 1986).

Hanson, D.J. (1996). Toxics release inventory report shows chemical emissions continuing to fall. *Chemical & Engineering News*, July 15, 29-30.

Herubin, C.A., & Marotta, T.W. (1981). *Basic Construction Materials*, Reston Publishing, Virginia.

HSWA (1984). *Hazardous and Solid Waste Amendments*. PL 98-616.

Janusa, M.A., Bourgeois, J.C., Heard, G.E., Kliebert, N.M., & Landry, A.A. (1998). Effects of particle size and contact time on the reliability of toxicity characteristic leaching procedure for solidified/stabilized waste. *Microchem. J.*, 59, 326-332.

Janusa, M.A., Heard, G.E., Bourgeois, J.C., Kliebert, N.M., & Landry, A.A. (1998). Effects of curing temperature on the leachability

of lead undergoing solidification/stabilization with cement. *Microchem. J.*, 60, 193-197.

Janusa, M.A., Champagne, C.A., Fanguy, J.C., Heard, G.E., Laine, P.L. & Landry, A.A. (2000). Solidification/stabilization of lead with the aid of bagasse as an additive to Portland cement. *Microchem. J.*, in press.

Means, J.L., Smith, L.A., Nehring, K.W., Brauning, S.E., Gavaskar, A.R., Sass, B.M., Wiles, C.C., & Mashni, C.I. (1995). *The application of solidification/stabilization to waste materials*, Lewis Publishers, Florida.

RCRA (1976). *Resource Conservation and Recovery Act*. PL 94-580.

U.S. Environmental Protection Agency (1989). *Information resources directory of environmental acronyms, abbreviations, and glossary of terms*, Executive Enterprises, New York. [SJ]

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