

**HEAVY METAL CONCENTRATIONS OF
LEACHATE FROM FLY ASH FILLS IN LOUISIANA**

FINAL REPORT

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ABSTRACT

The Louisiana Department of Transportation and Development, having an acute awareness of the potential of landfilled industrial wastes to pollute groundwater, conducted a laboratory leachate experiment to determine if self-setting fly ash poses such a pollution problem.

Ten fly ash models were constructed, using fly ash samples taken from the two sources for the Louisiana DOTD, to determine whether leachable metals are available in self-setting fly ash to pollute groundwaters.

Chromium was the only trace metal leached out of the fly ash and even in this case, the leachate chromium concentration is only three times greater than the Environmental Protection Agency's National Interim Primary Drinking Water Standard. Data from this study indicates that the environmental reservations about using fly ash for backfill construction purposes should be reduced for self-setting fly ash.

IMPLEMENTATION STATEMENT

Laboratory results indicate additional research is required. The monitoring of groundwaters before and after the use of self-setting fly ash for road sections is necessary to determine if laboratory results are duplicated in construction.

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INTRODUCTION

The aim of this research was to use the Atomic Absorption furnace analysis technique to determine if heavy metals found in fly ash fills may enter the groundwater ecosystem and contaminate present or future potable water sources in Louisiana.

Previous leachate standard tests did not appear to be applicable for self-setting fly ash because of the imperviability to water of the hardened fly ash mass. If the hardened fly ash mass is crushed and sieved to 1 cm^3 samples, as the EPA standard test recommends, this would also be nonrepresentative of what would happen in the environment.⁽¹⁾ In this case, the water penetrates over one centimeter but not over ten centimeters even with prolonged water contact.

For low volume solid waste materials, an existing standard leachate test may be warranted, but for a high volume solid waste such as fly ash, the authors feel that more realistic leachate models should be constructed. These representative models would then more accurately predict what will actually take place in the environment, allowing construction engineers to make more informed decisions on the use or non-use of high volume solid wastes for road construction and maintenance.

SCOPE

The range of activity for this leachate study included the construction of two fly ash models for each of five water samples. A four to one ratio of water to hardened fly ash was allowed to interact for 120 hours with samples of leachate being withdrawn at 24 hours and 120 hours. Stabilized samples taken before interacting, at 24 hours of interacting, and at 120 hours of interacting, were analyzed for nickel, lead, chromium, magnesium, sodium, copper, and zinc.

PURPOSE

The purpose of this study was to obtain an accurate analysis of fly ash leachate quality in order to provide valuable information to the DOTD that could be used in deciding the suitability of fly ash for road sections in Louisiana.

METHODOLOGY

Deionized water, fresh water taken from the Amite River, low pH fresh water taken from Menace Creek, brackish water taken from Lake Pontchartrain, and sea water taken from Grand Isle were each used as the leaching medium in two laboratory models.

Fly ash samples were obtained from the two suppliers for Louisiana state projects. These samples, designated Source M and Source D, were used to make simulated road sections by mixing in 40% by weight of the water used for the leachate. The liquid mixture of fly ash and water was poured into the aquarium around a centered polyethylene beaker. The fly ash slurry was given a slope of about one inch from one end of the aquarium to the other end. Upon setting, the plastic beaker was removed, leaving a void for the teflon coated magnetic stirring bar (Figure 1). The water was collected and sealed in a clean black polyethylene 55-gallon drum (Figure 2). A 250 ml sample of water was taken from the drum and stabilized to a pH below 2 by adding 1% redistilled nitric acid. Then a mass of water equal to four times the mass of the fly ash was taken from the drum and added to each aquarium previously prepared with the simulated fly ash road section. The magnetic stirrers were started immediately and the leaching action was timed from the moment the water was added to each aquarium.

A 250 ml water sample was taken before the water was added to the aquarium, two 250 ml water samples were taken after the water had circulated in the two models for 24 hours, and two 250 ml water samples were taken after the water had circulated in the two models for 120 hours. Each water sample collected was immediately checked for pH, then stabilized to a pH below 2 by adding 1% redistilled nitric acid.

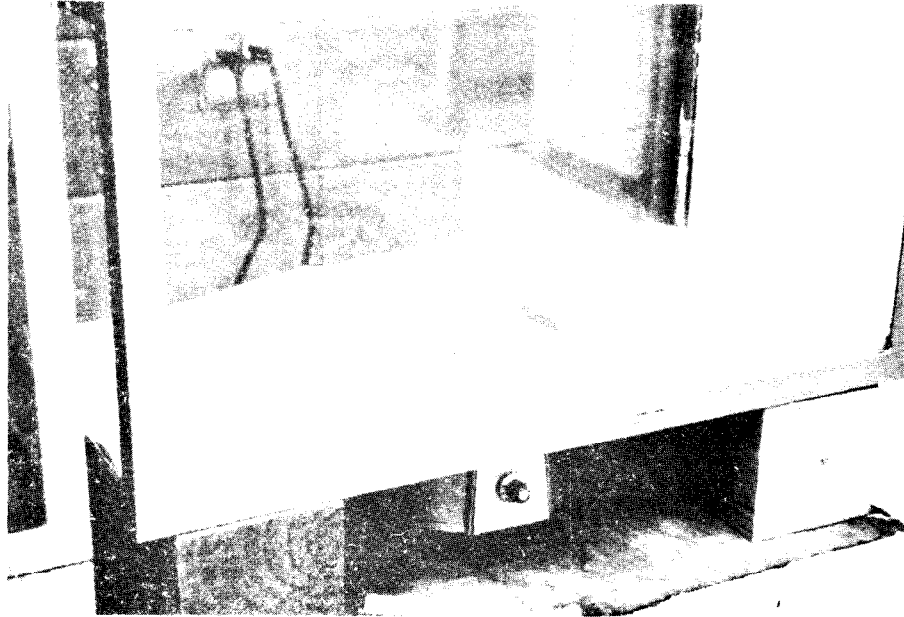


Figure 1
Teflon Coated Magnetic Stirring Bar

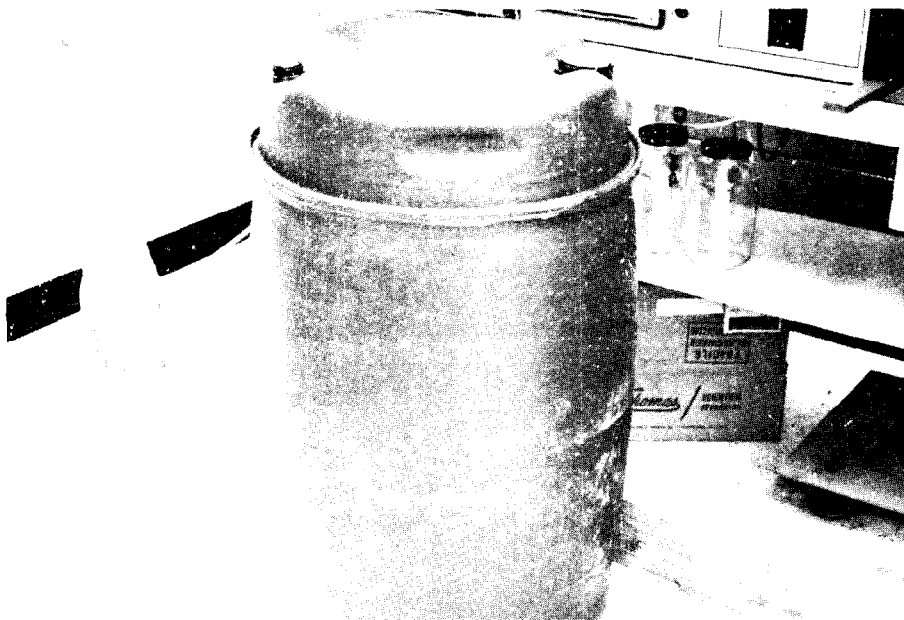


Figure 2
Black Polyethylene 55-Gallon Drum

Standards of 100 parts per million for zinc, nickel, lead, chromium, magnesium, sodium, and copper were purchased from a local environmental supply laboratory and diluted to the proper concentration range with ultra pure water obtained from the same laboratory. Each standard was stabilized to below a pH of 2 with 1% redistilled nitric acid. The samples and standards were run in at least triplicate on a model 4000 Perkin-Elmer Atomic Spectroscopy Instrument (Figure 3) equipped with an HGA-500 Graphite Furnace (Figure 4). Any values not within two standard deviation units were discarded and the average value was taken as the accepted value. Sodium, magnesium, and zinc metals were run on the above model Perkin-Elmer Atomic Spectroscopy Instrument equipped with a flame burner head, since their detection sensitivity was too great using the instrument in the graphite furnace mode.

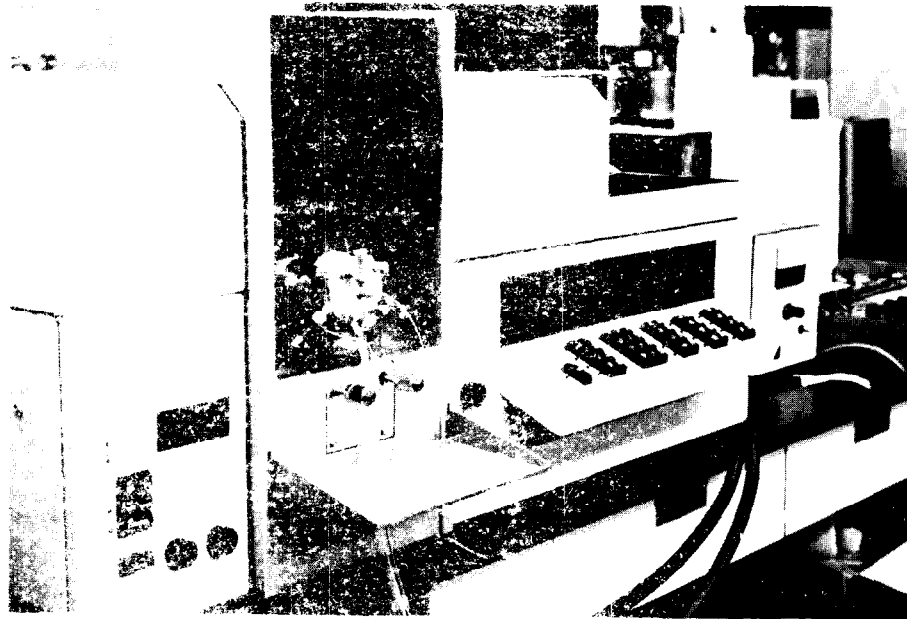


Figure 1

Figure 1. Laboratory Workstation for Atomic Spectroscopy Instrument

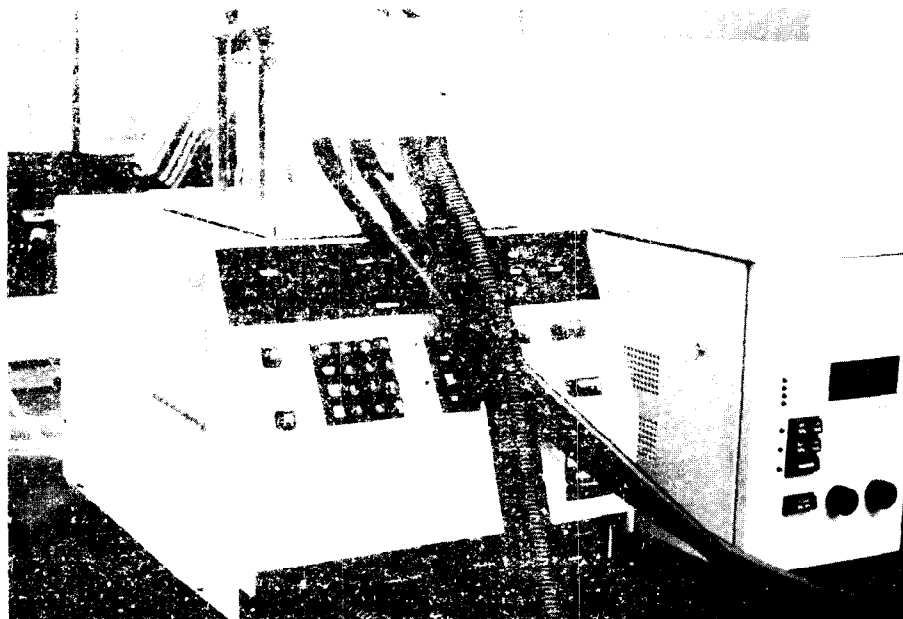


Figure 2

Figure 2. HGA-500 Graphite Furnace

DISCUSSION OF RESULTS

An accurate Atomic Absorption analysis of fly ash leachate quality was determined after the water had circulated in the two roadway section models for 24 hours and 120 hours. In each case the leachate contained a lower concentration of trace metals than would be expected for eastern fly ash.^(2,3) The results were expected, however, for self-setting fly ash since this type of fly ash has an imperviousness to water. Chromium was the only hazardous trace metal leached out of the fly ash and even in this case, the leachate chromium concentration is only three times greater than the Environmental Protection Agency's National Interim Primary Drinking Water Standard, Table VII.* This value was calculated by dividing the concentration by 5 since the EPA Leachate test uses a solid to liquid ratio of 1:20.⁽¹⁾ In terms of hazardous wastes, based on concentrations of trace metals leached under the EPA test, EPA considers 10 times the National Interim Primary Drinking Water Standards to be hazardous. One can readily observe this limited leaching trend in the leachate metal concentration by examining tables I through V. In addition, it is noted that tables I through V actually show a decrease in metal concentration for magnesium upon exposure of the water sample to self-setting fly ash.

Fly ash samples taken from the two sources used by the Louisiana Department of Transportation and Development were analyzed for Cu, Mg, Cr, Pb, Ni, Na, and Zn. The results are shown in table VI. These percentages indicate that the potential for ground water contamination is present if the metals found in the fly ash are leached out.

* All tables presented in the Appendix

The pH values for Amite River water, Menace Creek, Lake Pontchartrain, and Grand Isle were 7.4, 6.7, 7.2 and 7.1, respectively. Within 24 hours of leaching, the values had all increased to a pH of 10 or above. This increase in pH generally causes a decrease in concentration of metal ions in the leachate, and only materials that are soluble in basic solutions will be found in the leachate.⁽⁴⁾

CONCLUSIONS

The data derived from this research project shows that for the metals analyzed there is only limited leaching taking place. The consistency of this data with the physical properties of hardened fly ash is considerable and indicates that data from other leachate studies should be considered according to the physical and chemical properties of the solid waste. Certainly, data from this study indicate that studies carried out on eastern fly ash^(2,3) cannot be applied to self-setting fly ash. In addition, the environmental reservations about using fly ash for backfill construction purposes should be reduced for self-setting fly ash.

RECOMMENDATIONS

The recommendations generated by the data from this leachate study are as follows:

1. That previous leachate data obtained using eastern fly ash (ASTM Class F) not be used in considering the usability of western fly ash (ASTM Class C) for road construction.
2. That the potential which western fly ash may possess as a medium for reducing corrosion of enclosed structures should be investigated; in particular, investigate the oxidation state of the chromium ion being leached from self-setting fly ash, and if the chromium ion exist as the hexavalent chromate ion, determine at what concentration this ion starts providing corrosion protection.
3. That a field test be carried out to determine if the laboratory results are also true for real field situations.
4. That a laboratory leachate experiment be conducted to determine if self-setting fly ash in varying concentrations with other construction materials poses an environmental pollution problem.

APPENDIX

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TABLE I

FLY ASH LEACHATE USING DEIONIZED WATER

Elements	Deionized water	24 hours		120 hours	
	parts per billion	parts per billion		parts per billion	
		M	D	M	D
Nickel	0	0	0	0	0
Lead	0	0	0	0	0
Chromium	0	250	50	750	150
Magnesium	0	120	50	95	85
Sodium	0	118,750	78,250	350,000	200,000
Copper	0	2	2	4	2
Zinc	10	8	6	4	8

TABLE II

FLY ASH LEACHATE USING AMITE RIVER WATER

Elements	Amite River water	24 hours		120 hours	
	parts per billion	parts per billion		parts per billion	
		M	D	M	D
Nickel	3	2	2	4	2
Lead	6	4	2	13	18
Chromium	0	100	55	137	175
Magnesium	3300	1200	900	900	1050
Sodium	340,000	395,000	185,000	270,000	400,000
Copper	4	6	4	10	6
Zinc	7	5	4	5	3

TABLE III

FLY ASH LEACHATE USING MENACE CREEK WATER

Elements	Menace Creek water	24 hours		120 hours	
	parts per billion	parts per billion		parts per billion	
		M	D	M	D
Nickel	1	0	0	0	0
Lead	2	1	2	1	1
Chromium	2	66	14	36	28
Magnesium	720	380	900	90	110
Sodium	265,000	245,000	290,000	230,000	255,000
Copper	2	3	4	4	5
Zinc	7	3	4	3	3

TABLE IV

FLY ASH LEACHATE USING PONTCHARTRAIN LAKE WATER

Elements	Pontchartrain Lake water	24 hours		120 hours	
	parts per billion	parts per billion		parts per billion	
		M	D	M	D
Nickel	0	0	0	0	0
Lead	2	2	2	2	2
Chromium	0	72	50	125	70
Magnesium	222,000	71,000	44,000	8,000	25,000
Sodium	1,133,000	800,000	1,233,000	1,067,000	933,000
Copper	3	4	2	4	3
Zinc	9	8	8	8	8

TABLE V

FLY ASH LEACHATE USING GRAND ISLE WATER

Elements	Grand Isle water	24 hours		120 hours	
	parts per billion	parts per billion		parts per billion	
		M	D	M	D
Nickel	3	0	2	0	36
Lead	8	4	9	8	9
Chromium	0	169	95	231	140
Magnesium	1,750,000	1,200,000	1,200,000	1,150,000	950,000
Sodium	8,500,000	11,000,000	8,500,000	2,200,000	10,000,000
Copper	0	0	5	0	21
Zinc	5	4	4	4	4

TABLE VI

METAL CONTENT OF FLY ASH USED IN LEACHATE STUDY

METAL	SOURCE M (values in percentages)	SOURCE D (values in percentages)
Copper	.017	.014
Magnesium	.693	.281
Chromium	.006	.008
Lead	.006	.009
Nickel	.007	.009
Sodium	.782	.697
Zinc	.006	.018

TABLE VII

INORGANIC CHEMICAL PORTION OF THE
NATIONAL INTERIM PRIMARY DRINKING WATER STANDARDS

CONTAMINANT	DRINKING WATER LEVEL, MG/L
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium	0.05
Lead	0.05
Mercury	0.002
Selenium	0.01
Silver	0.05
Copper	1.0
Zinc	5.0

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