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ASSESSMENT OF RCRA/EP TEST RESULTS ON FBC RESIDUE

PART II - PROPOSED PROCEDURE IN FEDERAL REGISTER, Dec. 18, 1978

by

C. C. Sun and J. T. McAdams
Westinghouse R&D Center
Pittsburgh, PA 15235

Forward

[illegible] report prepared by the Westing[illegible] [illegible]opment Center is part of a major [illegible] [illegible] Industrial Environmental Research [illegible] Park), U.S. Environmental Prot[illegible] [illegible] impact of regulations developed [illegible] Disposal Act, as amended by the [illegible] [illegible]overy Act (RCRA) of 1976 on [illegible] [illegible]esidues. This report was not [illegible] [illegible]oring the extension of the com[illegible] [illegible]rocedure. This report prese[illegible] [illegible]ghouse from testing several FBC [illegible] [illegible]raction Procedure (EP) for [illegible] [illegible] 18, 1978 (43 FR 58956-57), [illegible] [illegible] should be noted that publicatio[illegible] [illegible]al Register does not signify [illegible] [illegible] necessarily reflect the views [illegible] [illegible] Protection Agency nor does [illegible] [illegible] products constitute endors[illegible] [illegible]use.

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1.0 INTRODUCTION

The federal laws having legislative power over the environmental impact of solid waste disposal are:

- Resource Conservation and Recovery Act (RCRA), 1976
  - Solid Waste Disposal Act, 1965
  - Resource Recovery Act, 1970
- Clean Water Act, 1977
  - Federal Water Pollution Control Act, 1972
  - Safe Drinking Water Act, 1974
- Clean Air Act Amendments, 1977
  - Clean Act Act, 1970
- Toxic Substances Control Act (TSCA), 1977
- Occupational Safety and Health Act (OSHA), 1970
- Marine Protection, Research and Sanctuaries Act, 1972.

The passage of RCRA closed the legislative loop of environmental laws (air/water/solid) and created a new level of control over solid waste disposal. Of special concern are the regulations to be promulgated under Subtitle C - Hazardous Waste Management.[1-4] Of the characteristics currently proposed for hazardous waste (ignitability, corrosivity, reactivity and toxicity), toxicity causes the most concern. Both the previously drafted March 1978 toxic extraction procedure (TEP)[2] and the recently proposed extraction procedure (EP)[3] were carried out on selected samples of the fluidized-bed combustion residues and reference solids. Results from the former tests (TEP) and recommendations were communicated to EPA.[1,4,5]

The results of EP tests are summarized here along with comments on the proposed procedures in the hope of providing EPA with useful information for its continued efforts to refine the extraction procedures and promulgate regulations.

2.0 BACKGROUND

Table 1 summarizes the history of regulation development under RCRA Sec. 3001, and efforts undertaken by Westinghouse accordingly. Table 2 lists the key differences among the previous draft versions and the proposed regulations (Fed. Reg. Dec. 18, 1978).

The results of Westinghouse efforts in testing the TEP procedures with residues from FBC processes and recommendations were summarized in an informal document entitled "Assessment of RCRA/TEP test results on FBC residue, Part I" and communicated to EPA in December of 1978.[4] This report represents continued effort with the proposed EP procedures.

Table 1 - RCRA 3001 REGULATION DEVELOPMENT

Draft Regulations	Proposed Regulations	Key Issues	Westinghouse Actions
March '78		Toxic Extraction Procedure, "TEP", drafted for hazardous waste identification	"TEP" initiated on selected samples • to assist RCRA Sec. 3001 development. • to provide initial indication of "hazardous" or "non-hazardous" nature of residues.
Sept. '78		TEP significantly modified, to be renamed extraction procedure, EP.	
Nov. '78	Dec. 18, 1978	• Extraction Procedure, "EP", proposed--significantly different than the previous "TEP". • A structural integrity test, "SIT" specified for monolithic block. • "Special Waste" Category created (including utility waste): subjected to partial exemption of hazardous waste regulations. • Advance notice for Proposed Rulemaking on radioactivity and bioassay.	"EP" initiated on selected FBC, reference materials and raw sorbents.

Table 2 - DEVELOPMENT OF EPA LEACH TEST

Parameters \ Draft Date	March '78	Sept. '78	Proposed in Fed. Reg. Dec. 18, 1978
Sample Size	Not specified	≥ 100 gm	≥ 100 gm
Sample Preparation	Grinding to 3/8"	Grinding to 3/8", or "SIT" hammer test on monolithic block	Same as Sept. '78
Leach Medium	Deionized water with NaOH or acetic acid added	Deionized Water with 0.5N acetic acid added	Same as Sept. '78
Titrating Agent	1N NaOH or 1:1 Acetic acid	0.5N Acetic Acid	Same as Sept. '78
Maximum Titration	No Limit	Maximum=4ml/gm solid	Same as Sept. '78
Final pH	4.9 - 5.2	4.9 - 5.2 or controlled by maximum acid allowed	Same as Sept. '78
Temperature	"Room Temperature"	20 - 30°C	20 - 40°C
Extraction Time	2 x 24 hr. = 48 hr. total	24 hr. Single extraction	Same as Sept. '78
Solid/Liquid Ratio	1:10 for each for each extraction, plus original liquor	1:20 plus original liquor	Same as Sept. '78
Agitator	Not specified	Not specified, but overhead stirring suggested	Same as Sept. '78

3.0 EXPERIMENT

3.1 Samples

Ten FBC residue samples were selected for preliminary RCRA/EP tests to include process variations: limestone/dolomite, AFBC/PFBC/adiabatic, bed/cyclone/additional filter. Untreated and treated FGD sludges, and a conventional coal ash were also tested for comparison. Raw sorbent and natural gypsum were tested in parallel to provide references.

3.2 Procedures and Equipments

The EP procedures as specified in the Federal Register December 18 were followed, allowing for the following interpretations or adjustments:

- "Representative Sample" - We used 25 g instead of 100 g because of the limited quantities of FBC solids available. Because of the granular nature of the solids, however, we believe that the samples (25 g) were representative.
- Neither the structural integrity test (SIT) nor the handling of liquor was required for FBC residue because of the nature of the solids (dry granular, <3/8 in).
- "Suitable extractor" - We used an Eberbach automatic shaker at its highest speed (140 excursions per min.) and found that it provided good solid/water mixing and prevented stratification. The high-speed shaker was selected also because of the following facts:

    - The suggested extractor by Associated Design and Manufacturing Co., Alexandria, VA was not commercially available[6] at the time we initiated the EP tests.

- Oak Ridge National Laboratories who were testing the EP procedures under contract to the EPA Office of Solid Waste designed and built their own extraction apparatus.[7]

- A Chemtrix Type 45A pH controller was used for automatic titration of some samples. Prior to obtaining the automatic titrator, we followed the manual pH adjustment procedures. Both performed satisfactorily.

3.3 Results

Table 3 summarizes the trace elements in the EP leachates and compare them to the criteria for hazardous waste, ten times the primary drinking water standards (DWS). None exceeded the criteria, thus all were nontoxic. Although lower than the criteria, EP leachates of the AFBC and PFBC fines (from the 3rd cyclone or the final filter) had Cr concentrations much higher than did the other leachates and were close to 10 x DWS. They, therefore, warrant special attention in future investigations. Similarly, Se in the EP leachates of conventional coal ash and FGD sludge was near 10 x DWS (0.1 ppm) and was much higher than the average Se concentrations found in the FBC leachates. Analyses for the chlorinated organic pesticides and herbicides which were also proposed in Sec. 3001 criteria were felt to be unnecessary.

Table 4 summarizes the characteristics of EP leachates in addition to the trace elements. As expected, the major species, such as Ca, SO_4, and TDS were high in the EP leachates of FBC residues. In most cases the maximum allowable acid (4 ml of 0.5N acetic acid per gram of solid) was reached so that the final pH was much higher than 5.

Table 3 - LEACHATE CHARACTERISTICS (TRACE ELEMENTS) FROM RCRA/EP TEST

Process Residue	Trace Elements, mg/ℓ									
	Ag	As	Ba	Cd	Cr	F	Hg	NO_3 (as N)	Pb	Se
AFBC bed	<0.04	0.001	<1	<0.01	0.09	<1	0.0005	<5	<0.04	0.001
AFBC carryover	<0.04	0.001	<1	<0.01	0.06	<1	0.0007	1.6	<0.04	<0.001
AFBC fines	<0.04	0.004	<1	<0.01	0.4	<1	0.0008	15	<0.04	0.01
PFBC bed	<0.04	0.002	<1	<0.01	<0.05	<1	0.0005	<1	<0.04	0.003
PFBC carryover	<0.04	0.002	<1	<0.01	0.06	<1	0.001	<1	<0.04	0.02
PFBC fines	<0.04	0.012	<1	0.045	0.35	<1	0.002	<1	<0.04	0.017
FGD untreated sludge	<0.04	0.069	<1	<0.01	<0.05	4.2	0.0013	≤1	<0.04	0.017
FGD stabilized sludge	<0.04	0.058	<1	<0.01	<0.05	1.7	0.001	≤1	<0.04	0.08
Conventional coal ash	<0.04	0.065	<1	<0.01	<0.02	<1	0.0006	<1	<0.04	0.02
Reference, natural gypsum	<0.04	0.001	<1	<0.01	<0.05	<1	0.0011	1.4	<0.04	<0.001
Reference, raw dolomite sorbent	<0.04	<0.001	<1	<0.01	<0.05	<1	0.0009	<1	<0.04	<0.001
Criteria: 10 x DWS (NIPDWR, 1976)	0.5	0.5	10.0	0.1	0.5	14 to 24	0.02	100.0	0.5	0.1

Table 4 - LEACHATE CHARACTERISTICS (MAJOR SPECIES) FROM RCRA/EP TEST

Process Residue	Total Volume 0.5N Acetic Acid Added/ml.	Final pH	Specific Conductance millimho/cm	Ca, mg/1	Mg, mg/1	$SO_4^{=}$, mg/1
AFBC bed	*100	11.99	12.2	3,144	0	2,192
AFBC carryover	*100	12	11.73	3,156	<10	902.5
AFBC fines	*100	10.7	7.04	2,416	28	1,000
PFBC bed**	*100	9-10.1	7.09-7.8	1,440-2,432	81-926	1,150-1,200
PFBC carryover**	*100	9.52-11.12	7.52-7.67	1,512-2,560	7.2-787.2	1,060-1,896
PFBC fines**	16-*100	5.02-9.2	4.91-7.1	472-1,520	446-931	1,395-2,800
FGD untreated sludge	*100	6.32	6.44	2,140	88	1,020
FGD stabilized sludge	88	5.35	5.55	1,744	64	737
Conventional coal ash	24	5.05	1.62	372	21	1,010
Reference, natural gypsum	11	5.02	2.19	600	<10	830
Reference, raw limestone sorbent	*100	6.82	6.32	2,120	0	<10
Reference, raw dolomite sorbent	95	5.08	4.64	776	460	>10

*Maximum allowable amount of 0.5N acetic acid allowed.
**Several samples were tested within each category.

4.0 DISCUSSIONS

Preliminary results indicated that the FBC waste would not be considered hazardous (Table 5). Neither would conventional coal ash and FGD sludge, based on test results of a single sample (which may or may not be representative). Although these results indicated that the FBC residue would not be hazardous, and, therefore, need not be subject to the regulations on "special waste category" under RCRA Sec. 3004, it should be pointed out that the proposed "special waste," utility wastes among the list, did not mention FBC residue. We recommend, therefore, that the FBC waste be added to the list of utility wastes that currently includes FGD, bottom ash, and fly ash.

In our previous communication to EPA[4], several difficulties encountered in testing TEP procedure were mentioned: the high concentration of acetic acid specified in TEP, the large amount of acid required to neutralize the highly alkaline FBC residue to reach pH-5, the extraction temperature, and the agitation mode. The first three situations were significantly improved by the new EP procedure, as shown on Table 2. Some uncertainty still exists as to what is a suitable extractor because "well-mixing" depends not only on the type of apparatus but also on the nature of the solids. In this test we found that a high-speed automatic shaker (e.g., 140 excursions/min) provided good mixing of the FBC solids.

Other questions may arise in the future, such as the compatability of biological testing with the acetic-based leachate, and the cost and reliability of the various specified procedures (mutagenicity, bioaccumulation, and radioactivity). We hope that the forthcoming report by Oak Ridge National Laboratories[8] on the RCRA-TEP and EP test results will provide some answers.

Table 5 - HAZARDOUS WASTE CRITERIA (RCRA SECTION 3001)

Characteristics	Status	Preliminary Indications FBC Residue	Comment
1. Ignitability	Proposed Dec. 18, 1978 in Fed. Reg. Scheduled to be promulgated Dec. 31, 1979.	no	
2. Corrosivity	Not intended to be static. To be reviewed periodically.	no	Current proposed regulations apply only to liquid waste pH ≥12 or ≤3. But proposed regulations may change.
3. Reactivity		no	"Sulfide bearing waste which can generate toxic gases"...or, "reacts violently with water".... Some uncertainty may arise from the interpretation of this qualitative statement, especially with regard to regenerative, PFBC residue.
4. Toxicity		no	Based on up-to-date results: "EP" leachates pass 10X primary DWS
5. Radioactivity	Advanced Notice for Proposed Rulemaking, Dec. 18, '78.		
6. Generic Activity	Comments/information invited.		
7. Bioaccumulation	To be proposed in Fed. Reg. no sooner than 1 yr. from		
8. Additional Aspects of Toxicity	the Advance Notice date, i.e., Dec. 18, '79.		

Finally, experts in the area differ in their opinions about the best approach to identifying hazardous waste: the "single-test" approach (which differentiates solid wastes into hazardous or nonhazardous) versus "multi-test" screening (which may classify wastes into degree of hazardousness). In the former approach, EPA-OSW has successfully formulated an Extraction Procedure to which we react favorably on the basis of our experience with FBC solids. On the other hand, because a waste can be hazardous or nonhazardous depending on where and how it is disposed of, an approach based on "degree of hazardousness" on a site-specific multi-test screening basis also requires serious consideration.

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