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Summary of Tank Waste Physical Properties at the Hanford Site

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Date Published
April 1994

Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

Westinghouse
Hanford Company

P.O. Box 1970
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Hanford Operations and Engineering Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

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New or novel (patentable) subject matter? ☒ No ☐ Yes If "Yes", has disclosure been submitted by WHC or other company? ☐ No ☐ Yes (Disclosure No(s)).		Information received from others in confidence, such as proprietary data, trade secrets, and/or inventions? ☒ No ☐ Yes (Identify)	
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			Name (printed) Signature Date
Classification/Unclassified Controlled Nuclear Information	☐	☒	S. W. BERGLIN <i>M. Boston for SWB</i> <i>Per telecon. 3/28/94</i>
Patent - General Counsel	☒	☐	
Legal - General Counsel	☒	☐	
Applied Technology/Export Controlled Information or International Program	☐	☒	
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Information conforms to all applicable requirements. The above information is certified to be correct.			
Yes No References Available to Intended Audience ☒ ☐ Transmit to DOE-HQ/Office of Scientific and Technical Information ☒ ☐ Author/Requestor (Printed/Signature) Date Q. H. Nguyen <i>Q. H. Nguyen</i> 3/28/94		INFORMATION RELEASE ADMINISTRATION APPROVAL STAMP Stamp is required before release. Release is contingent upon resolution of mandatory comments. <div align="center"> </div>	
Intended Audience ☐ Internal ☐ Sponsor ☒ External Responsible Manager (Printed/Signature) Date G. V. DeLisle <i>G. V. DeLisle</i> 3/28/94		Date Cancelled Date Disapproved	

Document Title: Summary of Tank Waste Physical
Properties at the Hanford Site

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EXECUTIVE SUMMARY

This report summarizes the physical parameters measured from Hanford Site tank wastes. Physical parameters were measured to determine the physical nature of the tank wastes to develop simulants and design in-tank equipment. The physical parameters were measured mostly from core samples obtained directly below tank risers. Tank waste physical parameters were collected through a database search, interviewing and selecting references from documents. This report shows the data measured from tank waste but does not describe how the analyses were done. This report will be updated as additional data are measured or more documents are reviewed.

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SUMMARY OF TANK WASTE PHYSICAL PROPERTIES AT THE HANFORD SITE

1.0 INTRODUCTION

The Hanford Site has 177 tanks for storage of waste. Out of those 177 tanks, 149 are single-shell and 28 are double-shell. Throughout the years, hazardous waste and materials were deposited in these tanks. The waste has formed layers of salt cake, sludge, and supernatant liquid in the physical forms ranging from solid to liquid. Tank waste has been characterized for physical and chemical properties through core samples. Only a subset of 177 tanks are characterized. Information contained in this report reflects some of the collected information on tank waste physical properties.

This summary report of tank waste physical properties arose from needs for tank waste characterization data for developing design criteria for choosing retrieval equipment and simulant development guidelines for development and testing of new technologies. Physical properties of tank waste must be known to design retrieval equipment properly, such as mixer pumps, transfer pumps, air conveyance systems, and a long reach manipulator arm. Simulants are needed to model the mechanics and behaviors of the real waste. Physical parameters need to be defined to simulate the actual tank waste accurately. The safety and success of new technologies depend heavily on the development of the simulants.

Work is being carried out to measure additional tank waste physical properties that are currently not available or not provided accurately through core sample measurement. Some of the frequently needed measurements of tank waste physical properties are included in the standard laboratory procedures for core samples analysis of various tanks. Both Westinghouse Hanford Company and Pacific Northwest Laboratory have their own laboratory test procedures to perform measurements of the tank waste physical parameters through core samples. Some of the frequently collected parameters are bulk density, weight percent of solid and liquid, volume percent of solid and liquid, pH, and settling velocity. In some instances, other measurements such as compressive strength and shear strength were also collected.

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2.0 PURPOSE AND OBJECTIVE

The purpose of this report is to summarize measured physical properties from tank waste at the Hanford Site through tank waste core samples analyses.

The objective of this task is to make information readily available to developers of technology; devices; and methods for the characterization, retrieval, or processing of tank waste.

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3.0 LIMITATIONS

The author does not guarantee that all information available on physical properties of tank waste is recorded in this report. However, every effort was made to ensure the accuracy of all data recorded. This report will be updated as additional physical properties of tank waste are measured or more documents are reviewed. Laboratory procedures used to measure the physical parameters of tank waste from Pacific Northwest Laboratory, Westinghouse Hanford Company, and Rockwell Hanford Operation are not described in this report, but they can be found in *Westinghouse Hanford Company and Pacific Northwest Laboratory Analytical Laboratory Procedures to Characterize Physical Properties of Waste* (Pushpa 1993) and *Laboratory Physical and Chemical Characterization of Hanford Wastes* (Mitchell 1980).

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4.0 METHODS OF SEARCH

A summary of tank waste physical parameters was made through the review of existing documents from Westinghouse Hanford Company, Pacific Northwest Laboratory, and Rockwell Hanford Operations. The documents were obtained by using a database from Westinghouse Hanford Company, contacting key personnel, and obtaining reference documents.

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5.0 RECORDED DATA

5.1 LIST OF TANKS RECORDED

The following is a list of all tanks recorded in this report.

Table 1. List of Tanks with Physical Parameters Recorded.

Tank Farm	Tank number
AZ	101
BX	102, 106, 107, 110, 111, 112
BY	101, 103, 104, 105, 106, 107, 112
C	108, 108, 109
SY	101, 102
T	101, 104, 107
TX	118
TY	101, 102, 103, 104, 105, 106

Note: Appendix A describes each physical parameter.

5.2 LIST OF PHYSICAL PROPERTIES AND UNITS

Table 2 shows a list of all physical parameters and their units. Units of all physical parameters listed in this report conform to this list unless otherwise indicated.

Table 2. Units of All Physical Parameters Used.

Parameter	Units
Boiling point	Celsius (°C)
Critical velocity	ft/s
Density	g/mL
Particle size	micron
Penetration resistance	μm
pH	pH
Settling rate	cm/h
Shear strength	dynes/cm ²
Specific gravity	g/mL
Radiation	rad/h
Vol%	percentage
Viscosity	centipoise
Weight	g
Wt%	percentage

TANK 241-AZ-101

Core #2 (Composite Solids and Supernate)

Date	Parameter	Value
2/6/90	pH	
	Composite solids	--
	Supernate	13.8
	Density	
	Composite solids	1.62
	Supernate	1.22
	Settling rate	0
	Vol% settled solids	100
	Vol% centrifuged solids	76
	Wt% centrifuged solids	81
	Centrifuged solids density	1.73
	Wt% total solids	57
	Wt% dissolved solids	5.37
	Wt% oxides	41
	Mean particle size	
	Based on population	1.2
	Based on volume	5.0
	Penetration resistance	
	0.25 in. dia. end	0.2
	1.00 in. dia. end	0.8
	Shear strength	15,000

(Peterson 1990).

Core #2 (Waste Dilutions)

Date	Parameter	60 wt% solids	30 wt% solids	10 wt% solids
2/6/90	pH	13.5	13.5	13.5
	Density	1.51	1.35	1.34
	Settling rate ^a	0	0.11	0.13
	Vol% settled solids ^b	100	77	56
	Vol% centrifuged solids	56	27	22
	Wt% centrifuged solids	67	36	29
	Centrifuged solids density	1.80	1.77	1.79
	Centrifuged supernate density	1.14	1.22	1.24
	Wt% dissolved solids	10.4	18.5	20.2
	Wt% total solids	47	41	NA

^aAverage over a 24-hour period.^bMeasured after 121 hours.

NA = Not analyzed.

(Peterson 1990).

TANK 241-BX-102

Date	Parameter	Value
9/30/74	Specific gravity	1.47
	% Water	49.3
	pH	14
	Radiation	1.5 rad/h
1/27/70	Specific gravity	1.03

(WHC 1993).

TANK 241-BX-106

Date	Parameter	Value
10/27/95	Specific gravity	1.37
	% Water	57.8
	pH	13.92
	Radiation	1 rad/h
3/16/90	Specific gravity	1.33
	% Water	63.8
	pH	--
	Radiation	--
12/4/74	Specific gravity	1.49
	% Water	43.4
	pH	>14.0
	Radiation	450 mrad/h
6/7/74	Specific gravity	1.19
	% Water	75.2
	pH	11.9
	Radiation	100 mrad/h
4/12/74	Specific gravity	1.21
	% Water	73.3
	pH	12.45
	Radiation	150 mrad/h

(WHC 1993).

TANK 241-BX-107

Parameter	Segment 1	Segment 2	Segment 3	Composite
Total weight (g)	806	625	748	--
Composite blend (g)	396	96	343	--
Archive (g)	68	51	76	--
Supernate (g)	--	265	--	--
Solids (g)	--	360	--	--
Percent water (wt%)	53.12	55.05	52.83	--
Bulk density	1.422	1.424	1.541	--
Particle density	1.834	2.190	2.726	--
Water solubility (wt%)	--	--	--	45.0
Thermal analysis	--	--	--	--

Segment 1: Yellow-brown salt cake matrix.

Segment 2: Salt cake matrix.

Segment 3: Salt cake matrix.

(Bratzel 1980).

TANK 241-BX-110

Date	Parameter	Value
3/16/90	Specific gravity	1.37
	% Water	56.6
	pH	12.5
9/18/80	Specific gravity	1.45
	% Water	51.9
2/14/79	Specific gravity	1.44
	% Water	42.0

(WHC 1993).

TANK 241-BX-111

Date	Parameter	Value
3/16/90	Specific gravity	1.44
	% Water	53.3
	pH	12.7

(WHC 1993).

TANK 241-BX-112

Parameter	Segment 1	Segment 2	Segment 3	Composite
Total weight (g)	224.63	494.68	517.09	--
Composite blend (g)	75	30	30	--
Archive (g)	61.60	47.65	66	--
Supernate (g)	--	--	--	--
Solids (g)	--	--	--	--
Percent water (wt%)	63.13	62.01	62.82	57.47
Bulk density	1.226	1.224	1.208	1.38
Particle density	1.446	1.395	1.347	1.953
Water solubility (wt%)	--	--	--	--
Thermal analysis	--	--	--	Endotherm 105 °C

Segment 1 = 6-in. sludge and 20-mL supernate.
 Segment 2 = 12-in. sludge and 50-mL supernate.
 Segment 3 = 14-in. sludge and 100-mL supernate.
 (Bratzel 1980).

TANK 241-BY-101

Date	Parameter	Value
8/16/72	Specific gravity	1.423
	% Water	94
	% Volume solids	--
	pH	11.2
	Boiling point	117 °C

(WHC 1993).

TANK 241-BY-103

Date	Parameter	Value
6/3/91	Specific gravity	1.45
	% Water	52
	pH	13.5
10/14/71	Specific gravity	1.469 @ 30 °C 1.479 @ 40 °C 1.494 @ 50 °C 1.500 @ 60 °C
	% Volume solids	22.0 @ 30 °C 14.8 @ 40 °C 8.90 @ 50 °C 1.50 @ 60 °C

(WHC 1993).

TANK 241-BY-104

Date	Parameter	Value
10/26/92	% Water pH	83.9 12.5
3/16/76	Specific gravity	1.61 Sludge 1.45 Supernate
	% Water	28.3 Sludge 48 Supernate

(WHC 1993).

TANK 241-BY-105

Date	Parameter	Value
3/16/76	Specific gravity % Water pH	1.39 54 13.3

(WHC 1993).

TANK 241-BY-106

Date	Parameter	Value
6/3/91	Specific gravity % Water pH	1.465 49.5 13.5
4/13/72	Specific gravity % Water	1.414 53.2
10/14/71	Specific gravity	1.453 @ 30 °C 1.484 @ 40 °C 1.484 @ 50 °C 1.478 @ 60 °C
	% Volume solids	19.6 13.2 5.2 0

(WHC 1993).

TANK 241-BY-107

Date	Parameter	Value
7/16/79	Specific gravity	1.449
	% Water	44.72
	pH	1.449

(MHC 1993).

TANK 241-BY-112

Date	Parameter	Value
4/4/72	Specific gravity	1.48 top solid 1.42 liquid 1.44 bottom solid
	% Water	50.5 bottom solid

(MHC 1993).

TANK 241-C-106

Date	Parameter	Segment 1	Segment 2	Segment 3	Composite
9/18/80	Total weight (g)	--	--	--	--
	Composite blend (g)	--	--	--	--
	Archive (g)	--	--	--	--
	Supernate (g)	--	--	--	--
	Solids (g)	--	--	--	--
	Percent water (wt%)	45.0	45.5	40.8	45.3
	Bulk density	1.220	1.324	1.579	1.365
	Particle density	0.727	1.082	1.495	1.121
	Water solubility (wt%)	48.7	83.9	50.7	69.4
	Thermal analysis	--	--	--	--

Segment 1 = 10-in. dark-brown sludge and 200-ml supernate.
 Segment 2 = 8-in. dark-brown sludge and 1-ml supernate.
 Segment 3 = 2-in. dark-brown sludge.
 (Bratze] 1980).

TANK 241-C-108

Date	Parameter	Value
9/19/75	Specific gravity	1.134
	% Water	81.94
	pH	11.8
	Radiation	50 mrad/h

(WHC 1993).

TANK 241-C-109

Date	Parameter	Value
9/19/75	Specific gravity	1.212
	% Water	73.54
	pH	12.5
	Radiation	300 mrad/h

(WHC 1993).

TANK 241-SY-101

Physical Properties of Convective Liquid (Herting 1992)
Segment 3

Parameter	32 °C	50 °C	65 °C	80 °C
Density (g/ml) bulk	1.60	1.59	1.60	1.59
Centrifuged supernate	1.49	1.51	1.51	1.51
Centrifuged solids	1.80	1.73	1.71	1.73
Vol% settled solid	71%	70%	68%	67%
Vol% centrifuged solids	35%	37%	27%	21%
Wt% centrifuged solids	40%	39%	30%	24%

Segment 8

Parameter	32 °C	50 °C	65 °C	80 °C
Density (g/ml) bulk	1.59	1.60	1.62	1.58
Centrifuged supernate	1.52	1.50	1.51	1.50
Centrifuged solids	1.70	1.75	1.85	1.81
Vol% settled solid	65%	66%	69%	72%
Vol% centrifuged solids	41%	39%	28%	24%
Wt% centrifuged solids	44%	43%	33%	28%

Segment 13

Parameter	32 °C	50 °C	65 °C	80 °C
Density (g/ml) bulk	1.61	1.59	1.59	1.57
Centrifuged supernate	1.51	1.47	1.50	1.53
Centrifuged solids	1.72	1.75	1.77	1.66
Vol% settled solid	72%	69%	76%	83%
Vol% centrifuged solids	44%	42%	31%	27%
Wt% centrifuged solids	47%	46%	34%	29%

Physical Properties of the Nonconvective Slurry (Herting 1992)

Segment 15

Parameter	32 °C	50 °C	65 °C	80 °C
Density (g/ml) bulk	1.65	1.64	1.62	1.60
Centrifuged supernate	1.55	1.51	1.52	1.49
Centrifuged solids	1.72	1.78	1.74	1.82
Vol% settled solid	94%	95%	90%	92%
Vol% centrifuged solids	60%	48%	43%	33%
Wt% centrifuged solids	63%	51%	46%	37%

Segment 19

Parameter	32 °C	50 °C	65 °C	80 °C
Density (g/ml) bulk	1.72	1.75	1.74	1.72
Centrifuged supernate	1.57	1.51	1.54	1.52
Centrifuged solids	1.76	1.82	1.84	1.85
Vol% settled solid	100%	95%	100%	100%
Vol% centrifuged solids	78%	73%	93%	57%
Wt% centrifuged solids	80%	77%	67%	62%

Note: Physical properties of convective liquid and nonconvective slurry measured on 8/21/92.

TANK 241-SY-102

Date	Parameter	Value
6/3/89	Shear strength	39,000
	Density	1.52 to 1.8
	Critical velocity (3-in.-diameter pipe)	
	1:1 Volume dilutions	1 ft/s
	2:1 Volume dilutions	0.58 ft/s
	Particle size	10 to 20

(Peterson 1989).

TANK 241-T-101

Date	Parameter	Value
8/1/89	Specific gravity % Water	1.2 69
10/27/75	Specific gravity % Water pH Radiation	1.3 66.5 13.0 900 mrad/h
3/25/74	Specific gravity % Water pH Radiation	1.31 65.3 12.35 200 mrad/h

(WHC 1993).

TANK 241-T-104

Date	Parameter	Segment 2	Segment 3	Segment 4	Segment 5
9/18/80	Total weight (g)				
	Composite blend (g)	166	371	290	273
	Archive (g)	54	59	71	69
	Supernate (g)	88	130	86	132
	Solids (g)	345	723	565	574
	Percent water (wt%)	57.0	58.8	58.2	60.6
	Bulk density	1.39	1.271	1.348	1.36
	Particle density	2.27	1.572	1.902	1.786
	Water solubility (wt%)	--	--	--	--
	Thermal analysis	--	--	--	--

WHC-EP-0756

Parameter	Segment 6	Segment 7	Segment 8	Segment 9	Composite
Total weight (g)					
Composite blend (g)	337	405	213	300	--
Archive (g)	55	79	75	44	--
Supernate (g)	113	113	68	54	--
Solids (g)	720	716	463	600	--
Percent water (wt%)	62.4	64.3	64.2	61.1	62.2
Bulk density	1.346	1.275	1.276	1.298	1.307
Particle density	1.810	2.184	1.439	1.201	2.413
Water solubility (wt%)	--	--	--	--	34.8
Thermal analysis	--	--	--	--	24.1

Segment 2 = 8-in. sludge.

Segment 3 = 5-in. dark-brown sludge.

Segment 4 = 16-in. sludge; two phases of solids

Segments 6 through 9 = No descriptions available.

(Bratzel 1980).

TANK 241-T-107

Date	Parameter	Value
8/1/89	Specific gravity	1.2
	pH	11.1
11/26/75	Specific gravity	1.13
	% Water	85.08
	pH	12.3
	Radiation	1 rad/h

(WHC 1993).

TANK 241-TX-118

Date	Parameter	Value
10/16/81	pH	12.3
2/13/76	Specific gravity	1.31
	% Water	60.88
	pH	13.2
2/12/76	Specific gravity	1.229
	% Water	71.3

(WHC 1993).

TANK 241-TY-101

Date	Parameter	Segment 3	Segment 4	Composite
9/18/80	Total weight (g)			--
	Composite blend (g)	--	250.9	--
	Archive (g)	--	66.7	--
	Supernate (g)	--	--	--
	Solids (g)	--	--	--
	Percent water (wt%)	52.12	37.27, ^a 26.82 ^b	--
	Bulk density	1.707	1.206, ^a 1.440 ^b	--
	Particle density	2.043	1.512, ^a 1.493 ^b	--
	Water solubility (wt%)	--	--	85.3 ^a 93.2 ^b
	Thermal analysis	--	--	--

^aSalt cake fraction.^bSludge fraction.

Segment 3 = 2-in. sludge; this was added to 135.5 g sludge portion #4 and blended.

Segment 4 = 2-in. brown sludge with white crystalline salt cake. (Bratzel 1980).

Date	Parameter	Value
7/8/87	Specific gravity	1.64
	pH	8.2
	Particle size	8.2 micron
	Viscosity	1,000 cP
12/6/82	Specific gravity	1.086
	% Water	90.8

(WHC 1993).

TANK 241-TY-102

Date	Parameter	Segment 2	Composite
9/18/80	Total weight (g)		
	Composite blend (g)	83.0	--
	Archive (g)	56.5	--
	Supernate (g)	73.5	--
	Solids (g)	210.5	--
	Percent water (wt%)	58.13	--
	Bulk density	1.51	--
	Particle density	3.16	--
	Water solubility (wt%)	--	73.8
	Thermal analysis	--	--

Segment 2 = 6 in. of white to rust-colored crystalline material.
(Bratzel 1980).

TANK 241-TY-103

Date	Parameter	Segment 3	Segment 4	Composite
9/18/80	Total weight (g)			
	Composite blend (g)	52	55	--
	Archive (g)	45	41	--
	Supernate (g)	151	26	--
	Solids (g)	132	131	--
	Percent water (wt%)	53.01	59.82	52.67
	Bulk density	1.74	1.67	1.50
	Particle density	2.37	3.09	2.18
	Water solubility (wt%)	--	--	80.0
	Thermal analysis	--	--	Exotherm 340 to 380 °C

Segment 3 = 6-in. sample.

Segment 4 = 4-in. yellow-brown sample with red coating at one end.
(Bratzel 1980).

Date	Parameter	Value
8/21/85	Specific gravity	1.7
	pH	11.05
	Particle size	10.25
	Viscosity	10,000
	Radiation	75 mR/h

(WHC 1993).

TANK 241-TY-104

Date	Parameter	Segment 1	Composite
9/18/80	Total weight (g)		
	Composite blend (g)	-	--
	Archive (g)	--	--
	Supernate (g)	--	--
	Solids (g)	--	--
	Percent water (wt%)	37.2	52.73
	Bulk density	1.57	1.41
	Particle density	1.64	0.849
	Water solubility (wt%)	--	--
	Thermal analysis	--	--

Segment 1 = No description.
(Bratzel 1980).

Date	Parameter	Value
8/12/85	Specific gravity	1.625
	pH	11.95
	Particle size	8.1 micron
	Viscosity	10,000 cP
	Radiation	1375 mR/h

(WHC 1993).

TANK 241-TY-105

Date	Parameter	Segment 1	Segment 3	Segment 4a	Segment 4b
9/18/80	Total weight (g)	261	185.8	525.1	290.0
	Composite blend (g)	102	44.4	--	--
	Archive (g)	73	74.1	--	--
	Supernate (g)	38	--	--	--
	Solids (g)	--	--	--	--
	Percent water (wt%)	45.4	15.8	28.0	10.83
	Bulk density	1.44	1.37	1.38	1.51
	Particle density	2.16	1.48	1.49	1.28
	Water solubility (wt%)	--	--	--	--
	Thermal analysis	--	--	--	--

Segment 1 = 8-in. dark-brown sludge.

Segment 3 = 5-in. dark-brown sludge.

Segment 4 = 16-in. of two-phase sludge. Top (a) phase was light brown with large crystals. Bottom (b) phase was dark brown and contained less percent water.

(Bratzel 1980).

Parameter	Segment 5	Composite
Total weight (g)	766.6	--
Composite blend (g)	440.2	--
Archive (g)	73.0	--
Supernate (g)	--	--
Solids (g)	--	--
Percent water (wt%)	13.2	37.07
Bulk density	1.52	2.17
Particle density	1.36	1.36
Water solubility (wt%)	--	74.2
Thermal analysis	--	No exotherm

Segment 5 = 20-in. sludge; granular-sized particles throughout sample.

(Bratzel 1980).

TANK 241-TY-106

Date	Parameter	Composite
9/18/80	Total weight (g)	--
	Composite blend (g)	--
	Archive (g)	--
	Supernate (g)	--
	Solids (g)	--
	Percent water (wt%)	35.5
	Bulk density	1.86
	Particle density	1.63
	Water solubility (wt%)	68.8
	Thermal analysis	--

(Bratzel 1980).

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APPENDIX A

DESCRIPTION OF RECORDED PHYSICAL PARAMETERS

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DESCRIPTION OF RECORDED PHYSICAL PARAMETERS

Apparent viscosity--Viscosity of a fluid defined as a ratio of the shear stress (at a particular shear rate) and the shear rate.

Bulk density--Determined on a centrifuged, solid waste sample by measuring the mass to volume ratio (including void spaces).

Compressive strength--The greatest strain that a specimen can maintain when subjected to stress in a single direction, usually in an axial direction in the case of a cylindrical specimen.

Density or specific gravity--Density is the mass per unit volume; specific gravity is the ratio of the density of the sample and a reference material.

Drainable liquor--Drainable liquor analyses determine the volume of liquid collected from the core sampler during sample breakdown in the hot cell.

Interstitial solution--The solution contained within the original sludge sample.

Particle density--Determined using the dried sample from the percent moisture analysis. Particle density is calculated by the addition of specified volume of normal paraffin hydrocarbon to the dried sample (to correct for void volume) and measuring the mass to volume ratio.

Particle shape--The form of a particle.

Particle size--The dimension of a particle.

Particle size distribution--Will be conducted on the sludge sample to determine the population distribution of particle size ranges.

Penetration resistance--The minimum force per unit area required to penetrate a material.

Percent moisture--Percent moisture analyses will be determined on both the solid waste and drainable liquor samples. After centrifugation of sludge samples to decant drainable liquor, percent moisture was previously determined by the weight loss after heating the sample for at least 8 hours at 110 °C in a laboratory oven.

pH--A measure of the acidity or alkalinity of a solution. $\text{pH} = \log[\text{H}^+]$. pH is applicable to aqueous solutions or slurries only.

Physical appearance--The physical state (solid, liquid, sludge, slurry), color, and consistency.

Salt cake--A solid consisting mainly of sodium salts, which is sometimes layered over the sludge. A major radioactive element is cesium.

Shear strength--The maximum shear stress that a material can withstand without rupture. The ability of material to withstand shear stress.

Sludge--Wet solids having little or no standing liquid, i.e., mudlike. Sludge, which has settled on the bottom of the tanks, consists of iron, aluminum, and other insoluble components.

Slurry--A combination of liquid and suspended solid waste. Its major radioactive components include cesium, strontium, and transuranic waste containing components such as plutonium, neptunium, americium, and curium.

Softening point-- The temperature at which a solid-phase sample begins to "flow."

Solids settling rate--The rate at which the solids in a homogenized sample settle.

Solution--A liquid phase containing dissolved material.

Supernate--A liquid form of tank waste that is located at the top of the other waste forms. Like salt cake, its main component is sodium salts; a major radioactive element is cesium.

Thermal analysis--A group of techniques in which a physical property of a substance is measured as a function of temperature while the substance is subjected to a controlled-temperature program.

Thermal conductivity--The measure of the heat flow across a surface per unit area per unit time, divided by the negative of the rate of change of temperature with distance in a direction perpendicular to the surface.

Viscosity--Viscosity analyses will be performed on both the drainable liquor and phase sample as a function of temperature.

Vol% Centrifuged solids--The percentage of the volume of the sample that the solids occupy after being centrifuged for a specific time and force.

Vol% Settled solids--The percentage of the sample volume occupied by the settled solids .

Water solubility--Water solubility analyses will quantitatively and qualitatively determine chemical and radionuclide constituents that are water soluble upon contacting a fraction of the sludge with deionized water.

Wt% Centrifuged solids--The percentage of the sample mass occupied by the solids after being centrifuged.

Wt% Dissolved solids--The percentage of the sample mass dissolved in the aqueous portion of the sample.

Wt% Total oxides--The percentage of the sample mass that remains after converting all nonvolatile elements to oxides.

Wt% Total solids--The percentage of the sample mass that remains after removing volatiles, including free water by drying at 105 ± 5 °C for 24 hours.

Yield stress--The minimum stress required to initiate fluid movement.

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