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Retrieved Waste Properties and High-Level Waste Critical Component Ratios for Privatization Waste Feed Delivery

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U.S. Department of Energy Contract DE-AC06-96RL13200

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Abstract: The purpose for this document is to provide the basis for the retrieved waste properties and high-level waste critical component ratios specified in the System Specification for the Double-Shell Tank System.

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RETRIEVED WASTE PROPERTIES AND HIGH-LEVEL WASTE CRITICAL COMPONENT RATIOS FOR PRIVATIZATION WASTE FEED DELIVERY

February 1998

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CONTENTS

LIST OF TERMS

DOE	U.S. Department of Energy
HLW	High-level waste
TWRS	Tank Waste Remediation System
TWRSO&UP	Tank Waste Remediation System Operation and Utilization Plan

RETRIEVED WASTE PROPERTIES AND HIGH-LEVEL WASTE CRITICAL COMPONENT RATIOS FOR PRIVATIZATION WASTE FEED DELIVERY

1.0 INTRODUCTION

The purpose for this document is to provide the basis for the retrieved waste properties and high-level waste (HLW) critical component ratios specified in the *System Specification for the Double-Shell Tank System* (Grenard and Claghorn 1998).

2.0 WASTE PROPERTIES

The system shall be capable of retrieving from double-shell tanks, during Privatization Phase 1B, wastes having the following initial properties:

2.1 SUPERNATANT

The waste properties provided below are only for the supernatant phase with few or no solids present.

2.1.1 Supernatant Density

Density: 1 - 1.57 g/mL

Basis: dilute transfers will be ~ 1.0 g/mL, upper density from *Tank Characterization Report for Double-Shell Tank 241-SY-101* (Herting et al. 1995).

2.1.2 Supernatant pH

pH: 8 - 14+

Basis: A pH of 8 is the minimum allowed per *Data Quality Objectives for Tank Farm Waste Compatibility Program* (Mulkey 1997). Free hydroxide concentrations up to 10 $\underline{M}$ (pH 14+) are specified as acceptable in *Data Quality Objectives for Tank Farm Waste Compatibility Program* (Mulkey 1997).

2.1.3 Supernatant Sodium Concentration

Sodium: Up to 14.5 Molar

Basis: 14.5 is the soluble Na molarity of Tank AN-103 per the *Tank Waste Remediation System Operation and Utilization Plan* (TWRSO&UP) (Kirkbride et al. 1997).

2.2 SOLUBLE WASTE

The waste properties provided below are for settled slurries produced by evaporation of dilute wastes (primarily double-shell slurry and double-shell slurry feed). These slurries consist primarily of precipitated sodium salts and tend to be highly soluble in dilute aqueous solutions.

2.2.1 Waste Slurry Solubility

Solubility: Assuming intimate mixing with dilution water, a majority of the soluble waste will dissolve rapidly. At dilution ratios of up to 1:1 (parts water:parts waste), the resulting solution will likely contain <3.5 wt% undissolved solids. Tank 241-AN-105 dissolution kinetics tests (Herting 1997) indicate that, with intimate mixing, soluble waste dissolution occurs within 4 minutes or less. The undissolved (water insoluble) solids will typically consist of oxalate salts, silicon, chromium oxide/hydroxide, and iron oxide.

Basis: *Results of Dilution Studies with Waste from Tank 241-AN-105* (Herting 1997); TWRSO&UP (Kirkbride et al. 1997); *Test Plan for Tank 241-AN-104 Dilution Studies* (Herting 1998a), *Test Plan for Tank 241-AW-101 Dilution Studies* (Herting 1998b).

2.2.2 Soluble Waste Settled Solids Shear Strength

Shear Strength: 6.9 Pa at 300 s^{-1} (undiluted settled solids, 45 °C)
3.0 Pa at 300 s^{-1} (undiluted whole tank composite, 45 °C)

Basis: *Results of Dilution Studies with Waste from Tank 241-AN-105* (Herting 1997).

2.2.3 Soluble Waste Settled Solids In Situ Apparent Viscosity

Apparent Viscosity: 10,000 to 10,000,000 cP (in situ, unmixed)

Basis: *In Situ Rheology and Gas Volume in Hanford Double-Shell Waste Tanks* (Stewart et al. 1996).

2.2.4 Soluble Waste Settled Solids Yield Stress

Yield Stress: <500 Pa (in situ, unmixed)

Basis: Upper value extrapolated from *In Situ Rheology and Gas Volume in Hanford Double-Shell Waste Tanks* (Stewart et al. 1996), Figure 5.8. Applicable to tanks 241-AN-103, 241-AN-104, 241-AN-105, 241-AW-101, and 241-SY-103.

2.3 INSOLUBLE WASTE

The waste properties provided below are for settled slurries usually produced by neutralization of acid waste streams generated during fuel reprocessing. The solids in these slurries are primarily metal oxides and hydroxides and are relatively insoluble in water solutions. Some components (primarily aluminum) are soluble in concentrated sodium hydroxide solutions.

2.3.1 Insoluble Waste Shear Strength

Shear Strength: 210 to 5360 Pa

Basis: Shear strength of HLW sludge in tanks 241-AZ-101 and 241-AZ-102 as listed in TWRSO&UP (Kirkbride et al. 1997), Table 3.4-10.

3.0 HIGH-LEVEL WASTE SLUDGE WASHING CRITICAL COMPONENT RATIOS

The system design goal is to optimize the pretreatment process, such that it provides for the greatest benefit to the U.S. Department of Energy (DOE) in terms of life-cycle cost minimization and contract compliance. Specific critical component ratios to be targeted can not be quantified at this time. They will be developed after information is received from the Privatization Contractors in their Phase 1A deliverables (e.g, Technical Reports) and the final Phase 1B contract.

The critical component ratios will then be established and the pretreatment process can be optimized to approach the targeted compositions, while remaining within contractual requirements. The critical component ratios to be targeted will be identified in the next revision of *Alternatives Generation and Analysis for the Phase I High-Level Waste Pretreatment Process Selection* (Manuel 1997).

A number of HLW feed components are currently outside Envelope D specifications. After pretreatment these will be within the envelope but a number of them are expected to be near (within 20 percent) a minimum or maximum limit. These include Ag, Al, Fe, Mn, Na, Ni, Pb, S, U, and Zr. In addition, some feed components are critical in producing HLW glass but due to their expected concentrations do not approach Envelope D limits. These components include B, Ca, Cr, K, Li, and Mg. Several radionuclides including ^{241}Am, ^{137}Cs, ^{60}Co, ^{154}Eu, ^{155}Eu, ^{239}Pu, ^{241}Pu, ^{106}Ru, and ^{90}Sr are critical to determine gamma and neutron dose rates for operations in the vitrification facility and for the product canisters.

4.0 REFERENCES

DOE-RL, 1996, *TWRS Privatization Request for Proposals,* Solicitation DE-RP06-96RL13308, U.S. Department of Energy, Richland, Washington.

Grenard, C. E., and R. D. Claghorn, 1998, *System Specification for the Double-Shell Tank System*, HNF-SD-WM-TRD-007, Rev. C, Numatec Hanford Corporation, Richland, Washington.

Herting, D. L., T. L. Welsh, R. W. Lambie, T. T. Tran, 1995, *Tank Characterization Report for Double-Shell Tank 241-SY-101,* WHC-SD-WM-ER-409, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Herting, D. L., 1997, *Results of Dilution Studies With Waste From Tank 241-AN-105*, HNF-SD-WM-DTR-046, Rev. 0, Numatec Hanford Corporation, Richland, Washington.

Herting, D. L., 1998a, *Test Plan for Tank 241-AN-104 Dilution Studies*, HNF-1863, Rev. 0, Numatec Hanford Corporation, Richland, Washington.

Herting, D. L., 1998b, *Test Plan for Tank 241-AW-101 Dilution Studies*, HNF-2239, Rev. 0, Numatec Hanford Corporation, Richland, Washington.

Kirkbride, R. A., G. K. Allen, P. J. Certa, A. F. Manuel, R. M. Orme, L. W. Shelton, E. J. Slaathaug, R. S. Wittman, and G. T. MacLean and D. L. Penwell (SESC), 1997, *Tank Waste Remediation System Operation and Utilization Plan*, HNF-SD-WM-SP-012, Rev. 0, Vol. I and II, Numatec Hanford Corporation, Richland, Washington.

Manuel, A. F., 1997, *Alternatives Generation and Analysis for the Phase I High-Level Waste Pretreatment Process Selection*, HNF-SD-TWR-AGA-003, Rev. 0, Numatec Hanford Corporation, Richland, Washington.

Mulkey, C. H., 1997, *Data Quality Objectives for Tank Farms Waste Compatibility Program*, HNF-SD-WM-DQO-001, Rev 2, Lockheed Martin Hanford Corporation, Richland, Washington.

Stewart, C. W., J. M. Alzheimer, M. E. Brewster, G. Chen, R. E. Mendoza (WHC), H. C. Reid, C. L. Shepard, and G. Terrones, 1996, *In Situ Rheology and Gas Volume In Hanford Double-Shell Waste Tanks*, PNNL-11296, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.

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APPENDIX A

SELECTED PAGES FROM CITED BASIS DOCUMENTS

- *Tank Waste Remediation System Operation and Utilization Plan* (Kirkbride et al. 1997), pages A-3 through A-5
- *Data Quality Objectives for Tank Farms Waste Compatibility Program* (Mulkey 1997), pages A-6 through A-7
- *TWRS Privatization Request for Proposals* (DOE-RL 1996), pages A-8 through A-9
- *Results of Dilution Studies With Waste From Tank 241-AN-105* (Herting 1997), pages A-10 through A-14
- *In Situ Rhelology and Gas Volume In Hanford Double-Shell Waste Tanks* (Stewart et al. 1996) pages A-15 through A-21.

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Table 3.1-8. Low-Activity Waste Feed Processing Sequence.

Tank	Waste Type	Waste Envelope	Projection Quality	Borderline Classification?	% Margin, Limiting Species	Feed Available (Static Date or Date of Projection)	(Na), (M) Soluble	SpG Bulk	Volume, (L) Bulk	Dilution Ratio Final:Original Volume	Liquid Phase Fraction Included In Target	Solid Phase Fraction Included In Target
Projections							Targeted Feed					
AZ-102	NCAW->B		H			01-93	2.5	1.11	3.40E+06	1.00	1.0	-
AY-101			M			03-97	2.3	1.11	4.01E+05	1.00	1.0	-
AW-105	NCRW		L			06-96	0.4	1.03	1.53E+06	1.00	1.0	-
AY-102			L			11-98	0.9	1.06	3.65E+06	1.00	1.0	-
AP-106			L			01-99	2.2	1.11	6.63E+05	1.00	1.0	1.0
AW-103	NCRW		L			08-98	4.3	1.23	3.88E+06	1.00	1.0	-
AW-104			L			10-99	5.6	1.27	3.83E+06	1.00	1.0	-
AP-101			L			04-99	7.7	1.35	4.18E+06	1.11	1.0	-
AN-101	DSSF		L			12-99	9.6	1.38	4.23E+06	1.37	1.0	1.0
AP-105			L			06-98	9.1	1.50	3.85E+06	1.30	1.0	-
AW-106			L			12-99	6.1	1.3	7.43E+05	1.00	1.0	-
AW-101	DSSF	A	H			01-93	10.2	1.50	4.27E+06	1.58	1.0	1.0
AN-105	DSSF	A	H	Y	18% TOC_{max}	01-93	11.5	1.50	4.13E+06	1.35	1.0	1.0
AN-104	DSSF	A	H	Y	8% $SO4_{max}$	01-93	12.7	1.58	3.77E+06	1.51	1.0	1.0
AN-103	DSS	A	H	Y	17% Al_{max}	01-93	14.5	1.59	3.69E+06	1.82	1.0	1.0
AZ-101	NCAW	B	H			01-93	4.9	1.22	3.19E+06	1.00	1.0	-
AN-102	CC	C	H			01-93	11.3	1.42	4.07E+06	1.62	1.0	-
AN-106		C	M			07-99	8.5	1.33	4.32E+06	1.22	1.0	1.0
SY-101	CC	C	H			01-93	14.1	1.65	4.28E+06	2.02	1.0	1.0
AP-102		C	H	Y	3% TOC_{min}	10-99	4.4	1.19	1.04E+05	1.00	1.0	1.0
AP-103	CP	C	H	Y	19% TOC_{min}	10-99	4.5	1.19	4.16E+06	1.00	1.0	1.0
SY-102		C	L			01-00	5.3	1.20	1.27E+06	1.00	1.0	-
AP-107		C	L			11-99	5.8	1.23	1.06E+05	1.00	1.0	1.0
AP-104	DC	C	L	Y	7% $^{99}Tc_{max}$	01-00	5.9	1.23	4.05E+06	1.00	1.0	1.0
AP-108		C	L			07-99	7.8	1.27	6.50E+05	1.11	1.0	1.0
AN-107	CC	C	H	Y	19% TRU_{max}	10-97	9.3	1.37	4.26E+06	1.33	1.0	-
SY-103	CC	C	H	Y	7% Al_{max}	01-93	11.2	1.49	2.79E+06	1.60	1.0	1.0
AW-102		C	L			11-99	5.4	1.2	8.41E+05	1.00	1.0	-

Tank	Liquid Phase (Na), (M)	Bulk SpG	Solids, wt% (Estimate)	Volume, (L)	Na, (MT)	Description of Retrieved Feed	Description of Waste Excluded from Retrieval	Incremental Insertion	Mixer Pump(s)	Mobilize with Slurry Distributors in Recirc. Loop	In-Line Dilution	Supernate\Slurry Transfer or Decant Pump	Retrieval Difficulty Score	Early Retrieval Desirability	Desired Processing Sequence	Tank
	Retrieved Feed				Projections			Retrieval Equipment					Sequencing			
AZ-102	2.52	1.11		3.40E+06	197	Supernate	0.35 - .88 ML Fluffed Sludge.					x	1.00	0	5	AZ-102
AY-101	2.26	1.11		4.01E+05	21	Supernate	0.31 ML Sludge					x	1.00	3		AY-101
AW-105	0.44	1.03		1.53E+06	15	Supernate	1.12 ML Sludge					x	1.00	6		AW-105
AY-102	0.86	1.06		3.65E+06	72	Supernate	.71 - 1.78 ML Fluffed Sludge					x	1.00	6		AY-102
AP-106	2.19	1.11	1.08%	6.63E+05	33	Supernate - Entire tank	-					x	1.00	6		AP-106
AW-103	4.34	1.23		3.88E+06	388	Supernate	1.37 ML Sludge					x	1.00	6		AW-103
AW-104	5.58	1.27		3.83E+06	491	Supernate	0.68 ML Sludge & 0.42 ML salts					x	1.00	6		AW-104
AP-101	7.00	1.31		4.63E+06	745	Supernate - Entire Tank	-				x	x	2.00	6		AP-101
AN-101	7.00	1.27	0.01%	5.82E+06	937	Slurry - Entire Tank	-		x		x	x	3.58	6		AN-101
AP-105	7.00	1.38		5.00E+06	805	Slurry - Entire Tank	-		x		x	x	3.58	6		AP-105
AW-106	6.07	1.26		7.43E+05	104	-	-	-	-	-	-	-	-	9		AW-106
AW-101	6.50	1.32	3.41%	6.73E+06	991	Slurry - Entire Tank	-		x		x	x	3.58	3	3	AW-101
AN-105	8.50	1.37	0.09%	5.58E+06	1090	Slurry - Entire tank	-		x		x	x	3.58	6	1	AN-105
AN-104	8.40	1.39	0.21%	5.70E+06	1100	Slurry - Entire tank	-		x		x	x	3.58	6	2	AN-104
AN-103	8.00	1.32	0.14%	6.71E+06	1234	Slurry - Entire tank	-	x	x		x	x	4.81	6	4	AN-103
AZ-101	4.90	1.22		3.19E+06	359	Supernate	0.25 - 0.62 ML Fluffed Sludge					x	1.00	0	5	AZ-101
AN-102	7.00	1.26		6.59E+06	1060	Supernate	0.34 ML Sludge				x	x	2.00	1	8	AN-102
AN-106	7.00	1.27	0.49%	5.27E+06	846	Supernate	0.05 ML Sludge				x	x	2.00	3	9	AN-106
SY-101	7.00	1.32	0.12%	8.64E+06	1390	Soluble Portion - Entire Tank	Insoluble portion.		x		x	x	3.58	3	10	SY-101
AP-102	4.44	1.19		1.04E+05	11	Supernate - Entire tank	-					x	1.00	6		AP-102
AP-103	4.55	1.19	0.04%	4.16E+06	435	Supernate - Entire tank	-					x	1.00	6		AP-103
SY-102	5.29	1.20		1.27E+06	155	Supernate	0.27 ML Sludge					x	1.00	6		SY-102
AP-107	5.83	1.23	0.01%	1.06E+05	14	Supernate - Entire tank	-				x	x	2.00	6		AP-107
AP-104	5.93	1.23	0.01%	4.05E+06	552	Supernate - Entire tank	-					x	1.00	6		AP-104
AP-108	7.00	1.24	0.01%	7.25E+05	117	Supernate - Entire tank	-					x	1.00	6		AP-108
AN-107	7.00	1.28		5.68E+06	913	Supernate	0.51 ML Sludge				x	x	2.00	6	6-7	AN-107
SY-103	7.00	1.31	0.58%	4.48E+06	718	Soluble Portion - Entire Tank	Insoluble portion.		x		x	x	3.58	6	11	SY-103
AW-102	5.39	1.22		8.41E+05	104	-	-	-	-	-	-	-	-	9		AW-102

Early Retrieval Desirability Matrix

Look-up table breakpoints for Retrieval Difficulty	Projection Quality* H	M	L	-	
0	9	9	9	9	Waste not retrieved
0.5	0	3	6	9	Pump only
1.5	1	3	6	9	Pump w/dilution water
2.5	2	4	6	9	Pump w/dilution water and slurry dist.
3.1	3	4	6	9	Mixer w/anything but incremental
4.05	5	5	6	9	Incremental w/anything but mixer
4.6	5	5	6	9	Incremental & mixer w/anything.

*Tanks with Borderline Envelope Classification are treated as having L Projection Quality

SORT ORDER: This list is sorted by Envelope, Early Retrieval Desirability (more desirable first), and then Target Bulk SpG (increasing).

Retrieval Difficulty Score: Larger values are more difficult.
Early Retrieval Desirability: Smaller values are more desirable.

DATA SET IDENTIFICATION		
HTWOS RUN NUMBER:		data
HTWOS RUN DATE:		9/5/97 3:42:24 p.m.
SNAPSHOT DATE:		6/2/00
9/5/97	Case 09	Base Case For Phase 1

Desired Processing Sequence: This sequence differs from the sort order to reflect constraints such as minimum and maximum order quantity, ISSTRS receiver tank in AN-Farm, DST space considerations, necessity of bootstrap transfers, etc.

Notes:

1) This is a snapshot of the projected DST contents on 6/2000 for the purposes of establishing the LAW Feed Delivery Sequence.

2) Mass balances that include heels remaining in the cross-site transfer origin tank, pre-staging tanks and intermediate staging tanks and the private contractors feed tanks are not reflected in this table.

3) The PHMC Team is refining the operating scenario to satisfy the minimum order quantities of Envelope A feed and the maximum combined order quantities for Envelopes A, B and C. Additionally, the DOE/WIT are working on refining the Envelopes to reclassify a significant amount of Envelope C waste as Envelope A waste.

Table 3.4-10. Shear Strength of Phase I Sludges.

Sample	Shear strength (dynes/cm²)	Temperature (°C)
241-AY-102 Segment 1R top Segment 1R middle Segment 1R bottom	 53,600 16,700 21,700	 35 35 35
241-AZ-101 First Core Sample	2,100 and 2,600	28 and 28
241-AZ-101 Second Core Sample	15,000	30
241-AZ-102 Segment 1	15,400 and 13,140	31 and 31
241-AZ-102 Segment 2	26,500	31

Table 3.4-11. Effective Cleaning Radius and Mobilization Using Two Mixer Pumps.

Shear strength (dynes/cm²)	Effective cleaning radius (m)	% mobilized
7,000	12.5	99
14,000	7.9	75
28,000	4.9	36
70,000	2.7	11

A composite of the second 241-AZ-101 core was analyzed on the Brinkman Model 2010 particle size analyzer (1) as-is, and (2) after washing. Table 3.4-12 shows the mean particle diameter on a volume and population basis. There was essentially no difference between unwashed and washed solids. The Brinkman instrument registered few 241-AZ-101 particles bigger than 13 microns, and 90 percent (by population) were less than 2 microns. The same samples were analyzed again after six weeks, yielding essentially the same results.

5.0 CORROSION

5.1 PROBLEM/QUESTION

The following question posed by the decision makers was discussed and accepted.

Will any transfer increase corrosion in pipes and tanks?

Both DOE and Ecology have acknowledged that corrosion in pipes occurs. Both parties agree on the need to control corrosion in the tanks. Both parties disagree on the meaning of "increase." Ecology has indicated that increase means "increase beyond a minimal value based on best available technology." The DOE has indicated that increase means from current corrosion rates.

The result is that the two parties have not agreed upon the need to implement treated flush water after transfers. The DOE and Ecology have agreed on the following tank corrosion specifications to mitigate corrosion in the tanks.

5.2 INPUTS

The established inputs to evaluate corrosion potential for all tanks and piping systems are hydroxide $[OH^-]$, nitrate $[NO_3^-]$, and nitrite $[NO_2^-]$. Inputs are slightly different for tanks depending upon the temperature, $T \leq 100$ °C (212 °F) and $T > 100$ °C (212 °F).

5.2.1 Tank Composition

Temperatures ($T \leq 100$ °C (212 °F))

Variable	Specification Limit
For $[NO_3^-] \leq 1.0\underline{M}$:	
$[OH^-]$	$0.010\underline{M} \leq [OH^-] \leq 5.0\underline{M}$
$[NO_2^-]$	$0.011\underline{M} \leq [NO_2^-] \leq 0.5\underline{M}$
$[NO_3^-]/([OH^-] + [NO_2^-])$	<2.5

(For solutions below 75 °C (167 °F), the $[OH^-]$ maximum limit is $8.0\underline{M}$)

For $1.0\underline{M} < [NO_3^-] \leq 3.0\underline{M}$:

$[OH^-]$	$0.1([NO_3^-]) \leq [OH^-] < 10\underline{M}$
$[OH^-] + [NO_2^-]$	$\geq 0.4([NO_3^-])$

For $[NO_3^-] > 3.0\underline{M}$:

$[OH^-]$	$0.3\underline{M} \leq [OH^-] < 10\underline{M}$
$[OH^-] + [NO_2^-]$	$\geq 1.2\underline{M}$
$[NO_3^-]$	$\leq 5.5\underline{M}$

For high operating temperatures (T >100 °C (212 °F) for AY and AZ tanks), the previously stated limits apply with the exception that $[OH^-]$ must be <4M.

5.2.2 Input Basis for Hydroxide, Nitrite, Nitrate

The failure mechanisms are outlined to allow understanding of the concentration of the ions that prevent corrosion. Premature failure of carbon steel components in hot nitrate solutions can be caused by stress corrosion cracking (SCC). In the absence of residual stresses approaching yield strength, failure of carbon steel components can still occur by pitting. At the Savannah River Site (SRS), SCC occurred in non-stress relived tanks. The non-stress relieved carbon steel waste tanks also contained waste with hydroxide and nitrite compositions outside the specification limits leading to SCC. Similar failures were also noted at the Hanford Site in the SSTs. These failures have also been attributed to SCC caused by nitrate (Anantatmula et al. 1994). Based on laboratory experiments, waste composition specifications were developed at the SRS (Ondrejcin et al. 1979) that would mitigate accelerated corrosion of carbon steel by pitting and SCC in SRS wastes. Because of the similarities between the waste compositions, the tank steel types and the operating conditions at the Hanford Site and SRS, it was recommended that the corrosion specifications in use at the SRS be used at the Hanford Site (Moore 1979) for the DSTs. The technical basis document for waste tank corrosion specifications (Kirch 1984) lists the concentration ranges of hydroxide and nitrite relative to nitrate in waste solutions. The concentrations listed result in waste solutions that are not corrosive to tank steel and waste transfer equipment. The DSTs were stress relieved and, thus far, no failures have been observed in the Hanford Site DSTs. Additional substantiation of limits when nitrate is <1.0M, is found in Danielson and Burnell (1994).

The presence of adequate concentrations of hydroxide and nitrate and using correct ratios of these anions prevents pitting/SCC of carbon steel. The inputs in Section 5.2.1 are from SD-WM-TI-150, *Technical Basis for Waste Tank Corrosion Specifications* (Kirch 1984), AC-EP-0772, *Characterization of the Corrosion Behavior of the Carbon Steel Liner in Hanford Single-Shell Tanks* (Anantatmula et al. 1994), and TWRS-PP-94-025, *Sludge Washing Materials Study: The Behavior of Carbon Steel in a Dilute Waste Environment* (Danielson and Burnell 1994). The nitrite, nitrate, and hydroxide concentrations are controlled in order to inhibit accelerated uniform

Table TS–7.1 LAW Chemical Composition (Continued)

Chemical Analyte	Maximum Ratio, analyte (mole) to sodium (mole)		
	Envelope A	Envelope B	Envelope C
OH	7.0E-01	7.0E-01	7.0E-01
Pb	6.8E-04	6.8E-04	6.8E-04
PO_4	3.8E-02	1.3E-01	3.8E-02
SO_4	9.7E-03	7.0E-02	2.0E-2
TIC	3.0E-01	3.0E-01	3.0E-01
TOC[1]	6.0E-02	6.0E-02	5.0E-01
U	1.2E-03	1.2E-03	1.2E-03

Note:

1 For each atom of Carbon in TOC.

Table TS–7.2 LAW Radionuclide Content

Radionuclide[1]	Maximum Ratio, radionuclide (Bq) to sodium (mole)		
	Envelope A	Envelope B	Envelope C
TRU	4.8E+05	4.8E+05	3.0E+06
^{137}Cs	4.3E+09	6.0E+10	4.3E+09
^{90}Sr	4.4E+07	4.4E+07	8.0E+08
^{99}Tc	7.1E+06	7.1E+06	7.1E+06

Notes:

1 Some radionuclides, such as ^{90}Sr and ^{137}Cs, have daughters with relatively short half-lives. These daughters have not been listed in this table. However, they are present in concentrations associated with the normal decay chains of the radionuclides.

Specification 7: Low-Activity Waste Envelopes Definition

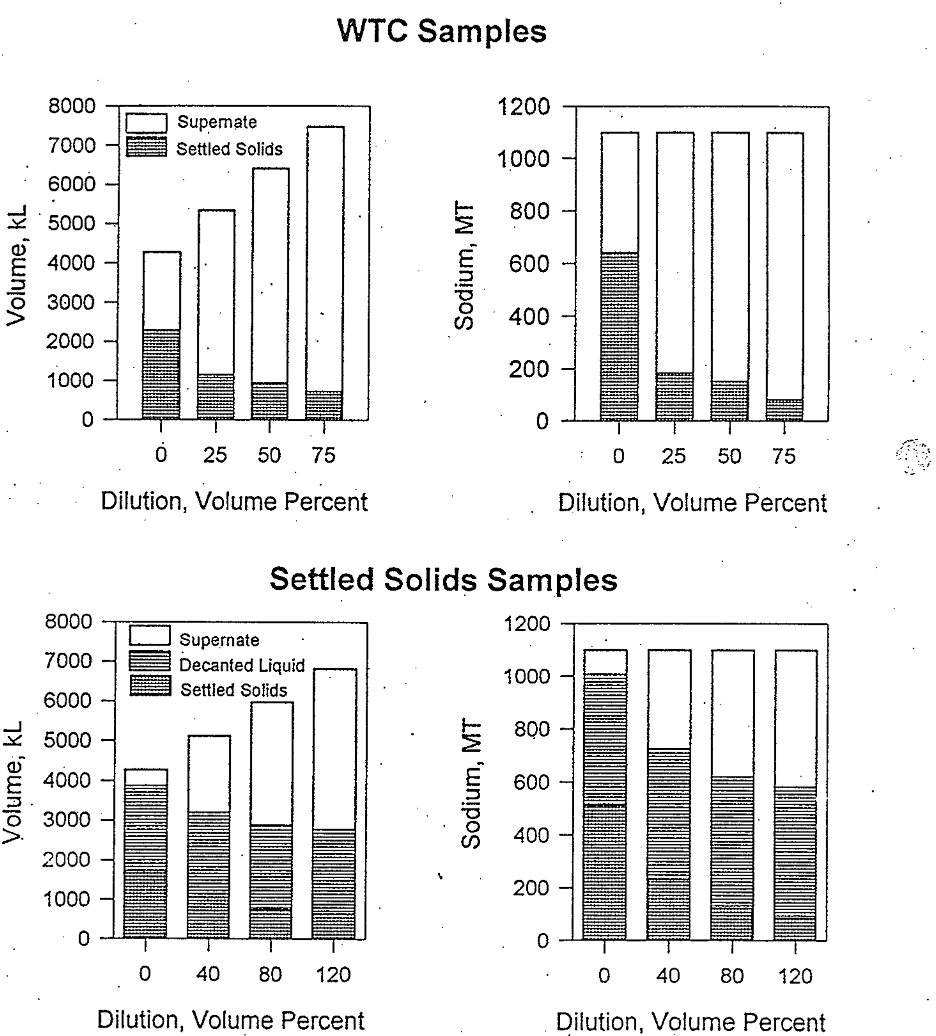
7.1 Scope: This *Specification* establishes three waste envelopes for Low-Activity Waste (LAW) services: Waste Envelopes A, B, and C. Each waste envelope provides the compositional range of chemical and radioactive constituents in the waste feed to be treated.

7.2 Composition: This specification lists the concentration limits for the LAW Envelopes A, B, and C feed to be transferred by DOE to the Contractor for LAW services. The waste feed will be delivered with a sodium concentration between 3M and 14M. The insoluble solids fraction will not exceed 5 volume % of the waste transferred as Waste Envelopes A, B, and C. Trace quantities of radionuclides, chemicals, and other impurities may be present in the waste feed. All feed provided will meet the Tank Farm Operations specifications given in OSD-T-151-00007.

Table TS–7.1 LAW Chemical Composition

Chemical Analyte	Maximum Ratio, analyte (mole) to sodium (mole)		
	Envelope A	Envelope B	Envelope C
Al	1.9E-01	1.9E-01	1.9E-01
Ba	1.0E-04	1.0E-04	1.0E-04
Ca	4.0E-02	4.0E-02	4.0E-02
Cd	4.0E-03	4.0E-03	4.0E-03
Cl	3.7E-02	8.9E-02	3.7E-02
Cr	6.9E-03	2.0E-02	6.9E-03
F	9.1E-02	2.0E-01	9.1E-02
Fe	1.0E-02	1.0E-02	1.0E-02
Hg	1.4E-05	1.4E-05	1.4E-05
K	1.8E-01	1.8E-01	1.8E-01
La	8.3E-05	8.3E-05	8.3E-05
Ni	3.0E-03	3.0E-03	3.0E-03
NO_2	3.8E-01	3.8E-01	3.8E-01
NO_3	8.0E-01	8.0E-01	8.0E-01

Figure 7-1. Tank Waste Volumes and Sodium Inventories as a Function of Dilution



ref. HNF-SD-WM-DTR-046-REV.0

8C510-97-028

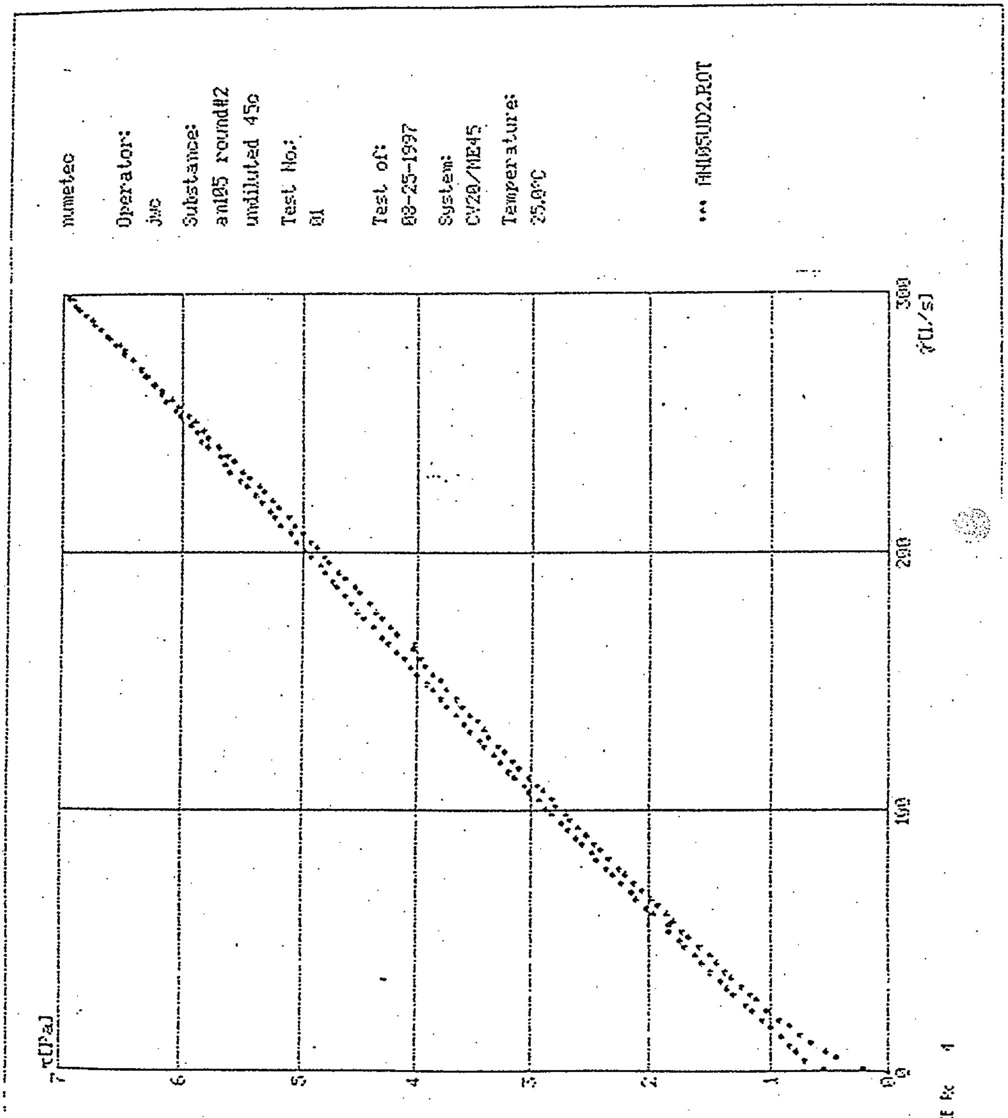
Attachment XII

VISCOSITY ANALYSIS OF UNDILUTED SETTLED SOLIDS
AT APPROXIMATELY 45°C

Consisting of 7 Pages including the cover page

~~A-77~~

ref. HNF-SD-WM-DTR-046-REV.0



~~A-78~~

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Attachment VI

VISCOSITY ANALYSIS OF UNDILUTED WHOLE TANK COMPOSITE
AT APPROXIMATELY 45°C

Consisting of 7 Pages including the cover page

~~A-36~~

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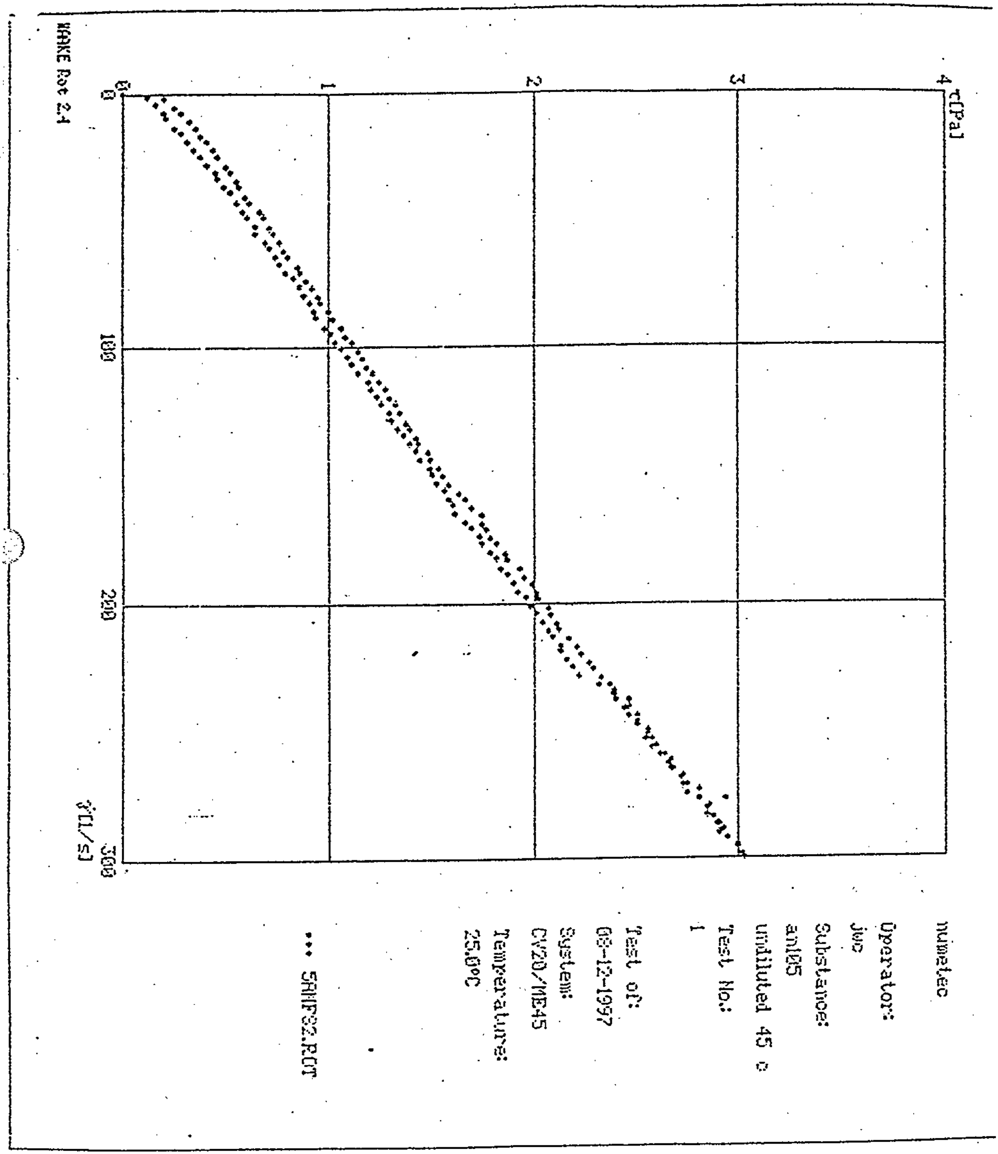


5.3 Rheology and Waste Configuration

In the two preceding sections we presented the results of the gas volume calculations and attempted to describe the implications and answer the "so what?" question. The last question that eventually must be answered is, "Why?". Why was the GRE behavior of SY-101 so much more severe than in the other tanks? Why does AN-103 store so much gas with hardly detectable GREs? Generally, how can we explain the gas retention and release behavior of each tank? As yet there is no satisfactory answers to these questions, but there are a few clues in the rheology and the physical condition of the waste.

The waste yield stress affects the way bubbles grow and how much is stored (Gauglitz et al. 1996). The apparent viscosity should also have some effect on the dynamics of a GRE. However, the apparent viscosity profiles presented in Section 4 are all very similar (note that first pass apparent viscosity for SY-103 was obtained at 3 cm/s). There are as many variations among risers in a tank as there are among different tanks. The yield stress profiles are shown in Figure 5.8. Except for AN-103 and the lower portion of SY-103, the estimated yield stress profiles are equivalent within their uncertainty.

Waste density is another indicator of GRE behavior. The ratio of supernatant to nonconvective layer densities determines the void fraction at neutral buoyancy where a rollover is possible. Density profiles of the convective layer and the nonconvective layer density are shown for all tanks in Figure 5.9 (SY-101 values are pre-mixer pump recommendations of Reynolds 1993). SY-101 and AN-103 have higher convective layer densities and much higher nonconvective layer densities than the others.

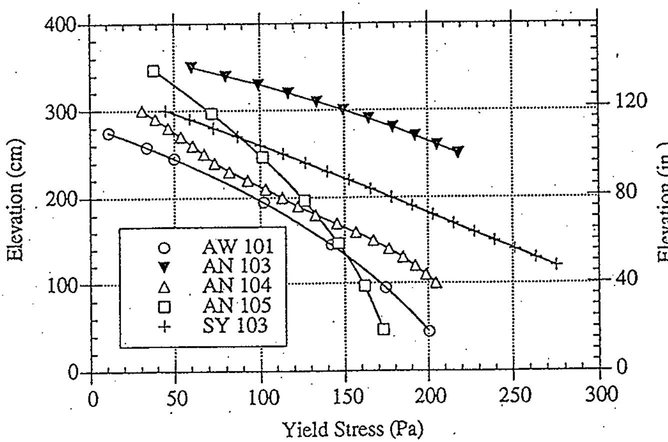


Figure 5.8. Yield Stress for Five Tanks

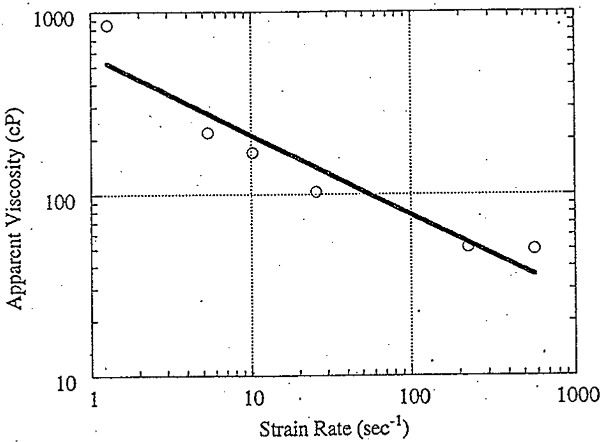


Figure 4.1.4. Apparent Viscosity of SY-101 Mixed Slurry

The ball was able to penetrate to within about 15 cm (approximately 6 in.) of the bottom of the tank in riser 4A. The material near the bottom showed shear-thickening behavior, with a very small yield stress of about 20 Pa (0.004 psi) and an average viscosity of about 20,000 cP. The yield strength profile is plotted in Figure 4.1.5.

The density of the mixed slurry derived from ball rheometer data is 1.60 ± 0.03 g/cm^3. The profiles of the specific gravity for the runs in 4A and 11B are shown in Figure 4.1.6. The data from riser 4A were obtained four days after a pump run; those from riser 11B were obtained just one day after a pump run. The difference in the profiles is clearly an effect of the different amounts of time available for solids to settle out in each case. Prior to mixing, Reynolds (1993) recommended a density of 1.57 ± 0.04 g/cm^3 for the convective layer and 1.70 ± 0.04 g/cm^3 for the nonconvective layer based on core samples following gas release Event E in December 1991 (Herting et al. 1992).

4.1.3 Void Fraction and Gas Volume

All of the void fraction measurements in SY-101 are plotted in Figure 4.1.7 along with the selected layers used to compute the average void fraction. Table 4.4 contains the average void fraction and gas volumes. Adding up the stored gas volumes in each of the three layers yields a total of 218 ± 53 m^3 ($7,700 \pm 1,900$ SCF) of gas at 1 atm. Given the waste level of 1019 cm (401 in.) when the VFI measurements were made, the degassed waste level would be 1010 cm (398 in.), not including the gas in the crust or in the mixed slurry above 200 cm. The computed barometric pressure response of the total in situ gas volume is -0.32 cm/kPa, and the effective pressure for compressibility is 1.23 atm.

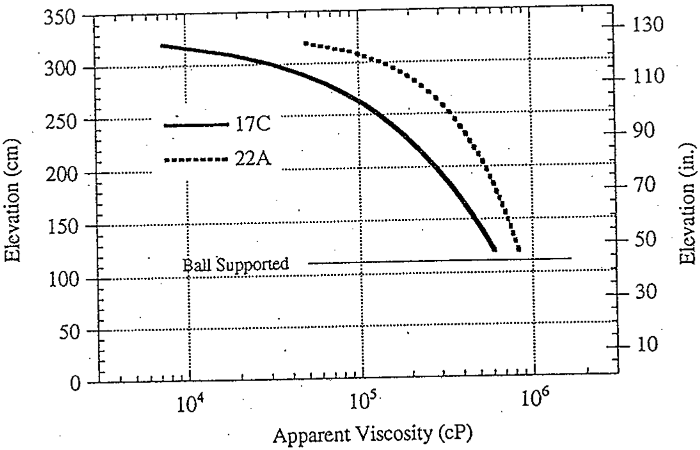


Figure 4.2.4. Apparent Viscosities in Risers 17C and 22A

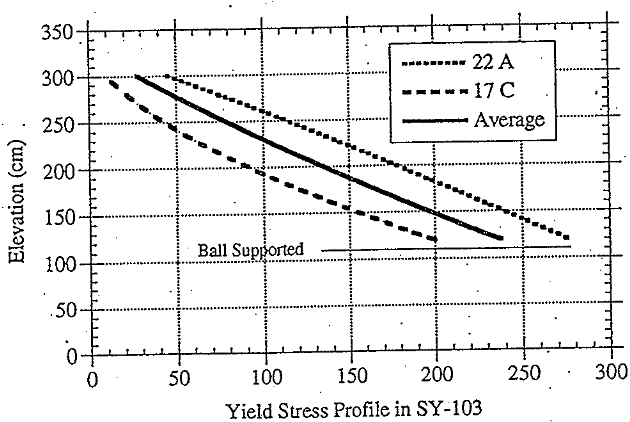


Figure 4.2.5. Yield Stress Profile in SY-103

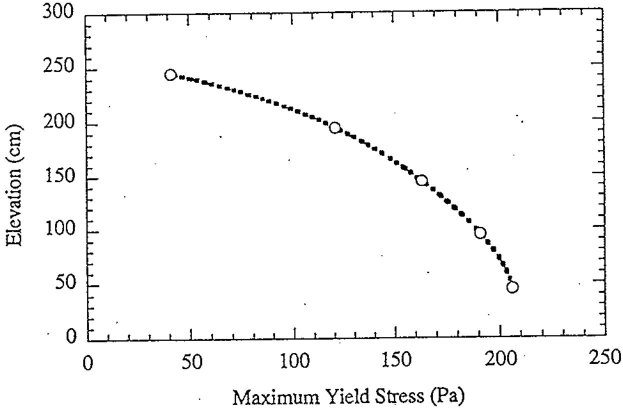
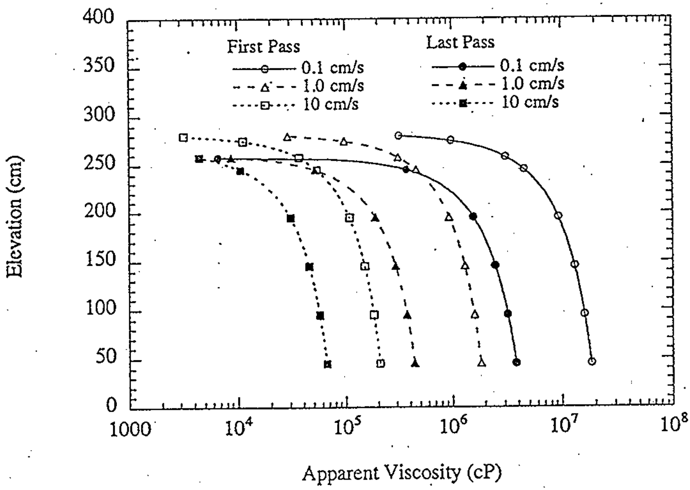


Figure 4.3.7. Upper Bound on the Yield Stress



AW-101

Figure 4.3.8. Apparent Viscosities of the First and Last Passes

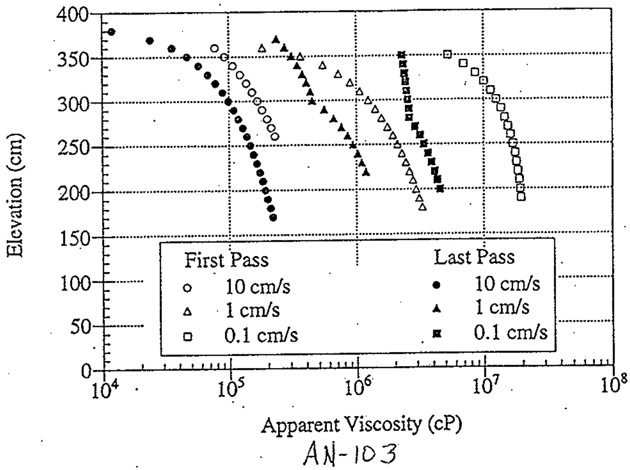


Figure 4.4.4. Apparent Viscosities in Riser 1B

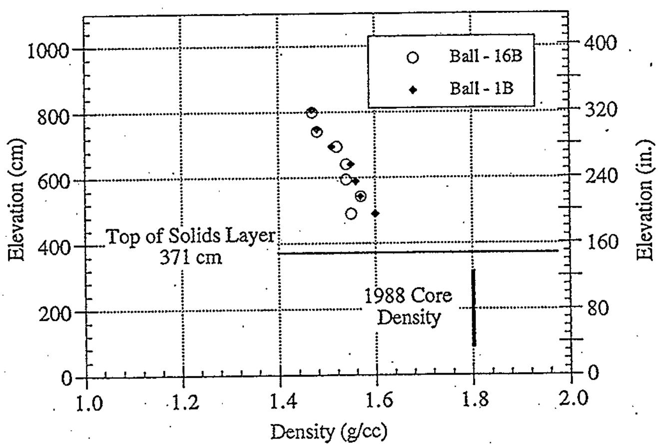


Figure 4.4.5. Density as a Function of Elevation

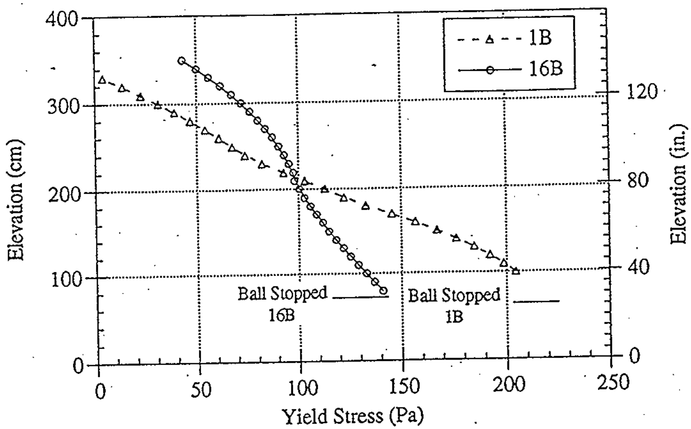
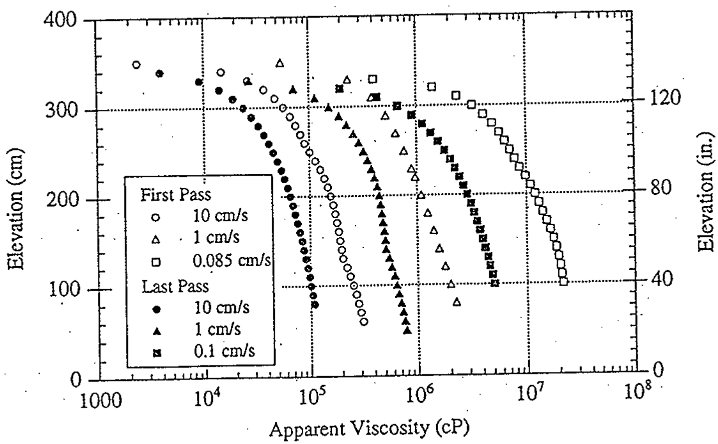


Figure 4.5.4. Upper Bound on the Yield Stress



AN-104

Figure 4.5.5. Apparent Viscosities at Three Strain Rates

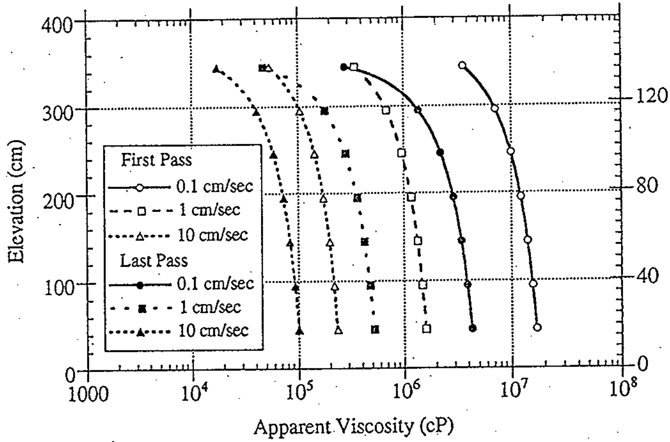


Figure 4.6.5. Apparent Viscosities on the First and Last Passes

The effective pressure ratio in the nonconvective layer is 2.08 ± 0.03 atm and 1.7 ± 0.13 atm for the entire tank gas content. The computed barometric pressure response or compressibility is -0.16 ± 0.06 cm/kPa, and the effective pressure for calculating the gas volume from the barometric response correlation is 1.6 ± 0.7 atm.

4.6.4 Gas Release

The character of GREs in AN-105 shares some of the features of both SY-103 (Shepard et al. 1995) and AW-101. The initial level drop is quite rapid, as is the gas release, although the total level drop typically requires several days. The typical drop is 4 cm or less. The largest recent level drop, 5.9 cm, occurred November 15, 1991. The maximum one-day drop was 6.1 cm on August 11, 1986. As mentioned in the introduction to this section, AN-105 experienced a 3 1/2 year hiatus in gas releases between January 1988 and July 1991.

A relatively large release occurred August 1995. The 3.6-cm drop indicates a 33.2 m^3 (1170 SCF) total release volume. Recently installed monitoring showed the hydrogen concentration peaked at just over 1.6%. This implies that about 16.8 m^3 (592 SCF) of hydrogen was released into the 1066-m^3 (38,000-ft^3) dome space, assuming instantaneous mixing without ventilation. The 3.6-cm (1.4-in.) level drop indicates a total release of 30.8 m^3 (1,090 SCF) if the gas is held at an effective pressure ratio of 2.08. Dividing the estimated hydrogen release by the total release volume implies that the gas contains about 54% hydrogen, which is consistent with recent preliminary data from the RGS.[(a)] No significant temperature changes were observed in the

(a) Personal communication of preliminary data by JM Bates, PNNL, August 1996.

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