Final Flush of the Shielded Cells Melter

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FINAL FLUSH OF THE SHIELDED CELLS MELTER (U)

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INTRODUCTION

A flush of the Savannah River Technology Center (SRTC) Shielded Cells melter was performed after the completion of a campaign to vitrify loaded crystalline silicotitanate (CST) ion exchange medium. The purpose of the flush was to lower levels of radioisotopes accumulated during the campaign and to lower the level of titanium dioxide present in the glass. This in turn would ready the melter for future campaigns involving the Defense Waste Processing Facility (DWPF).

The CST campaign began in August and was completed in September of 1997. The material that was vitrified had been used to sorb cesium and strontium from the Melton Valley Storage Tanks at the Oak Ridge National Laboratory (ORNL). It was loaded primarily with Cesium-137, and with smaller amounts of strontium.¹ At the beginning of the flush, the melter contained approximately ten kilograms of fifty-weight percent CST-loaded borosilicate glass. With this amount of glass, there was approximately 3.29 Curies in the melter². In addition, the glass contained greater than one-weight percent titanium dioxide, a component of the CST. Constraints on the composition of DWPF glass limit titanium dioxide content to below one-weight percent. Approximately forty kilograms of the DWPF startup frit, black Frit 565, were used to flush this material out of the melter.

NONRADIOACTIVE DWPF FEED

Frit 565 is a borosilicate frit intended for startup activities in the DWPF. The frit formulation is shown in Table 1. The frit was first mixed with sea sand in the ratio of 9:1 and then fed to the melter in batches. Sea sand was added to the frit to increase the silica content, which served to decrease the liquidus temperature of the frit, and reduce crystal formation. Approximately forty kilograms of the frit and sand mixture were added to the melter for the flush.

Table 1. Black Frit 565 Formulation³

Component	Weight %
SiO ₂	49
B ₂ O ₃	8.8
Li ₂ O	3.5
Na ₂ O	11.5
MgO	0.7
CaO	1.2
TiO ₂	1
Fe ₂ O ₃	13.5
Al ₂ O ₃	4.7
MnO ₂	2.3
NiO	1.1
K ₂ O	2.6
Cr ₂ O ₃	0.1
	100

MELTER FLUSH OPERATION

At the end of the CST vitrification campaign, the SRTC Shielded Cells melter contained approximately ten kilograms of fifty-weight percent CST-loaded glass, at a level of approximately 3.29 Curies.² The glass also contained greater than the acceptable amount of titanium dioxide for DWPF composition control. In order to reduce the level of cesium and titanium, a flush was completed using DWPF black Frit 565.

The frit was added in batches via a funnel placed in the feed tube, located on top of the melter. Feedings took place in intervals of about twenty minutes. A feed batch was approximately 113 or 225 ml, depending on the rate the glass was pouring from the melter. During feeding, molten glass was poured into stainless steel beakers that each held approximately one kilogram of glass. By roughly matching the glass pour rate with the frit feed rate, the glass level in the melter remained essentially constant throughout flushing.

Total time of the feeding and pouring operation was approximately sixty-six hours. The total frit fed over the sixty-six hours was forty kilograms, and the total glass poured was thirty-nine kilograms. The glass was poured into thirty-six cans. See Attachment 1 for details of the flush.

RESULTS

The Shielded Cells melter was flushed with DWPF black Frit 565 in order to reduce the levels of titanium and cesium in the vessel, as well as to prepare the melter for future campaigns. The thirty-nine kilograms of glass poured during the flush represent 3.9 turnovers of the melter volume. The concentration of cesium after 3.9 melter volumes is expected to be reduced to 0.0215 of its original concentration (See Attachment 2 for graphical analysis). With the initial loading of cesium contributing approximately 3.29 Curies² to the melter, the final concentration of cesium is expected to be reduced to 0.071 Curies. This corresponds to 0.0071 Curies per kilogram of glass in the melter. By the same calculation, the original concentration of titanium dioxide in the melter should be reduced to well below one-weight percent.²

REFERENCES

1. Joe Walker, LMER Pretreatment, OR1-6-WT-41, 1996.
2. M. K. Andrews, et al., "Vitrification of Cesium-Loaded Crystalline Silicotitanate in the Shielded Cells Melter", WSRC-TR-97-00314, September 1997.
3. C. M. Jantzen, "Glass Composition and Frit Formulations Developed for DWPF", DPST-88-952, November 1988.

ATTACHMENT 1: MELTER FLUSH
(Ref: WSRC-NB-90-319)

Date	Time Put In	Can	Cumulative Glass Poured (kg)	Cumulative CS1 Batch Fed (g)	Cumulative 565 Frit Fed (g)	NOTES
	15:45	C31	1.1749		2500.00	
	16:45					Operation stopped; 1 bag frit fed
9/4/97	14:00					Operation resumed
	16:20	C32	2.1749		3146.55	
	17:20	C33	3.2174		4116.38	Operation stopped
9/5/97	9:35					Operation resumed
	10:35	C34	4.3764		5086.21	
	11:55	C35	5.5369		6056.03	
	12:45	C36	6.6633		7672.41	Operation stopped; C36 empty
9/8/97	8:40					Operation resumed
	10:00	C37	7.7534		8318.97	
	11:45	C38	8.7936		9450.43	
	13:50	C39	9.8856		10420.26	
	15:25	C40	10.9347		11390.09	
	17:10	C41	11.6920		12036.64	
	18:00	C42	12.7649		13329.74	
	18:40					Operation stopped
9/9/97	6:10					Operation resumed
	8:00	C43	13.9399		14461.21	
	9:45	C44	15.0929		15592.67	
	11:20	C45	16.0189		16724.14	
	13:05	C46	17.0908		17693.97	
	14:40	C47	18.1285		18825.43	
	16:40	C48	19.2051		19633.62	
	18:00	C49	20.2387		21250.00	
	18:40					Operation stopped
9/10/97	6:10					Operation resumed
	8:20	C50	21.2382		22381.47	
	10:15	C51	22.2480		23189.66	
	11:55	C52	23.4977		24644.40	
	13:50	C53	24.5302		25775.86	
	15:30	C54	25.6887		26422.41	
	16:35	C55	26.6916		27715.52	
	17:50					Operation stopped
9/11/97	6:10					Operation resumed
	7:35	C56	27.7374		29008.62	
	9:35	C57	28.7880		30140.09	
	11:30	C58	29.8434		30786.64	
	12:55	C59	30.9015		31756.47	
	15:10	C60	31.9946		32726.29	
	17:10	C61	33.1141		34019.40	
	18:00					Operation stopped
9/15/97	6:05					Operation resumed
	8:45	C62	34.1378		35312.50	
	10:55	C63	35.3884		36605.60	
	12:55	C64	36.4215		38221.98	
	15:00	C65	37.6514		39030.17	
	16:50	C66	38.7377		40000.00	
	18:10	F30				Operation stopped; Can F30 in chamber

ATTACHMENT 2: Melter Turnover Graph