Interlock Recovery During the Drying, Calcination and Vitrification Phase of Am/Cm Processing

by

T. K. Snyder

Westinghouse Savannah River Company

Savannah River Site

Aiken, South Carolina 29808

D. C. Witt

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INTERLOCK RECOVERY DURING AM/CM PROCESSING

The attached document summarizes the results of five CIM5 runs designed to demonstrate power interlock recovery methods during the drying, calcination and vitrification phases of the Am/Cm melter cycle. These tests were conducted in Am/Cm Pilot Facility located in Building 672-T. Please refer any questions you may have regarding the contents of this document to T. K. Snyder (Ext. 7-7682) or D. C. Witt (Ext. 7-7754)

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AM/CM PROCESSING (U)**

**T. K. SNYDER
D. C. WITT**

Westinghouse Savannah River Company
Savannah River Site
Aiken, SC 29808

SAVANNAH RIVER SITE

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**T. K. SNYDER
D. C. WITT**

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**Westinghouse Savannah River Company
Savannah River Site
Aiken, SC 29808**

SAVANNAH RIVER SITE

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APPROVALS

T. K. Snyder, Author
Immobilization Technology Section

12-9-99

Date

D. C. Witt, Author
Immobilization Technology Section

12/9/99

Date

T. M. Jones, Technical Reviewer
Immobilization Technology Section

12-9-99

Date

L. F. Landon, Manager
Immobilization Technology Section

12/9/99

Date

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I. INTRODUCTION

Five CIM5 runs to demonstrate power interlock recover methods during drying, calcination and vitrification phases began on 11/3/99 and were completed on 11/23/99. These runs were performed to support TTR#99-NMSS/SE-006, Task 3.03, ITS Activity Number ITS-99-0100. The interlocks were triggered at the conditions listed below:

Drying: Interlock occurred after 75-80 minutes of the automated power sequence (run time).

Calcination: Interlock occurred at the 251 minute mark of the automated power sequence (run time).

Vitrification: Interlock occurred at the 350 minute mark of the automated power sequence (run time).

The melter was allowed to cool overnight (~17 hours) to ambient temperature and recovery was then attempted. (Note: During one test a facility power outage resulted in an elapsed period of nearly 91 hours before recovery was initiated.) Due to a bed expansion experienced during the first calcination interlock run, two subsequent calcination interlock runs were completed.

II. SUMMARY

No anomalies were encountered during the drying and vitrification interlock recovery runs. However, recovery from an interlock that occurs during calcination produced a bed expansion that had to be manually vented. Although the wall temperatures during recovery match those for a standard run without an interlock, the bed temperature profile is different, suggesting a physical change in the precipitate/cullet bed. This physical change appears to inhibit gas removal from the bed during cerium reduction.

No further investigation into the mitigation of the bed expansion during recovery from a calcination interlock is planned at this time. Further direction will be provided by the Design Authority.

III. RECOMMENDATIONS

In consultation with SRS and industry experts, define an R&D program to develop an understanding why recovery from the calcination phase results in an unacceptable bed expansion. This program should address the following issues:

- Temperature range in which recoverability is accompanied by an unacceptable bed expansion?
- Length of time the melter can experience a loss of power during the calcination phase without experiencing an unacceptable bed expansion during resumption of the heating cycle?
- Technique(s) for mitigating volume expansion during recovery from an extended interlock.
- Redundancy in design of those systems that can result in a loss of power.
- Increasing the height of the melter to accommodate the bed expansion.

Additional funding must be provided for the above tasks because the current FY00 funding level will not support activities beyond that defined in the current Task Technical Plan.

IV. EVALUATION RUN DETAILS

Each run was performed using a standard 49 wt% Ln loaded glass and was processed utilizing the automated power sequence program of the Factory Link control system. This automated power sequence program begins at Run Time 0 and continues through drying (wall temperatures from startup to 250°C), calcination (wall temperatures from 251°C to 1000°C) and vitrification (wall temperatures from 1000°C to 1450°C). The thermocouple locations are shown in Attachment 1.

Drying Interlock Recovery

At Run time = 75 minutes, all power to the melter was removed by inducing a system interlock. Approximately ¼" of free liquid remained above the solids bed after the boiling stopped as a result of the induced power interlock and subsequent melter cooldown. The following day, the automated power sequence program was restarted at Run Time = 0 and the interlock recovery run completed. There were no anomalies encountered during the interlock recovery run. The temperature traces during the interlock recovery runs are shown in Figure 1. For comparison purposes temperature traces for a standard run producing a 49 wt% Ln glass are presented in Figure 2.

Calcination Interlock Recovery

Recovery from an interlock that occurs during calcination produced a bed expansion that had to be manually vented. Although the wall temperatures during recovery match those for a standard run without an interlock, the bed temperature profile is different, suggesting a physical change in the precipitate/cullet bed. This physical change may inhibit gas removal from the bed during cerium reduction.

First Calcination Run

At Run Time = 251 minutes, just after covering the vessel open top with an insulating board, all power to the melter was removed by inducing a system interlock. Sixty seven hours later the automatic power control sequence was to have been restarted at Run Time = 0 and the calcination interlock recovery run completed. However, electrical service to Building 672-T was lost and not restored until 24 hours later at which time the recovery run was completed. This run produced a bed expansion just prior to reaching Run Time = 350 where the peak power soak/bubbling phase begins. The top insulating cover was lifted by the bed expansion and the foam surface had to be manually vented. Following 75 minutes of sparging, the glass was poured producing a homogeneous glass product. Temperature traces for the recovery runs are displayed in Figure 3.

Figure 1. Temperature Traces for Drying Interlock Recovery Run

Figure 2. Temperature Traces for CIM5 Standard Run

Figure 3. Temperature Traces for Calcination Recovery Run

Second Calcination Run

The primary purpose of this run was to determine if the bed expansion in the first calcination run could be duplicated. At Run Time = 251 minutes, all power to the melter was again removed by inducing a system interlock. This recovery run was initiated the following day as opposed to the 91 hour hold on the first calcination run and yielded nearly identical results with the bed expansion occurring at the same point and lifting the insulating cover.

Third Calcination Run

To evaluate a potential method for recovery, a third calcination interlock run was conducted on 11/22 and 11/23. 1700 ml of water was added to the cooled melter prior to starting the recovery run. The purpose was to provide a heat load to the previously dried and partially calcined batch bed which would result in a temperature profile upon reheating that resembled more closely that of the initial heating profile for standard runs. This did not however, mitigate the bed expansion. At Run Time = 335 of the recovery run, the bed expansion reached the insulating cover board on top of the melter vessel. Three minutes later the foam lifted the cover and was manually vented. A second expansion again lifted the board five minutes later. Cone wall temperature traces and bed temperature traces for each of the calcination recovery runs are compared with a standard run in Figures 4 and 5, respectively. In Figure 4, T2A-1, T2A-2, and T2A-3 represent the T2A cone wall temperature for the first, second and third calcination recovery runs. In Figure 5 the bed temperatures for these runs are denoted by T3C-1, T3C-2, and T3C-3. At Run Time = 350, all the foam was incorporated back into the glass pool. Glass pouring was then completed without incident.

Vitrification Run

At Run Time = 350, just after installing the glass bubbler at a 1" elevation from the melter bottom, and initiating argon flow at 1.5 scfh all power to the melter was removed by inducing a system interlock. The following day, the automated power sequence program was restarted at Run Time = 0 and the interlock recovery run completed. There were no anomalies encountered during the interlock recovery run. The temperature traces for the interlock recovery are shown in Figure 6.

Figure 4. Cone Wall Temperature

Figure 5. Bed Temperatures

Figure 6. Temperature Profile for Vitrification Interlock Recovery Run

V. REFERENCES

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VI. ATTACHMENT

Attachment 1 – CIM5 Thermocouple Placement

Attachment 1

CIM5 THERMOCOUPLE PLACEMENT

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