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AM/CM VITRIFICATION PROCESS: VITRIFICATION MATERIAL BALANCE CALCULATIONS (U)

F. G. Smith, III

Westinghouse Savannah River Company
Savannah River Site
Aiken, SC 29808

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APPROVALS

_____	_____
F. G. Smith, III, Author Immobilization Technology Section	Date
_____	_____
D. C. Witt, Technical Reviewer Immobilization Technology Section	Date
_____	_____
L. F. Landon, Manager Immobilization Technology Section	Date

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SUMMARY

This report documents material balance calculations for the Americium/Curium vitrification process and describes the basis used to make the calculations. The material balance calculations reported here start with the solution produced by the Am/Cm pretreatment process as described separately in Reference [1]. Following pretreatment, small batches of the product will be further treated with an additional oxalic acid precipitation and washing. The precipitate from each batch will then be charged to the Am/Cm melter with glass cullet and vitrified to produce the final product. The material balance calculations in this report are designed to provide projected compositions of the melter glass and off-gas streams. Except for decanted supernate collected from precipitation and precipitate washing, the flowsheet neglects side streams such as acid washes of empty tanks that would go directly to waste. Complete listings of the results of the material balance calculations are provided in the Appendices to this report.

This revision is required to reflect minor changes resulting from a revision to the pretreatment material balance described in Reference [1], which changed some of the values in the vitrification calculations. No changes have been made to any of the bases for the vitrification material balance.

BACKGROUND

Based on 1998 analytical measurements, Tank 17.1 contains approximately 11,000 liters of Americium/Curium solution at about 8 M nitric acid. The material stored in Tank 17.1 will be diluted, denitrated using formic acid, and precipitated with oxalic acid to separate actinides and lanthanides from transition metals, aluminum and alkali constituents. The precipitate will then be washed to further remove impurities. Following these clean-up steps, the solution will be treated with concentrated nitric acid to redissolve the precipitate and destroy oxalate. The solution will then be water stripped, denitrated to reduce the nitric acid concentration, and concentrated to produce a solution having about 100 g/l of solids on an oxide basis in 1.0 M nitric acid. These processing steps are included in the pretreatment material balance [1].

Approximately seven liter batches of the pretreated material will then be precipitated and washed with oxalic acid to further remove transition metals and convert the actinides and lanthanides to oxalate salts. This solution will be fed to the melter along with a glass cullet and heated to remove water and form the Am/Cm glass product. During melter heating, the water in solution is driven off, oxalate ions are burned to carbon dioxide and carbon monoxide and nitrate ions form NO_x gas species. The material balance was implemented in an Excel™ spreadsheet that relies on experimental data, empirical formulas and simplifying assumptions to make the flowsheet calculations.

CALCULATION BASES

The calculations in this report are designed to determine the compositions of the melter feed, the glass product from the Americium/Curium vitrification campaign, and the melter off-gas streams. The material balance starts with the product of the pretreatment process. These material balance calculations used the most recent (1998) analytical measurements of the composition of the solution in Tank 17.1 as a starting point. Table 1 summarizes some of the basic assumptions used to make the vitrification material balance calculations.

Table 1. Calculation basis for vitrification material balance.

Parameter	Assumed Value
Glass cullet	25 Sr ABS-F
Waste loading in glass as oxides	32%
Lanthanide loading in glass as oxides	49%
Melter feed batch	6.91 liters
Melter off-gas pressure	-2 inches water
Melter off-gas temperature	200 – 700 ºC
Solids entrainment in off-gas	0.1% of melter feed
Cesium volatility	20%

The material balance calculations also relied on the following bases and assumptions:

- Salts of the metal impurities remaining in Tank 17.1 are completely soluble. The true chemical form of the metal impurity salts is uncertain. Choi [2] has determined a composition based on the chemical analysis of Tank 17.1 that best conserves mass and satisfies electroneutrality. This proposed composition was used for the pretreatment flowsheet. During the redissolving step, where concentrated nitric acid is added to the solution, the metal impurities are likely converted to the nitrate salts. However, to simplify the calculations, it is assumed that the chemical species proposed by Choi remain intact throughout the entire pretreatment process. During vitrification, these materials are converted into the oxide form.

- Following the assumption used by Rudisill [3], trace amounts of the elements Tb, Dy, Ho, Er, Tm, Yb and Lu are assumed to be present in the Tank 17.1 solution. The concentrations that are assumed for these elements represent the minimum detectable quantities that could be present in the Tank 17.1 solution.

- Solubilities of oxalate salts of the lanthanides, uranium and transuranic metals are based on experimental data. The data obtained by Beck [4] and Rudisill [3] were used to calculate the solubility of the oxalate salts of Lanthanide metals. Full details of the solubility calculation are provided in the report on the pretreatment material balance [1].

- The oxalate precipitate layer has an apparent specific volume of 0.5 l/mole [4].

- When streams are mixed, if the final volume is not specified, it is simply assumed that the mixing volumes are additive. The mixture density is then calculated from the ratio of solution mass to volume.

- Air purges to the tanks are calculated using the methodology developed by Marek [5] to limit the hydrogen concentration in the vapor space of these vessels to 25% of the Lower Flammability Limit. It is assumed that the air purge is saturated air at 20 ºC. The solution volumes shown in the Table 2 were used as a basis for the air purge calculations. These are the volumes of solution in the tanks when the greatest air purge is required.

Table 2. Vessel Volumes for Air Purge Calculations

Vessel	Solution Volume (liters)
Liquid Feed Tank	48.0
Batch Control Tank	6.91
Precipitator	6.91

- The air sweep over the melter is assumed to be saturated air at 20 ºC. Even though saturated air at a higher temperature will carry more water vapor, the worst case with the greatest dilution air or off-gas heating requirement was found to be colder air. Most of the off-gas mass comes directly from the air sweep and not from the melter. Therefore, colder air which is more easily condensed is the limiting operating condition that requires the greatest dilution air or off-gas heating. The off-gas heating or dilution airflow is set to give a relative humidity of 70% in the mixed off-gas [6, 7].

- 0.10% of the feed material added to the melter is lost to entrainment in the off-gas.

- 20.0% of the cesium added to the melter is volatilized into the off-gas during the drying stage.

- 20.0% of the carbon monoxide in the melter off-gas from the calcination reactions is burned to carbon dioxide.

- 50.0% of the NO_x in the melter off-gas is decomposed to nitrogen and oxygen.

- Off-gases from melter drying, calcination and vitrification operations are included in the combined melter off-gas streams. Gas releases from the melter are converted from absolute amounts into flow rates by assuming a one-hour duration for each of the melter steps. The one hour duration assumed for each of the melter steps is likely low and therefore conservative for calculating off-gas flows.

- The material loading in the glass product is calculated to give 49.0% actinide and lanthanide oxides.

- Based on simulant experiments performed at TNX, the melter feed batch size is 6.91 liters.

OXIDATION REACTIONS

The following oxidation reactions are applied to convert the salts in the melter feed solution into metal oxides and gas phase products. In some cases, the reaction can be applied to more than the one element used to illustrate the stoichiometry. In these cases, the metals that the reaction applies to are listed in parentheses to the right of the example reaction equation.

Oxalate salts:

$La_2(C_2O_4)_3 \rightarrow La_2O_3 + 3\ CO + 3\ CO_2$ (Lanthanides, Am, Cm)

$Np_2O_4(C_2O_4) \rightarrow Np_2O_5 + CO + CO_2$

$Pu(C_2O_4)_2 \rightarrow PuO_2 + 2\ CO + 2\ CO_2$

$UO_2(C_2O_4) \rightarrow UO_3 + CO + CO_2$

$Fe_2(C_2O_4)_3 \rightarrow Fe_2O_3 + 3\ CO_2 + 3\ CO$

$H_2(C_2O_4) \rightarrow H_2O + CO_2 + CO$

Nitrate salts:

$2\ Al(NO_3)_3 \rightarrow Al_2O_3 + 6\ NO_x + 3\ O_2$ (Al, Fe, Cr)

$Ca(NO_3)_2 \rightarrow CaO + 2\ NO_x + O_2$ (Ca, Ni, Mn, Zn)

$Zr(NO_3)_4 \rightarrow ZrO_2 + 4\ NO_x + 2\ O_2$

$2\ H(NO_3) \rightarrow H_2O + 2\ NO_x + O_2$ (H, Na, K)

Nitrite salts:

$2\ Na(NO_2) \rightarrow Na_2O + 2\ NO_x$

Sulfate salts:

$4\ Al_2(SO_4)_3 \rightarrow 4\ Al_2O_3 + 12\ SO_x + 3\ O_2$ (Al, Fe)

Phosphate salts:

$2\ Fe(PO_4) \rightarrow Fe_2O_3 + 2\ PO_x$

Fluoride salts:

$2\ AlF_3 + 3\ H_2O \rightarrow Al_2O_3 + 6\ HF$

Chloride salts:

$2\ FeCl_3 + 3\ H_2O \rightarrow Fe_2O_3 + 6\ HCl$

Sodium salt reactions in the material balance that produce no off-gas are:

$$Na_2(SiO_3) \rightarrow Na_2O + SiO_2$$

$$Na_2(B_4O_7) \rightarrow Na_2O + 2\ B_2O_3$$

Oxides of nitrogen, sulfur and phosphorous are assumed to be equal molar mixtures of true oxides. That is, we take the x oxides to be:

$$NO_x = ½\ (NO + NO_2)$$

$$SO_x = ½\ (SO_2 + SO_3)$$

$$PO_x = ½\ (PO_2 + PO_3)$$

At the projected melter plenum temperatures, we assume that 20% of the carbon monoxide is oxidized to carbon dioxide according to the reaction:

$$CO + ½\ O_2 \rightarrow CO_2$$

At the melter gas temperatures, we also assume that 50% of the NO_x is thermally decomposed to N_2 and O_2 according to the reaction

$$2\ NO_x \rightarrow N_2 + 1½\ O_2$$

Based on the reactions listed above, the gaseous components of the melter off-gas stream are:

O_2, N_2, H_2O, CO, CO_2, NO_x, SO_x, PO_x, HF and HCl

Oxygen, nitrogen and some water vapor are added to the melter off-gas from airflow into the melter vapor space. Water is volatilized into the off-gas from the melter feed.

PROCESS FLOW DIAGRAMS

Figures 1 through 2 show process flow diagrams for the melter feed preparation and vitrification parts of the Am/Cm vitrification process as modeled by the material balance calculations. Stream numbers shown in the figures correspond to the column numbers assigned in the material balance spreadsheet. All streams in the material balance calculations are identified on the figures. Page numbers given in the titles indicate the pages in the spreadsheet where the streams are listed. Both the stream and spreadsheet page numbers continue from the numbering in the pretreatment material balance spreadsheet.

Melter Feed Preparation (Spreadsheet Pages 17-22,25)

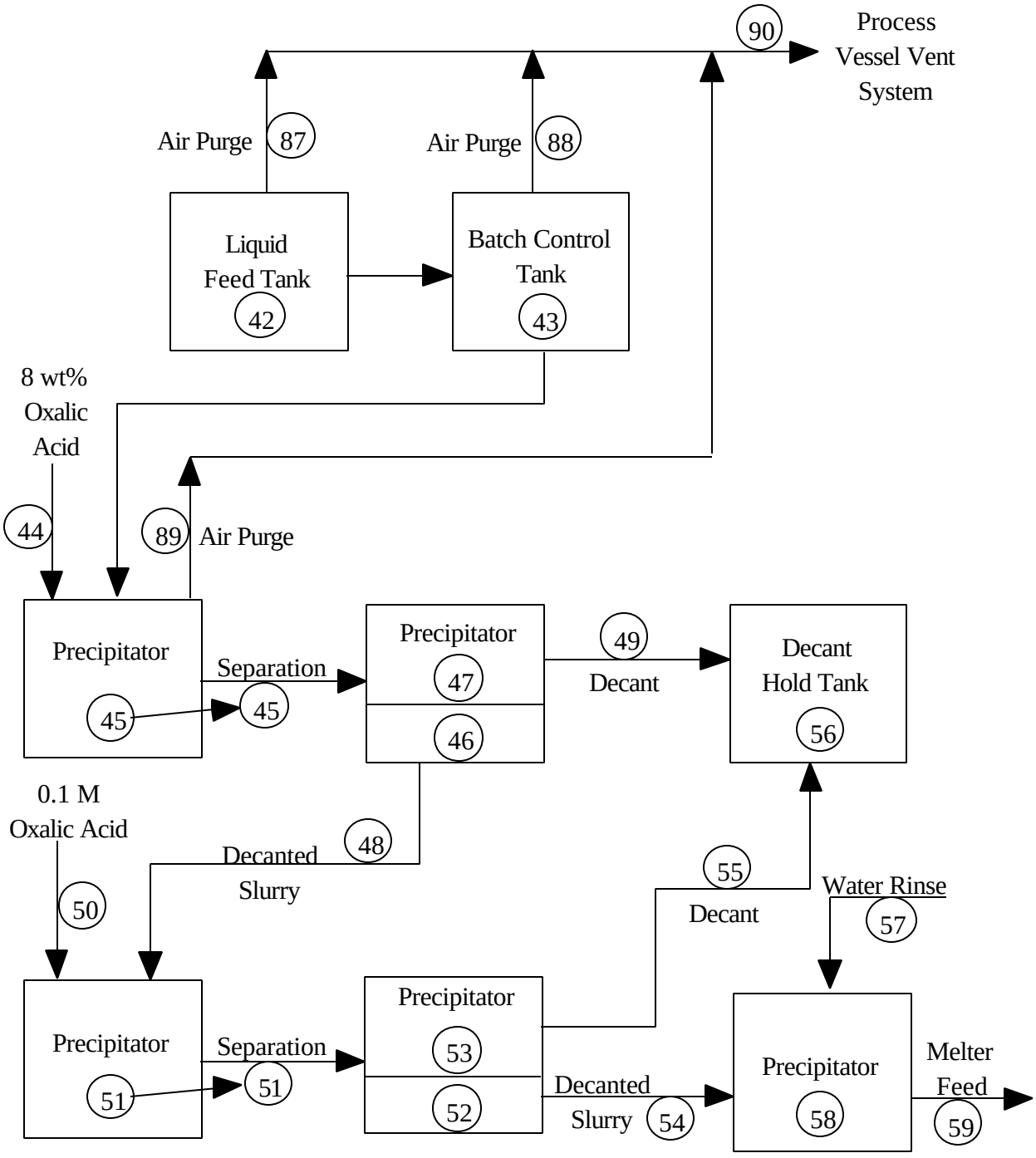

Figure 1. Flow diagram for Am/Cm vitrification melter feed preparation process.

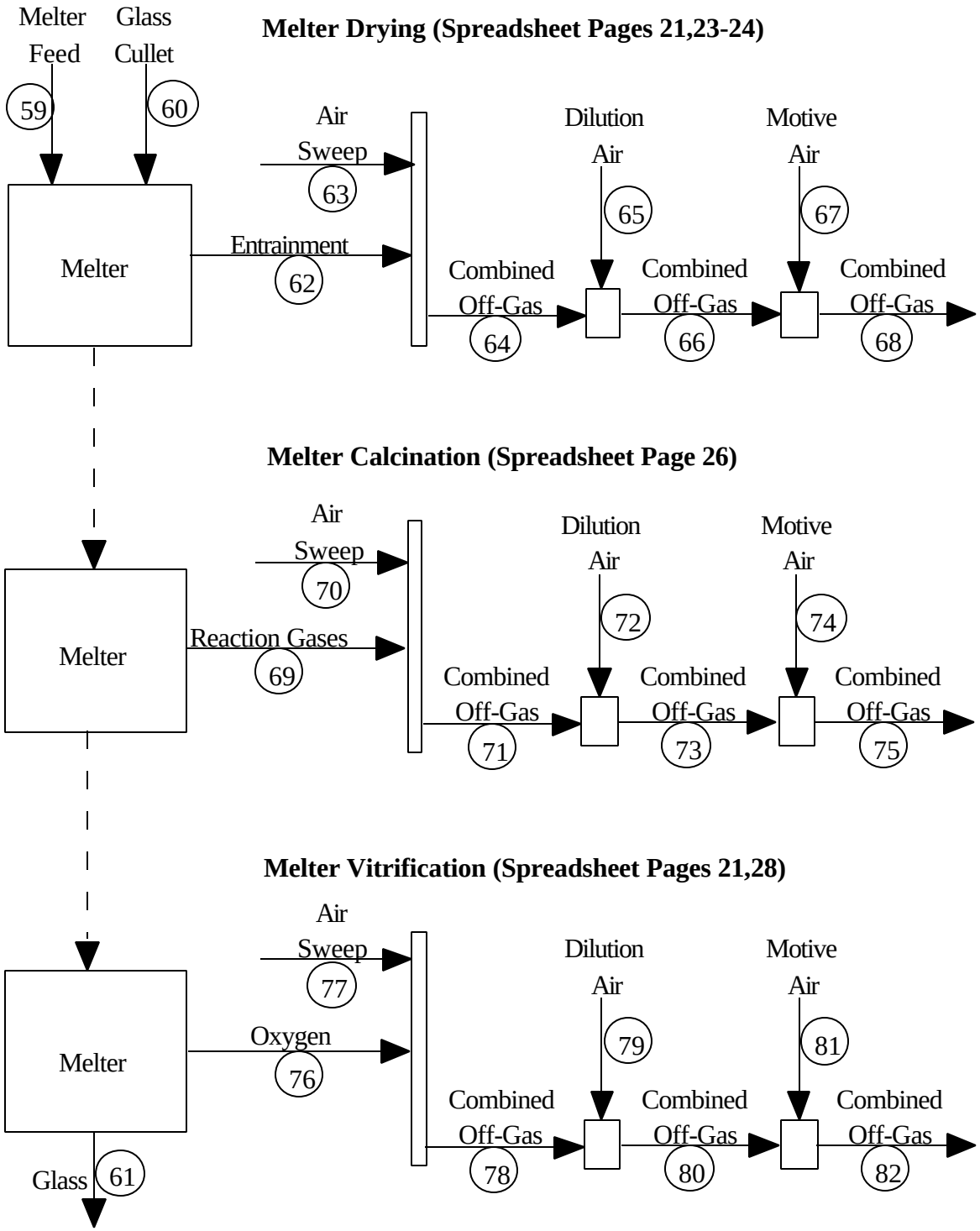

Figure 2. Flow diagram for Am/Cm vitrification and melter off-gas process.

FLOWSHEET

The pretreatment material balance for processing steps prior to stream 43 has been reported separately [1]. Oxalic acid precipitation and washing steps that further treat the melter feed are included as part of the melter feed preparation process. These oxalic acid precipitation and washing calculations are based on the same solubility data used previously for the pre-treatment material balance. It was found that using a constant volume ratio of adding 1.74 liter of 8% oxalic acid to each liter of feed solution produced a product having very close to the desired 0.3 M excess acid (see Stream 45). Therefore, this simplified calculation was used in the calculations. A listing of the streams in the vitrification material balance flowsheet and brief descriptions of each stream are provided in Tables 3 and 4.

Calculations are made in the material balance to determine the composition of glass product from the Am/Cm vitrification campaign and to estimate the average composition of the melter off-gas stream. Stream 60 gives the composition of the glass cullet (25 Sr ABS, [8]) in total grams and as the weight percent oxides. It is assumed that a stochiometric mixture of carbon monoxide and carbon dioxide is produced by the oxidation reactions in the melter. Subsequently, it is assumed that 20% of the carbon monoxide is burned to carbon dioxide in the off-gas. As assumed in the previous material balance calculations, 50% of the NO_x in the off-gas is decomposed to N_2 and O_2. Also, as in previous material balances, the off-gas is converted from total mass into a mass flow rate by assuming representative times for the melter operating steps. Three stages of melter operation are considered:

1. Drying phase from 50 °C to 200 °C that removes water from the feed solution.

2. Calcination phase from 200 °C to 700 °C where conversion of the feed material into oxides takes place.

3. Vitrification phase from 700 °C to 1450 °C where Ce^{IV} is reduced to Ce^{III}.

The material balance assumes that the melter processes occur uniformly over the specified time. The off-gas flow is then calculated by computing the total gas released from the melter and dividing by the specified operating time. For example, if the calcination step is assumed to occur in one hour, the products of the calcination reactions are assumed to be released uniformly over the one-hour time period.

The mixture off-gas temperature during the drying stage is calculated using constant specific heats of 0.4787 cal/g-C for water and 0.252 cal/g-C for air. The drying stage is the only gas mixing process where a significant amount of water is added to the off-gas. On a mass basis, most gaseous species other than water such as air, CO and CO_2 have similar heat capacities. Therefore, during the other melter phases the mixing off-gases are all simply treated as air.

Table 3. Vitrification Process Steps

Step	Description	Comment
	Precipitation/Decant	
43	Product of pre-treatment processing in Tank 17.3E	Solution used for melter feed preparation
44	Oxalic acid solution added to precipitator	8 wt% oxalic acid added with 0.3 molar excess over stochiometric requirement
45	Precipitator composition after oxalic acid addition and conversion from nitrate to oxalate salts	Total mixed contents of precipitator after oxalate salt precipitation
46	Precipitate layer formed in precipitator by oxalic acid addition	Volume calculated from 0.5 liter/mole [4]
47	Supernate layer formed in precipitator after settling	Composition based on salt solubility
48	Decanted precipitate and remaining supernate in precipitator	Assumes 1.5 liters supernate remains in precipitator for each batch
49	Supernate decanted from precipitator	
	Precipitate Washing	
50	Wash solution added to precipitator	0.1 M oxalic acid
51	Combined decanted slurry and oxalic acid wash in precipitator before separation	Total mixed contents of precipitator
52	Precipitate layer formed in precipitator after oxalic acid wash addition	Volume calculated from 0.5 liter/mole [4]
53	Supernate layer formed in precipitator after oxalic acid wash addition	Composition based on salt solubility
54	Decanted precipitate and remaining supernate after oxalic acid washing	Assumes that 1.5 liters supernate remains in precipitator after each batch
55	Supernate decanted from precipitator after oxalic acid washing	
56	Combined supernate decanted from precipitator after precipitation and washing	Stream 49 + Stream 55
	Melter Feed and Glass Product	
57	Deionized water used to rinse precipitator after transfer of contents into melter	270 ml of deionized water
58	Combination of decanted slurry and rinse solution representing total material fed to glass melter	
59	Melter feed composition as equivalent oxides	
60	Glass cullet composition	Grams and wt% oxides of 25 Sr ABS-F
61	Glass product composition	Grams and wt% oxides of Am/Cm glass

Table 3. Vitrification Process Steps (Continued)

Step	Description	Comment
	Melter Off-Gas: Drying Phase	
62	Entrainment in melter off-gas and water from melter feed	Assumes 0.1% of melter feed is entrained in off-gas flow during drying phase
63	Sweep air passing over melter during drying stage	Sweep air flow set to 65 scfm based on TNX testing
64	Combination of streams 62 and 63.	
65	Dilution air added to off-gas stream to prevent condensation. (optional)	Dilution air flow calculated to give 70% relative humidity in stream 66 [6, 7]
66	Combination of streams 64 and 65.	Mixture temperature calculated by heat balance using c_p (H_2O) = 0.4787 cal/g-C and c_p(air) = 0.252 cal/g-C
67	Motive air added to off-gas stream at exhaust jet.	Motive air flow set equal to sum of sweep air flow and dilution air flow
68	Combination of streams 66 and 67	
	Melter Off-Gas: Calcination Phase	
69	Calcination reaction products	Oxidation reactions
70	Sweep air passing over melter during calcination stage	Sweep air flow set to 65 scfm based on TNX testing
71	Combination of streams 69 and 70	
72	Dilution air added to off-gas stream to prevent condensation (optional)	Dilution air flow calculated to give 70% relative humidity in stream 73 [6, 7]
73	Combination of streams 71 and 72	
74	Motive air added to off-gas stream at exhaust jet	Motive air flow set equal to sum of sweep air flow and dilution air flow
75	Combination of streams 73 and 74	
	Melter Off-Gas: Vitrification Phase	
76	Oxygen released during vitrification	Reduction of Ce^{IV} to Ce^{III}
77	Sweep air passing over melter in vitrification stage	Sweep air flow set to 65 scfm based on TNX testing
78	Combination of streams 76 and 77	
79	Dilution air added to off-gas stream to prevent condensation (optional)	Dilution air flow calculated to give 70% relative humidity in stream 80 [6, 7]
80	Combination of streams 78 and 79	
81	Motive air added to off-gas stream at exhaust jet	Motive air flow set equal to sum of sweep air flow and dilution air flow
82	Combination of streams 80 and 81	

Table 4. Pretreatment and Vitrification Process Air Purges

Step	Description	Comment
	Tank Air Purges	
83	Air purge to Tank 17.1	Air purge calculations are based on maximum hydrogen gas generation in each tank.
84	Air purge to Tank 16.1E	
85	Air purge to Tank 16.3	
86	Air purge to Tank 17.3E	
87	Air purge to melter feed tank	
88	Air purge to melter batch tank	
89	Air purge to precipitator	
90	Combination of streams 83 through 89	Total air purge requirements for pretreatment and vitrification processing steps.

RESULTS

Full results from the vitrification material balance calculations are presented in the two Appendices attached to this report. These pages were printed directly from the material balance spreadsheet. Appendix A shows a material balance carrying all of the Am/Cm material through each step in the vitrification process. These tables report the total amounts of glass product and off-gases released. Appendix B shows a material balance for the melter feed preparation and vitrification parts of the flowsheet using a 6.91 liter batch of feed material from tank 17.3. The 6.91 liter batch is the batch size that has been used for full scale testing at TNX and the batch size that will be processed in the F-Canyon operations to produce canisters of glass. In all of the spreadsheets, dark shading is used to indicate cells where fixed parameter values have been entered. Light shading is used in the spreadsheets to indicate cells where values have been adjusted to produce the target values in the lightly shaded cells that the attached arrows point to.

Stream 43 is the final product of the pre-treatment processing collected in the 17.3 evaporator that will serve as material for the melter feed preparation process. The material balance shows 1197 liters of feed solution in Tank 17.3 (stream 43) which at 6.91 liters/batch translates into 173.23 melter feed batches. In Appendix A, all of this material is shown in each remaining stage of the process. In Appendix B, stream 43 is reduced to a 6.91 liter batch of the solution in 17.3 which is then passed through the melter feed preparation and vitrification stages of the processes. Beyond stream 43 in Appendix B, the calculations are all based on the mass and composition of this 6.91 liter batch.

Stream 61 gives the composition of the projected glass product in total grams of each metal oxide assuming a 49% loading from the actinide and lanthanide oxides in the feed stream. The glass cullet used is type 25SrABS-F with the composition specified by Meaker [8]. At the bottom of column 61, we see that about 320 kg of glass are predicted to be produced from the projected melter feed supply. The mass summation at the bottom of column 61 in Appendix B, shows that a 6.91 liter batch of the projected melter feed will produce 1.85 kg of glass. Column 61a gives the glass product composition as weight percent oxides.

Assuming that 0.10% of the total oxides in the melter feed are entrained in the off-gas flow, the top section of stream 62 shows the grams of each oxide that is lost from the melter through entrainment. The lower section of stream 62 shows the total grams of water produced from the melter drying step. Streams 69 and 76 show the total grams of gas produced in the melter calcination and vitrification steps, respectively. Streams 65, 72 and 79 on Spreadsheet pages 25, 27 and 29 show the dilution air that must be added to the combined melter off-gas and sweep air stream to give a mixture relative humidity of 70%. To calculate the required dilution airflow, a supply temperature of 20 ºC was assumed. Trial calculations showed that colder dilution air would more readily condense water vapor and was therefore the most conservative design case. Streams 66, 73 and 80 show combined melter off-gas flows obtained by adding the gaseous products from the melter operations with the dilution air. As an alternative to adding dilution air to the melter off-gas, Streams 66, 73 and 80 on Spreadsheet pages 26, 28 and 30 show the temperature to which the combined melter off-gas and sweep air stream must be heated to reduce the relative humidity to 70%. During the drying stage, when most of the water is released from the melter, the calculation shows that a temperature of about 37 °C is required to meet the 70% relative humidity criterion. During the other phases of the melter operation, an off-gas temperature of only about 26 °C is needed. An estimate of the humidity (700 ppm) in the F Canyon process air supply was obtained from SOP 221-F-62042. The motive airflow in the off-gas system was set equal to the sum of the melter off-gas, sweep air and dilution airflow. All of the combined gas streams show the material flow in g/hr assuming that the melter gases evolve over a one hour time period.

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APPENDIX A

Am/Cm Material Balance With Total Material in Streams – Melter Feed Preparation Steps and Melter Operations

Am/Cm Material Balance Spreadsheet Page 17

Batch	Precipitation								
Stream Name	Batch Tank	MPPF Feed	Oxalic Acid 8 wt%	Converted Composition	Precipitate	Supernate In Tank	Decanted Slurry	Decant Collection	Percent Recovery
Units	grams	g/l	grams	grams	grams	grams	grams	grams	
Stream Number	43	43	44	45	46	47	48	49	
Lan salts									
La(NO3)3	3.431E+04	2.866E+01	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Ce(NO3)3	2.689E+04	2.247E+01	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Pr(NO3)3	2.297E+04	1.919E+01	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Nd(NO3)3	6.517E+04	5.444E+01	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Sm(NO3)3	1.505E+04	1.257E+01	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Eu(NO3)3	3.046E+03	2.545E+00	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Gd(NO3)3	7.595E+03	6.345E+00	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Tb(NO3)3	9.555E+02	7.982E-01	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Dy(NO3)3	9.439E+02	7.885E-01	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Ho(NO3)3	9.363E+02	7.822E-01	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Er(NO3)3	9.292E+02	7.762E-01	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Tm(NO3)3	1.244E+03	1.039E+00	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Yb(NO3)3	9.124E+02	7.622E-01	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Lu(NO3)3	9.070E+02	7.577E-01	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Lan oxalates									
La2(C2O4)3	ZERO	ZERO	ZERO	2.861E+04	2.483E+04	3.776E+03	2.515E+04	3.462E+03	87.90
Ce2(C2O4)3	ZERO	ZERO	ZERO	2.244E+04	2.145E+04	9.936E+02	2.153E+04	9.110E+02	95.94
Pr2(C2O4)3	ZERO	ZERO	ZERO	1.918E+04	1.865E+04	5.298E+02	1.869E+04	4.857E+02	97.47
Nd2(C2O4)3	ZERO	ZERO	ZERO	5.452E+04	5.398E+04	5.321E+02	5.403E+04	4.878E+02	99.11
Sm2(C2O4)3	ZERO	ZERO	ZERO	1.264E+04	1.213E+04	5.033E+02	1.217E+04	4.615E+02	96.35
Eu2(C2O4)3	ZERO	ZERO	ZERO	2.560E+03	2.518E+03	4.179E+01	2.521E+03	3.831E+01	98.50
Gd2(C2O4)3	ZERO	ZERO	ZERO	6.401E+03	6.373E+03	2.771E+01	6.375E+03	2.541E+01	99.60
Tb2(C2O4)3	ZERO	ZERO	ZERO	8.060E+02	5.552E+02	2.508E+02	5.761E+02	2.299E+02	71.47
Dy2(C2O4)3	ZERO	ZERO	ZERO	7.977E+02	5.469E+02	2.508E+02	5.678E+02	2.299E+02	71.18
Ho2(C2O4)3	ZERO	ZERO	ZERO	7.922E+02	5.415E+02	2.508E+02	5.623E+02	2.299E+02	70.98
Er2(C2O4)3	ZERO	ZERO	ZERO	7.872E+02	5.364E+02	2.508E+02	5.573E+02	2.299E+02	70.79
Tm2(C2O4)3	ZERO	ZERO	ZERO	1.054E+03	8.037E+02	2.508E+02	8.245E+02	2.299E+02	78.20
Yb2(C2O4)3	ZERO	ZERO	ZERO	7.752E+02	5.244E+02	2.508E+02	5.453E+02	2.299E+02	70.34
Lu2(C2O4)3	ZERO	ZERO	ZERO	7.714E+02	5.206E+02	2.508E+02	5.415E+02	2.299E+02	70.19
Act salts									
Am(NO3)3	1.566E+04	1.308E+01	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Cm(NO3)3	3.843E+03	3.210E+00	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
NpO2(NO3)	6.289E-01	5.253E-04	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Pu(NO3)4	4.400E+03	3.676E+00	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
UO2(NO3)2	2.635E+02	2.201E-01	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
CsNO3	1.360E+00	1.136E-03	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Act oxalates									
Am2(C2O4)3	ZERO	ZERO	ZERO	1.369E+04	1.367E+04	2.547E+01	1.367E+04	2.335E+01	99.83
Cm2(C2O4)3	ZERO	ZERO	ZERO	3.360E+03	3.345E+03	1.537E+01	3.346E+03	1.409E+01	99.58
Np2O4(C2O4)	ZERO	ZERO	ZERO	5.947E-01	0.000E+00	5.947E-01	4.943E-02	5.452E-01	8.31
Pu(C2O4)2	ZERO	ZERO	ZERO	3.751E+03	3.733E+03	1.798E+01	3.735E+03	1.648E+01	99.56
UO2(C2O4)	ZERO	ZERO	ZERO	2.394E+02	0.000E+00	2.394E+02	1.990E+01	2.195E+02	8.31
Cs2C2O4	ZERO	ZERO	ZERO	1.234E+00	0.000E+00	1.234E+00	1.026E-01	1.132E+00	8.31

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Am/Cm Material Balance Spreadsheet Page 18

	Precipitation								
Stream Name	Batch Tank	MPPF Feed	Oxalic Acid 8 wt%	Converted Composition	Precipitate	Supernate in Tank	Decanted Slurry	Decant Collection	Percent Recovery
Units	grams	g/l	grams	grams	grams	grams	grams	grams	
Stream Number	43	43	44	45	46	47	48	49	
Metallic salts									
Al2(SO4)3	1.085E+03	9.068E-01	ZERO	1.085E+03	ZERO	1.085E+03	9.023E+01	9.952E+02	8.31
AlF3	7.992E+01	6.677E-02	ZERO	7.992E+01	ZERO	7.992E+01	6.644E+00	7.328E+01	8.31
Al(NO3)3	6.982E+02	5.833E-01	ZERO	6.982E+02	ZERO	6.982E+02	5.804E+01	6.402E+02	8.31
Ca(NO3)2	7.110E+01	5.940E-02	ZERO	7.110E+01	ZERO	7.110E+01	5.910E+00	6.519E+01	8.31
Cr(NO3)3	4.702E+02	3.928E-01	ZERO	4.702E+02	ZERO	4.702E+02	3.909E+01	4.311E+02	8.31
Fe2(SO4)3	2.193E+03	1.832E+00	ZERO	2.193E+03	ZERO	2.193E+03	1.823E+02	2.011E+03	8.31
FePO4	4.956E+02	4.140E-01	ZERO	4.956E+02	ZERO	4.956E+02	4.120E+01	4.544E+02	8.31
FeCl3	3.860E+02	3.225E-01	ZERO	3.860E+02	ZERO	3.860E+02	3.208E+01	3.539E+02	8.31
Fe2(C2O4)3	4.258E+02	3.557E-01	ZERO	4.258E+02	ZERO	4.258E+02	3.539E+01	3.904E+02	8.31
Fe(NO3)3	9.099E+02	7.601E-01	ZERO	9.099E+02	ZERO	9.099E+02	7.563E+01	8.342E+02	8.31
KNO3	1.463E+02	1.222E-01	ZERO	1.463E+02	ZERO	1.463E+02	1.216E+01	1.342E+02	8.31
Mn(NO3)2	2.337E+04	1.952E+01	ZERO	2.337E+04	ZERO	2.337E+04	1.942E+03	2.142E+04	8.31
NaNO3	1.718E+02	1.436E-01	ZERO	1.718E+02	ZERO	1.718E+02	1.428E+01	1.576E+02	8.31
NaNO2	2.648E+02	2.212E-01	ZERO	2.648E+02	ZERO	2.648E+02	2.201E+01	2.428E+02	8.31
Na2B4O7	1.010E+01	8.434E-03	ZERO	1.010E+01	ZERO	1.010E+01	8.392E-01	9.256E+00	8.31
Na2SiO3	1.666E+01	1.392E-02	ZERO	1.666E+01	ZERO	1.666E+01	1.385E+00	1.528E+01	8.31
Ni(NO3)2	2.341E+02	1.955E-01	ZERO	2.341E+02	ZERO	2.341E+02	1.946E+01	2.146E+02	8.31
Zn(NO3)2	1.602E+01	1.338E-02	ZERO	1.602E+01	ZERO	1.602E+01	1.331E+00	1.468E+01	8.31
Zr(NO3)4	3.944E+00	3.295E-03	ZERO	3.944E+00	ZERO	3.944E+00	3.278E-01	3.616E+00	8.31
Miscellaneous									
Insoluble solids	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
HNO3	7.543E+04	6.301E+01	ZERO	1.905E+05	ZERO	1.905E+05	1.584E+04	1.747E+05	
HCOOH	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
H2C2O4	ZERO	ZERO	1.729E+05	9.064E+04	ZERO	9.064E+04	7.534E+03	8.310E+04	
Gases/Water									
CO2	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
O2	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
N2	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
NOx	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
H2O	1.163E+06	9.717E+02	1.988E+06	3.151E+06	ZERO	3.151E+06	2.619E+05	2.889E+06	
Nitric Acid (M)	1.000E+00		ZERO	9.218E-01	ZERO	9.672E-01	6.074E-01	9.672E-01	
Oxalic Acid (M)	ZERO		9.218E-01	3.069E-01	ZERO	3.220E-01	2.022E-01	3.220E-01	
Mn+2 (M)									
Heat (W)	6.110E+03			6.110E+03	6.082E+03	2.770E+01	6.084E+03	2.540E+01	
G (H2)	6.575E-01			6.820E-01		6.675E-01	8.023E-01	6.675E-01	
H2 (g-mole/hr)	1.499E+00			1.555E+00		6.900E-03	1.821E+00	6.326E-03	
Air Purge (SCFM)	1.909E+00			1.980E+00		8.789E-03	2.320E+00	8.059E-03	
Volume (l)	1.197E+03		2.083E+03	3.280E+03	1.539E+02	3.126E+03	4.138E+02	2.866E+03	
Mass (kg)	1.476E+03		2.161E+03	3.636E+03	1.647E+02	3.472E+03	4.533E+02	3.183E+03	
Solids (g)	2.371E+05		ZERO	2.042E+05	1.647E+05	3.950E+04	1.680E+05	3.622E+04	
Solids (g/l)	1.981E+02		ZERO	6.226E+01	1.070E+03	1.264E+01	4.060E+02	1.264E+01	
Density (g/ml)	1.233E+00		1.037E+00	1.109E+00	1.070E+00	1.111E+00	1.096E+00	1.111E+00	
Phase	Liquid	Liquid	Liquid	Liquid	Solid	Liquid	Liquid	Liquid	
			Volume Ratio	Moles Precip			Volume Ratio		
			1.749	3.078E+02			8.313E-02		

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Am/Cm Material Balance Spreadsheet Page 19

Stream Name	Wash Oxalic Acid 0.1 M	Slurry and Wash	Precipitate	Supernate in Tank	Decanted Slurry	Decant Collection	Percent Recovery
Units	grams	grams	grams	grams	grams	grams	
Stream Number	50	51	52	53	54	55	
Lan salts							
La(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Ce(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Pr(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Nd(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Sm(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Eu(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Gd(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Tb(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Dy(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Ho(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Er(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Tm(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Yb(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Lu(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Lan oxalates							
La2(C2O4)3	ZERO	2.515E+04	2.515E+04	1.273E+00	2.515E+04	1.041E+00	87.90
Ce2(C2O4)3	ZERO	2.153E+04	2.153E+04	8.117E-01	2.153E+04	6.637E-01	95.94
Pr2(C2O4)3	ZERO	1.869E+04	1.869E+04	2.407E-01	1.869E+04	1.968E-01	97.47
Nd2(C2O4)3	ZERO	5.403E+04	5.403E+04	3.684E-01	5.403E+04	3.012E-01	99.10
Sm2(C2O4)3	ZERO	1.217E+04	1.217E+04	3.677E-01	1.217E+04	3.006E-01	96.35
Eu2(C2O4)3	ZERO	2.521E+03	2.521E+03	3.811E-02	2.521E+03	3.117E-02	98.50
Gd2(C2O4)3	ZERO	6.375E+03	6.375E+03	4.809E-02	6.375E+03	3.932E-02	99.60
Tb2(C2O4)3	ZERO	5.761E+02	5.759E+02	2.048E-01	5.759E+02	1.675E-01	71.45
Dy2(C2O4)3	ZERO	5.678E+02	5.676E+02	2.048E-01	5.676E+02	1.675E-01	71.16
Ho2(C2O4)3	ZERO	5.623E+02	5.621E+02	2.048E-01	5.622E+02	1.675E-01	70.96
Er2(C2O4)3	ZERO	5.573E+02	5.571E+02	2.048E-01	5.571E+02	1.675E-01	70.77
Tm2(C2O4)3	ZERO	8.245E+02	8.243E+02	2.048E-01	8.243E+02	1.675E-01	78.18
Yb2(C2O4)3	ZERO	5.453E+02	5.451E+02	2.048E-01	5.451E+02	1.675E-01	70.32
Lu2(C2O4)3	ZERO	5.415E+02	5.413E+02	2.048E-01	5.413E+02	1.675E-01	70.17
Act salts							
Am(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Cm(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
NpO2(NO3)	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Pu(NO3)4	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
UO2(NO3)2	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
CsNO3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Act oxalates							
Am2(C2O4)3	ZERO	1.367E+04	1.367E+04	2.100E+00	1.367E+04	1.717E+00	99.82
Cm2(C2O4)3	ZERO	3.346E+03	3.345E+03	1.051E+00	3.345E+03	8.595E-01	99.56
Np2O4(C2O4)	ZERO	4.943E-02	0.000E+00	4.943E-02	9.013E-03	4.042E-02	1.52
Pu(C2O4)2	ZERO	3.735E+03	3.713E+03	2.162E+01	3.717E+03	1.768E+01	99.09
UO2(C2O4)	ZERO	1.990E+01	0.000E+00	1.990E+01	3.628E+00	1.627E+01	1.52
Cs2C2O4	ZERO	1.026E-01	0.000E+00	1.026E-01	1.871E-02	8.389E-02	1.52

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Am/Cm Material Balance Spreadsheet Page 20

Stream Name	Wash Oxalic Acid 0.1 M	Slurry and Wash	Precipitate	Supernate in Tank	Decanted Slurry	Decant Collection	Percent Recovery
Units	grams	grams	grams	grams	grams	grams	
Stream Number	50	51	52	53	54	55	
Metallic salts							
Al2(SO4)3	ZERO	9.023E+01	ZERO	9.023E+01	1.645E+01	7.378E+01	1.52
AlF3	ZERO	6.644E+00	ZERO	6.644E+00	1.211E+00	5.432E+00	1.52
Al(NO3)3	ZERO	5.804E+01	ZERO	5.804E+01	1.058E+01	4.746E+01	1.52
Ca(NO3)2	ZERO	5.910E+00	ZERO	5.910E+00	1.078E+00	4.833E+00	1.52
Cr(NO3)3	ZERO	3.909E+01	ZERO	3.909E+01	7.127E+00	3.196E+01	1.52
Fe2(SO4)3	ZERO	1.823E+02	ZERO	1.823E+02	3.324E+01	1.491E+02	1.52
FePO4	ZERO	4.120E+01	ZERO	4.120E+01	7.512E+00	3.369E+01	1.52
FeCl3	ZERO	3.208E+01	ZERO	3.208E+01	5.850E+00	2.623E+01	1.52
Fe2(C2O4)3	ZERO	3.539E+01	ZERO	3.539E+01	6.453E+00	2.894E+01	1.52
Fe(NO3)3	ZERO	7.563E+01	ZERO	7.563E+01	1.379E+01	6.184E+01	1.52
KNO3	ZERO	1.216E+01	ZERO	1.216E+01	2.218E+00	9.945E+00	1.52
Mn(NO3)2	ZERO	1.942E+03	ZERO	1.942E+03	3.542E+02	1.588E+03	1.52
NaNO3	ZERO	1.428E+01	ZERO	1.428E+01	2.605E+00	1.168E+01	1.52
NaNO2	ZERO	2.201E+01	ZERO	2.201E+01	4.013E+00	1.800E+01	1.52
Na2B4O7	ZERO	8.392E-01	ZERO	8.392E-01	1.530E-01	6.862E-01	1.52
Na2SiO3	ZERO	1.385E+00	ZERO	1.385E+00	2.525E-01	1.132E+00	1.52
Ni(NO3)2	ZERO	1.946E+01	ZERO	1.946E+01	3.548E+00	1.591E+01	1.52
Zn(NO3)2	ZERO	1.331E+00	ZERO	1.331E+00	2.427E-01	1.089E+00	1.52
Zr(NO3)4	ZERO	3.278E-01	ZERO	3.278E-01	5.977E-02	2.681E-01	1.52
Miscellaneous							
insoluble solids	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
HNO3	ZERO	1.584E+04	ZERO	1.584E+04	2.888E+03	1.295E+04	
HCOOH	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
H2C2O4	1.078E+04	1.831E+04	ZERO	1.831E+04	3.339E+03	1.497E+04	
Gases/Water							
CO2	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
O2	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
N2	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
NOx	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
H2O	1.190E+06	1.452E+06	ZERO	1.452E+06	2.647E+05	1.187E+06	
Nitric Acid (M)	ZERO	1.560E-01	ZERO	1.717E-01	1.107E-01	1.717E-01	
Oxalic Acid (M)	1.000E-01	1.263E-01	ZERO	1.389E-01	8.962E-02	1.389E-01	
Mn+2 (M)							
Heat (W)		6.084E+03	6.082E+03	2.364E+00	6.082E+03	1.933E+00	
G (H2)		1.074E+00		1.062E+00	1.112E+00	1.062E+00	
H2 (g-mole/hr)		2.439E+00		9.365E-04	2.524E+00	7.658E-04	
Air Purge (SCFM)		3.107E+00		1.193E-03	3.215E+00	9.755E-04	
Volume (l)	1.197E+03	1.611E+03	1.468E+02	1.464E+03	4.138E+02	1.197E+03	
Mass (kg)	1.201E+03	1.654E+03	1.654E+02	1.489E+03	4.368E+02	1.217E+03	
Solids (g)	ZERO	1.680E+05	1.654E+05	2.630E+03	1.658E+05	2.151E+03	
Solids (g/l)	ZERO	1.043E+02	1.126E+03	1.797E+00	4.008E+02	1.797E+00	
Density (g/ml)	1.003E+00	1.027E+00	1.126E+00	1.017E+00	1.058E+00	1.017E+00	
Phase	Liquid	Liquid	Solid	Liquid	Liquid	Liquid	
		Moles Precip			Volume Ratio		
		2.937E+02			1.823E-01		

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Am/Cm Material Balance Spreadsheet Page 21

Stream Name	Total Decant	Rinse Water	Melter Feed	Melter Feed
Units	grams	grams	grams	g/l
Stream Number	56	57	58	58
Lan salts				
La(NO3)3	ZERO	ZERO	ZERO	ZERO
Ce(NO3)3	ZERO	ZERO	ZERO	ZERO
Pr(NO3)3	ZERO	ZERO	ZERO	ZERO
Nd(NO3)3	ZERO	ZERO	ZERO	ZERO
Sm(NO3)3	ZERO	ZERO	ZERO	ZERO
Eu(NO3)3	ZERO	ZERO	ZERO	ZERO
Gd(NO3)3	ZERO	ZERO	ZERO	ZERO
Tb(NO3)3	ZERO	ZERO	ZERO	ZERO
Dy(NO3)3	ZERO	ZERO	ZERO	ZERO
Ho(NO3)3	ZERO	ZERO	ZERO	ZERO
Er(NO3)3	ZERO	ZERO	ZERO	ZERO
Tm(NO3)3	ZERO	ZERO	ZERO	ZERO
Yb(NO3)3	ZERO	ZERO	ZERO	ZERO
Lu(NO3)3	ZERO	ZERO	ZERO	ZERO
Lan oxalates				
La2(C2O4)3	3.463E+03	ZERO	2.515E+04	5.460E+01
Ce2(C2O4)3	9.117E+02	ZERO	2.153E+04	4.675E+01
Pr2(C2O4)3	4.859E+02	ZERO	1.869E+04	4.058E+01
Nd2(C2O4)3	4.881E+02	ZERO	5.403E+04	1.173E+02
Sm2(C2O4)3	4.618E+02	ZERO	1.217E+04	2.644E+01
Eu2(C2O4)3	3.834E+01	ZERO	2.521E+03	5.474E+00
Gd2(C2O4)3	2.545E+01	ZERO	6.375E+03	1.384E+01
Tb2(C2O4)3	2.301E+02	ZERO	5.759E+02	1.250E+00
Dy2(C2O4)3	2.301E+02	ZERO	5.676E+02	1.232E+00
Ho2(C2O4)3	2.301E+02	ZERO	5.622E+02	1.221E+00
Er2(C2O4)3	2.301E+02	ZERO	5.571E+02	1.210E+00
Tm2(C2O4)3	2.301E+02	ZERO	8.243E+02	1.790E+00
Yb2(C2O4)3	2.301E+02	ZERO	5.451E+02	1.184E+00
Lu2(C2O4)3	2.301E+02	ZERO	5.413E+02	1.175E+00
Act salts				
Am(NO3)3	ZERO	ZERO	ZERO	ZERO
Cm(NO3)3	ZERO	ZERO	ZERO	ZERO
NpO2(NO3)	ZERO	ZERO	ZERO	ZERO
Pu(NO3)4	ZERO	ZERO	ZERO	ZERO
UO2(NO3)2	ZERO	ZERO	ZERO	ZERO
CsNO3	ZERO	ZERO	ZERO	ZERO
Act oxalates				
Am2(C2O4)3	2.507E+01	ZERO	1.367E+04	2.967E+01
Cm2(C2O4)3	1.495E+01	ZERO	3.345E+03	7.264E+00
Np2O4(C2O4)	5.857E-01	ZERO	9.013E-03	1.957E-05
Pu(C2O4)2	3.416E+01	ZERO	3.717E+03	8.071E+00
UO2(C2O4)	2.358E+02	ZERO	3.628E+00	7.879E-03
Cs2C2O4	1.215E+00	ZERO	1.871E-02	4.062E-05

Equivalent Feed Oxides

Stream Name	Oxide Feed	Dry Feed Oxides	Glass Cullet	25 SrABS Frit Oxides
Units	grams	wt%	grams	wt%
Stream Number	59	59	60	60
Lan oxides				
La2O3	1.512E+04	14.712	5.435E+04	25.000
Ce2O3	1.298E+04	12.634		
Pr2O3	1.129E+04	10.988		
Nd2O3	3.290E+04	32.015		
Sm2O3	7.517E+03	7.314		
Eu2O3	1.562E+03	1.520		
Gd2O3	3.994E+03	3.887		
Tb2O3	3.621E+02	0.352		
Dy2O3	3.594E+02	0.350		
Ho2O3	3.576E+02	0.348		
Er2O3	3.560E+02	0.346		
Tm2O3	5.284E+02	0.514		
Yb2O3	3.521E+02	0.343		
Lu2O3	3.508E+02	0.341		
Act oxides				
Am2O3	9.729E+03	9.466		
Cm2O3	2.384E+03	2.320		
Np2O5	7.976E-03	0.000		
PuO2	2.430E+03	2.365		
UO3	2.898E+00	0.003		
Cs2O	1.490E-02	0.000		
Metallic oxides				
Al2O3	8.171E+00	0.008	5.406E+04	24.870
B2O3	0.000E+00	0.000	2.943E+04	13.540
CaO	3.683E-01	0.000		
Cr2O3	4.551E+00	0.004		
Fe2O3	2.743E+01	0.027		
K2O	1.033E+00	0.001		
MnO	1.404E+02	0.137		
Na2O	2.927E+00	0.003		
NiO	1.450E+00	0.001		
SiO2	0.000E+00	0.000	7.322E+04	33.680
SrO	0.000E+00	0.000	6.326E+03	2.910
ZnO	1.043E-01	0.000		
ZrO2	2.171E-02	0.000		
Water/Acid			Cullet (kg)	
HNO3	2.888E+03		217.385	
H2C2O4	3.339E+03			
H2O	3.115E+05			
Volume (l)	4.605E+02			
Mass (kg)	4.205E+02			
Solids (g)	1.028E+05			
Solids (g/l)	2.232E+02			

Glass

Glass	Glass Oxides
grams	wt%
61	61a
6.945E+04	21.700
1.297E+04	4.053
1.128E+04	3.525
3.287E+04	10.270
7.509E+03	2.346
1.561E+03	0.488
3.990E+03	1.247
3.617E+02	0.113
3.590E+02	0.112
3.573E+02	0.112
3.556E+02	0.111
5.279E+02	0.165
3.517E+02	0.110
3.505E+02	0.110
9.719E+03	3.037
2.382E+03	0.744
7.968E-03	0.000
2.428E+03	0.759
2.896E+00	0.001
1.488E-02	0.000
5.407E+04	16.895
2.943E+04	9.197
3.679E-01	0.000
4.547E+00	0.001
2.740E+01	0.009
1.032E+00	0.000
1.403E+02	0.044
2.924E+00	0.001
1.449E+00	0.000
7.322E+04	22.876
6.326E+03	1.977
1.042E-01	0.000
2.169E-02	0.000
Glass (kg)	La+Ac (%)
320.052	49.00
Glass (l)	
86.501	

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Am/Cm Material Balance Spreadsheet Page 22

Stream Name	Total Decant	Rinse Water	Melter Feed	Melter Feed
Units	grams	grams	grams	g/l
Stream Number	56	57	58	58
Metallic salts				
Al2(SO4)3	1.069E+03	ZERO	1.645E+01	3.572E-02
AlF3	7.871E+01	ZERO	1.211E+00	2.630E-03
Al(NO3)3	6.876E+02	ZERO	1.058E+01	2.298E-02
Ca(NO3)2	7.002E+01	ZERO	1.078E+00	2.340E-03
Cr(NO3)3	4.631E+02	ZERO	7.127E+00	1.548E-02
Fe2(SO4)3	2.160E+03	ZERO	3.324E+01	7.217E-02
FePO4	4.881E+02	ZERO	7.512E+00	1.631E-02
FeCl3	3.801E+02	ZERO	5.850E+00	1.270E-02
Fe2(C2O4)3	4.193E+02	ZERO	6.453E+00	1.401E-02
Fe(NO3)3	8.961E+02	ZERO	1.379E+01	2.994E-02
KNO3	1.441E+02	ZERO	2.218E+00	4.815E-03
Mn(NO3)2	2.301E+04	ZERO	3.542E+02	7.690E-01
NaNO3	1.692E+02	ZERO	2.605E+00	5.655E-03
NaNO2	2.607E+02	ZERO	4.013E+00	8.713E-03
Na2B4O7	9.942E+00	ZERO	1.530E-01	3.322E-04
Na2SiO3	1.641E+01	ZERO	2.525E-01	5.483E-04
Ni(NO3)2	2.305E+02	ZERO	3.548E+00	7.703E-03
Zn(NO3)2	1.577E+01	ZERO	2.427E-01	5.271E-04
Zr(NO3)4	3.884E+00	ZERO	5.977E-02	1.298E-04
Miscellaneous				
Insoluble solids	ZERO	ZERO	ZERO	ZERO
HNO3	1.876E+05	ZERO	2.888E+03	6.270E+00
HCOOH	ZERO	ZERO	ZERO	ZERO
H2C2O4	9.808E+04	ZERO	3.339E+03	7.250E+00
Gases/Water				
CO2	ZERO	ZERO	ZERO	ZERO
O2	ZERO	ZERO	ZERO	ZERO
N2	ZERO	ZERO	ZERO	ZERO
NOx	ZERO	ZERO	ZERO	ZERO
H2O	4.076E+06	4.677E+04	3.115E+05	6.763E+02
Nitric Acid (M)	7.328E-01	ZERO	9.950E-02	
Oxalic Acid (M)	2.681E-01	ZERO	8.052E-02	
Mn+2 (M)				
Heat (W)	2.733E+01		6.082E+03	
G (H2)	7.496E-01		1.122E+00	
H2 (g-mole/hr)	7.644E-03		2.546E+00	
Air Purge (SCFM)	9.737E-03		3.243E+00	
Volume (l)	4.063E+03	4.677E+01	4.605E+02	
Mass (kg)	4.400E+03	4.677E+01	4.835E+02	
Solids (g)	3.837E+04	ZERO	1.658E+05	
Solids (g/l)	9.444E+00	ZERO	3.601E+02	
Density (g/ml)	1.083E+00	1.000E+00	1.050E+00	
Phase	Liquid	Liquid	Liquid	Liquid

Off-Gas Parameters

Entrainment	0.001
Volatile Cs	0.200
CO Burnup	0.200
NOx Decomposition	0.500

Glass Parameters

Glass Density (kg/l)	3.700
Glass Loading as Oxides	0.321

Batch Parameters

Batch Volume (l)	6.910
Residual Volume (l)	1.500
Rinse Volume (l)	0.270
Batch Pour Time (hr)	1.000
Number of Batches	173.23
Total Batch Time (hr)	173.23

Total Waste Volume (l)	8.435E+04

Am/Cm Material Balance Spreadsheet Page 23

Melter Off-Gas

Stream Name	Oxide Entrainment
Units	Grams
Stream Number	62
Lan oxides	
La2O3	1.512E+01
Ce2O3	1.298E+01
Pr2O3	1.129E+01
Nd2O3	3.290E+01
Sm2O3	7.517E+00
Eu2O3	1.562E+00
Gd2O3	3.994E+00
Tb2O3	3.621E-01
Dy2O3	3.594E-01
Ho2O3	3.576E-01
Er2O3	3.560E-01
Tm2O3	5.284E-01
Yb2O3	3.521E-01
Lu2O3	3.508E-01
Act oxides	
Am2O3	9.729E+00
Cm2O3	2.384E+00
Np2O5	7.976E-06
PuO2	2.430E+00
UO3	2.898E-03
Cs2O	1.490E-05
Metallic oxides	
Al2O3	8.171E-03
B2O3	0.000E+00
CaO	3.683E-04
Cr2O3	4.551E-03
Fe2O3	2.743E-02
K2O	1.033E-03
MnO	1.404E-01
Na2O	2.927E-03
NiO	1.450E-03
SiO2	0.000E+00
SrO	0.000E+00
ZnO	1.043E-04
ZrO2	2.171E-05
Total Mass (kg)	1.028E-01

Off-Gas Flow

Stream Name	Sweep Air	Combined Off-Gas	Dilution Air	Combined Off-Gas	Motive Air	Combined Off-Gas
Units	g/hr	g/hr	g/hr	g/hr	g/hr	g/hr
Stream Number	63	64	65	66	67	68
Lan oxides						
La2O3	ZERO	8.728E-02	ZERO	8.728E-02	ZERO	8.728E-02
Ce2O3	ZERO	7.495E-02	ZERO	7.495E-02	ZERO	7.495E-02
Pr2O3	ZERO	6.519E-02	ZERO	6.519E-02	ZERO	6.519E-02
Nd2O3	ZERO	1.899E-01	ZERO	1.899E-01	ZERO	1.899E-01
Sm2O3	ZERO	4.339E-02	ZERO	4.339E-02	ZERO	4.339E-02
Eu2O3	ZERO	9.018E-03	ZERO	9.018E-03	ZERO	9.018E-03
Gd2O3	ZERO	2.306E-02	ZERO	2.306E-02	ZERO	2.306E-02
Tb2O3	ZERO	2.090E-03	ZERO	2.090E-03	ZERO	2.090E-03
Dy2O3	ZERO	2.075E-03	ZERO	2.075E-03	ZERO	2.075E-03
Ho2O3	ZERO	2.065E-03	ZERO	2.065E-03	ZERO	2.065E-03
Er2O3	ZERO	2.055E-03	ZERO	2.055E-03	ZERO	2.055E-03
Tm2O3	ZERO	3.051E-03	ZERO	3.051E-03	ZERO	3.051E-03
Yb2O3	ZERO	2.032E-03	ZERO	2.032E-03	ZERO	2.032E-03
Lu2O3	ZERO	2.025E-03	ZERO	2.025E-03	ZERO	2.025E-03
Act oxides						
Am2O3	ZERO	5.616E-02	ZERO	5.616E-02	ZERO	5.616E-02
Cm2O3	ZERO	1.376E-02	ZERO	1.376E-02	ZERO	1.376E-02
Np2O5	ZERO	4.604E-08	ZERO	4.604E-08	ZERO	4.604E-08
PuO2	ZERO	1.403E-02	ZERO	1.403E-02	ZERO	1.403E-02
UO3	ZERO	1.673E-05	ZERO	1.673E-05	ZERO	1.673E-05
Cs2O	ZERO	8.601E-08	ZERO	8.601E-08	ZERO	8.601E-08
Metallic oxides						
Al2O3	ZERO	4.717E-05	ZERO	4.717E-05	ZERO	4.717E-05
B2O3	ZERO	0.000E+00	ZERO	0.000E+00	ZERO	0.000E+00
CaO	ZERO	2.126E-06	ZERO	2.126E-06	ZERO	2.126E-06
Cr2O3	ZERO	2.627E-05	ZERO	2.627E-05	ZERO	2.627E-05
Fe2O3	ZERO	1.583E-04	ZERO	1.583E-04	ZERO	1.583E-04
K2O	ZERO	5.964E-06	ZERO	5.964E-06	ZERO	5.964E-06
MnO	ZERO	8.104E-04	ZERO	8.104E-04	ZERO	8.104E-04
Na2O	ZERO	1.690E-05	ZERO	1.690E-05	ZERO	1.690E-05
NiO	ZERO	8.373E-06	ZERO	8.373E-06	ZERO	8.373E-06
SiO2	ZERO	0.000E+00	ZERO	0.000E+00	ZERO	0.000E+00
SrO	ZERO	0.000E+00	ZERO	0.000E+00	ZERO	0.000E+00
ZnO	ZERO	6.021E-07	ZERO	6.021E-07	ZERO	6.021E-07
ZrO2	ZERO	1.253E-07	ZERO	1.253E-07	ZERO	1.253E-07

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Am/Cm Material Balance Spreadsheet Page 24

Air Purge to Tanks	Tank 17.1	Evap 16.1E	Tank 16.3	Evap 17.3	Feed Tank	Batch Tank	Precip Tank	Feed Prep Vessel Vent
Units	g/hr	g/hr	g/hr	g/hr	g/hr	g/hr	g/hr	g/hr
Stream Number	83	84	85	86	87	88	89	90
Gases/Water Vapor								
CO2								
O2	1.310E+03	1.257E+03	6.857E+00	1.257E+03	3.883E+01	5.590E+00	2.723E+01	3.903E+03
N2	4.212E+03	4.043E+03	2.205E+01	4.043E+03	1.249E+02	1.797E+01	8.757E+01	1.255E+04
NOx								
H2O	8.069E+01	7.745E+01	4.223E-01	7.745E+01	2.392E+00	3.443E-01	1.677E+00	2.404E+02
Tank Volume (l)					48.00	6.91	6.91	
Purge Flow (SCFM)	2.583E+00	2.479E+00	1.352E-02	2.479E+00	7.655E-02	1.102E-02	5.369E-02	7.696E+00
Temperature (C)	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Temperature (K)	2.932E+02	2.932E+02	2.932E+02	2.932E+02	2.932E+02	2.932E+02	2.932E+02	2.932E+02
Psat (atm)	2.288E-02	2.288E-02	2.288E-02	2.288E-02	2.288E-02	2.288E-02	2.288E-02	2.288E-02
Volume Flow (l/hr)	4.710E+03	4.520E+03	2.465E+01	4.520E+03	1.396E+02	2.010E+01	9.790E+01	1.403E+04

Melter Mass Check Input	kg	Output	kg
Feed Material	483.544	Glass	320.052
Glass Cullet	217.385	Entrainment	0.103
		Water	311.475
		Calcine Rxn Prod.	68.666
		Vitrify Rxn Prod.	0.633
Total Mass	700.929	Total Mass	700.929

Am/Cm Material Balance Spreadsheet Page 25

Melter Off-Gas | Drying

Stream Name	Reaction Products
Units	grams
Stream Number	62
Gases	
H2O	3.115E+05
CO	
CO2	
O2	
N2	
NOx (NO + NO2)/2	
SO3	
POx (PO2 + PO3)/2	
HCl	
HF	
Temperature (C)	200.00
Pressure (in. H2O)	-2.00
Volume (l)	6.745E+05
Mass (g)	3.115E+05
Solids (g)	1.028E+02
Solids (g/l)	1.524E-04
Density (g/l)	4.619E-01
Phase	Vapor

Off-Gas Flow

Stream Name	Sweep Air	Combined Off-Gas	Dilution Air	Combined Off-Gas	Motive Air	Combined Off-Gas
Units	g/hr	g/hr	g/hr	g/hr	g/hr	g/hr
Stream Number	63	64	65	66	67	68
Gases						
H2O	2.031E+03	3.829E+03	1.502E+02	3.979E+03	2.497E+02	4.229E+03
CO						
CO2						
O2	3.297E+04	3.297E+04	4.592E+04	7.889E+04	7.633E+04	1.552E+05
N2	1.060E+05	1.060E+05	1.687E+05	2.747E+05	2.804E+05	5.550E+05
NOx (NO + NO2)/2						
SO3						
POx (PO2 + PO3)/2						
HCl						
HF						
Temperature (C)	20.00	24.26	20.00	21.70	20.00	20.85
Pressure (in. H2O)	0.00	0.00	0.00	0.00	0.00	0.00
Volume Flow (l/hr)	1.185E+05	1.227E+05	1.790E+05	3.022E+05	2.975E+05	6.006E+05
Mass Flow (g/hr)	1.410E+05	1.428E+05	2.146E+05	3.575E+05	3.567E+05	7.145E+05
Solids Flow (g/hr)		5.933E-01		5.933E-01		5.933E-01
Solids (g/l)		4.836E-06		1.963E-06		9.877E-07
Density (g/l)	1.190E+00	1.164E+00	1.199E+00	1.183E+00	1.199E+00	1.190E+00
Phase	Vapor	Vapor	Vapor	Vapor	Vapor	Vapor
Flow (SCFM)	6.500E+01	6.633E+01	9.815E+01	1.648E+02	1.632E+02	3.285E+02
Temperature (K)	2.932E+02	2.974E+02	2.932E+02	2.949E+02	2.932E+02	2.940E+02
Molecular Weight	2.861E+01	2.840E+01	2.884E+01	2.866E+01	2.884E+01	2.875E+01
Pvap (atm)	2.288E-02	4.242E-02	1.125E-03	1.777E-02	1.125E-03	9.483E-03
Psat (atm)	2.288E-02	2.963E-02	2.288E-02	2.539E-02	2.288E-02	2.411E-02
Dew Point (C)	1.992E+01	3.027E+01	-2.080E+01	1.592E+01	-2.080E+01	6.488E+00
Humidity (%)	1.000E+02	1.432E+02	4.918E+00	7.000E+01	4.918E+00	3.934E+01
ΔT (C)		-6.015E+00		5.781E+00		1.436E+01

Am/Cm Material Balance Spreadsheet Page 26

Melter Off-Gas	Drying
Stream Name	Reaction Products
Units	grams
Stream Number	62
Gases	
H2O	3.115E+05
CO	
CO2	
O2	
N2	
NOx (NO + NO2)/2	
SO3	
POx (PO2 + PO3)/2	
HCl	
HF	
Temperature (C)	200.00
Pressure (in. H2O)	2.00
Volume (l)	6.745E+05
Mass (g)	3.115E+05
Solids (g)	1.028E+02
Solids (g/l)	1.524E-04
Density (g/l)	4.619E-01
Phase	Vapor

Off-Gas Flow						
Stream Name	Sweep Air	Combined Off-Gas	Dilution Air	Combined Off-Gas	Motive Air	Combined Off-Gas
Units	g/hr	g/hr	g/hr	g/hr	g/hr	g/hr
Stream Number	63	64	65	66	67	68
Gases						
H2O	2.031E+03	3.829E+03		3.829E+03	9.947E+01	3.928E+03
CO						
CO2						
O2	3.297E+04	3.297E+04		3.297E+04	3.041E+04	6.338E+04
N2	1.060E+05	1.060E+05		1.060E+05	1.117E+05	2.177E+05
NOx (NO + NO2)/2						
SO3						
POx (PO2 + PO3)/2						
HCl						
HF						
Temperature (C)	20.00	24.26		36.73	20.00	28.39
Pressure (in. H2O)	0.00	0.00		0.00	0.00	0.00
Volume Flow (l/hr)	1.185E+05	1.227E+05		1.278E+05	1.185E+05	2.467E+05
Mass Flow (g/hr)	1.410E+05	1.428E+05		1.428E+05	1.421E+05	2.850E+05
Solids Flow (g/hr)		5.933E-01		5.933E-01		5.933E-01
Solids (g/l)		4.836E-06		4.641E-06		2.405E-06
Density (g/l)	1.190E+00	1.164E+00		1.117E+00	1.199E+00	1.155E+00
Phase	Vapor	Vapor	Vapor	Vapor	Vapor	Vapor
Flow (SCFM)	6.500E+01	6.633E+01		6.633E+01	6.500E+01	1.315E+02
Temperature (K)	2.932E+02	2.974E+02		3.099E+02	2.932E+02	3.015E+02
Molecular Weight	2.861E+01	2.840E+01		2.840E+01	2.884E+01	2.862E+01
Pvap (atm)	2.288E-02	4.242E-02		4.242E-02	1.125E-03	2.198E-02
Psat (atm)	2.288E-02	2.963E-02		6.060E-02	2.288E-02	3.781E-02
Dew Point (C)	1.992E+01	3.027E+01		3.027E+01	-2.080E+01	1.928E+01
Humidity (%)	1.000E+02	1.432E+02		7.000E+01	4.918E+00	5.812E+01
ΔT (C)		-6.015E+00		6.461E+00		9.111E+00

Am/Cm Material Balance Spreadsheet Page 27

Melter Off-Gas	Calcination
Stream Name	Reaction Products
Units	grams
Stream Number	69
Gases	
H2O	1.079E+03
CO	2.546E+04
CO2	4.000E+04
O2	1.719E+02
N2	
NOx (NO + NO2)/2	1.914E+03
SO3	3.151E+01
POx (PO2 + PO3)/2	1.767E+00
HCl	3.945E+00
HF	8.658E-01
Temperature (C)	700.00
Pressure (in. H2O)	2.00
Volume (l)	1.552E+05
Mass (g)	6.867E+04
Solids (g)	
Solids (g/l)	
Density (g/l)	4.424E-01
Phase	Vapor

Off-Gas Flow

Stream Name	Sweep Air	Combined Off-Gas	Dilution Air	Combined Off-Gas	Motive Air	Combined Off-Gas
Units	g/hr	g/hr	g/hr	g/hr	g/hr	g/hr
Stream Number	70	71	72	73	74	75
Gases						
H2O	2.031E+03	2.037E+03	3.345E+01	2.070E+03	1.329E+02	2.203E+03
CO		1.176E+02		1.176E+02		1.176E+02
CO2		2.771E+02		2.771E+02		2.771E+02
O2	3.297E+04	3.298E+04	1.023E+04	4.318E+04	4.064E+04	8.382E+04
N2	1.060E+05	1.060E+05	3.756E+04	1.436E+05	1.493E+05	2.928E+05
NOx (NO + NO2)/2		5.524E+00		5.524E+00		5.524E+00
SO3		1.819E-01		1.819E-01		1.819E-01
POx (PO2 + PO3)/2		1.020E-02		1.020E-02		1.020E-02
HCl		2.277E-02		2.277E-02		2.277E-02
HF		4.998E-03		4.998E-03		4.998E-03
Temperature (C)	20.00	21.91	20.00	21.42	20.00	20.71
Pressure (in. H2O)	0.00	0.00	0.00	0.00	0.00	0.00
Volume Flow (l/hr)	1.185E+05	1.196E+05	3.986E+04	1.595E+05	1.584E+05	3.184E+05
Mass Flow (g/hr)	1.410E+05	1.414E+05	4.779E+04	1.892E+05	1.899E+05	3.793E+05
Solids Flow (g/hr)						
Solids (g/l)						
Density (g/l)	1.190E+00	1.183E+00	1.199E+00	1.186E+00	1.199E+00	1.191E+00
Phase	Vapor	Vapor	Vapor	Vapor	Vapor	Vapor
Flow (SCFM)	6.500E+01	6.515E+01	2.186E+01	8.708E+01	8.686E+01	1.742E+02
Temperature (K)	2.932E+02	2.951E+02	2.932E+02	2.946E+02	2.932E+02	2.939E+02
Molecular Weight	2.861E+01	2.861E+01	2.884E+01	2.867E+01	2.884E+01	2.875E+01
Pvap (atm)	2.288E-02	2.296E-02	1.125E-03	1.748E-02	1.125E-03	9.309E-03
Psat (atm)	2.288E-02	2.571E-02	2.288E-02	2.497E-02	2.288E-02	2.390E-02
Dew Point (C)	1.992E+01	1.998E+01	-2.080E+01	1.566E+01	-2.080E+01	6.220E+00
Humidity (%)	1.000E+02	8.931E+01	4.918E+00	7.000E+01	4.918E+00	3.895E+01
ΔT (C)		1.927E+00		5.768E+00		1.449E+01

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Am/Cm Material Balance Spreadsheet Page 28

Melter Off-Gas	Calcination
Stream Name	Reaction Products
Units	grams
Stream Number	69
Gases	
H2O	1.079E+03
CO	2.546E+04
CO2	4.000E+04
O2	1.719E+02
N2	
NOx (NO + NO2)/2	1.914E+03
SO3	3.151E+01
POx (PO2 + PO3)/2	1.767E+00
HCl	3.945E+00
HF	8.658E-01
Temperature (C)	700.00
Pressure (in. H2O)	-2.00
Volume (l)	1.552E+05
Mass (g)	6.867E+04
Solids (g)	
Solids (g/l)	
Density (g/l)	4.424E-01
Phase	Vapor

Off-Gas Flow						
Stream Name	Sweep Air	Combined Off-Gas	Dilution Air	Combined Off-Gas	Motive Air	Combined Off-Gas
Units	g/hr	g/hr	g/hr	g/hr	g/hr	g/hr
Stream Number	70	71	72	73	74	75
Gases						
H2O	2.031E+03	2.037E+03		2.037E+03	9.947E+01	2.136E+03
CO		1.176E+02		1.176E+02		1.176E+02
CO2		2.771E+02		2.771E+02		2.771E+02
O2	3.297E+04	3.296E+04		3.296E+04	3.041E+04	6.337E+04
N2	1.060E+05	1.060E+05		1.060E+05	1.117E+05	2.177E+05
NOx (NO + NO2)/2		5.524E+00		5.524E+00		5.524E+00
SO3		1.819E-01		1.819E-01		1.819E-01
POx (PO2 + PO3)/2		1.020E-02		1.020E-02		1.020E-02
HCl		2.277E-02		2.277E-02		2.277E-02
HF		4.998E-03		4.998E-03		4.998E-03
Temperature (C)	20.00	21.91		25.97	20.00	22.98
Pressure (In. H2O)	0.00	0.00		0.00	0.00	0.00
Volume Flow (l/hr)	1.185E+05	1.196E+05		1.212E+05	1.185E+05	2.401E+05
Mass Flow (g/hr)	1.410E+05	1.414E+05		1.414E+05	1.421E+05	2.836E+05
Solids Flow (g/hr)						
Solids (g/l)						
Density (g/l)	1.190E+00	1.183E+00		1.167E+00	1.199E+00	1.181E+00
Phase	Vapor	Vapor	Vapor	Vapor	Vapor	Vapor
Flow (SCFM)	6.500E+01	6.515E+01		6.515E+01	6.500E+01	1.304E+02
Temperature (K)	2.932E+02	2.951E+02		2.991E+02	2.932E+02	2.961E+02
Molecular Weight	2.861E+01	2.861E+01		2.861E+01	2.884E+01	2.873E+01
Pvap (atm)	2.288E-02	2.296E-02		2.296E-02	1.125E-03	1.206E-02
Psat (atm)	2.288E-02	2.571E-02		3.280E-02	2.288E-02	2.743E-02
Dew Point (C)	1.992E+01	1.998E+01		1.998E+01	-2.080E+01	1.001E+01
Humidity (%)	1.000E+02	8.931E+01		7.000E+01	4.918E+00	4.395E+01
ΔT (C)		1.927E+00		5.986E+00		1.297E+01

Am/Cm Material Balance Spreadsheet Page 29

Melter Off-Gas | Vitrification

Stream Name	Reaction Products
Units	grams
Stream Number	76
Gases	
H2O	
CO	
CO2	
O2	6.329E+02
N2	
NOx (NO + NO2)/2	
SO3	
POx (PO2 + PO3)/2	
HCl	
HF	
Temperature (C)	700.00
Pressure (in. H2O)	2.00
Volume (l)	1.587E+03
Mass (g)	6.329E+02
Solids (g)	
Solids (g/l)	
Density (g/l)	3.988E-01
Phase	Vapor

Off-Gas Flow

Stream Name	Sweep Air	Combined Off-Gas	Dilution Air	Combined Off-Gas	Motive Air	Combined Off-Gas
Units	g/hr	g/hr	g/hr	g/hr	g/hr	g/hr
Stream Number	77	78	79	80	81	82
Gases						
H2O	2.031E+03	2.031E+03	4.626E+01	2.077E+03	1.457E+02	2.223E+03
CO						
CO2						
O2	3.297E+04	3.297E+04	1.414E+04	4.712E+04	4.455E+04	9.167E+04
N2	1.060E+05	1.060E+05	5.195E+04	1.580E+05	1.636E+05	3.216E+05
NOx (NO + NO2)/2						
SO3						
POx (PO2 + PO3)/2						
HCl						
HF						
Temperature (C)	20.00	20.02	20.00	20.01	20.00	20.01
Pressure (In. H2O)	0.00	0.00	0.00	0.00	0.00	0.00
Volume Flow (l/hr)	1.185E+05	1.185E+05	5.512E+04	1.738E+05	1.736E+05	3.480E+05
Mass Flow (g/hr)	1.410E+05	1.410E+05	6.609E+04	2.072E+05	2.082E+05	4.155E+05
Solids Flow (g/hr)						
Solids (g/l)						
Density (g/l)	1.190E+00	1.190E+00	1.199E+00	1.192E+00	1.199E+00	1.194E+00
Phase	Vapor	Vapor	Vapor	Vapor	Vapor	Vapor
Flow (SCFM)	6.500E+01	6.501E+01	3.023E+01	9.534E+01	9.523E+01	1.909E+02
Temperature (K)	2.932E+02	2.932E+02	2.932E+02	2.932E+02	2.932E+02	2.932E+02
Molecular Weight	2.861E+01	2.861E+01	2.884E+01	2.868E+01	2.884E+01	2.876E+01
Pvap (atm)	2.288E-02	2.296E-02	1.125E-03	1.602E-02	1.125E-03	8.574E-03
Psat (atm)	2.288E-02	2.290E-02	2.288E-02	2.289E-02	2.288E-02	2.288E-02
Dew Point (C)	1.992E+01	1.997E+01	-2.080E+01	1.431E+01	-2.080E+01	5.042E+00
Humidity (%)	1.000E+02	1.002E+02	4.918E+00	7.000E+01	4.918E+00	3.747E+01
ΔT (C)		4.265E-02		5.699E+00		1.496E+01

Am/Cm Material Balance Spreadsheet Page 30

Melter Off-Gas	Vitrification
Stream Name	Reaction Products
Units	grams
Stream Number	76
Gases	
H2O	
CO	
CO2	
O2	6.329E+02
N2	
NOx (NO + NO2)/2	
SO3	
POx (PO2 + PO3)/2	
HCl	
HF	
Temperature (C)	700.00
Pressure (in. H2O)	-2.00
Volume (l)	1.587E+03
Mass (g)	6.329E+02
Solids (g)	
Solids (g/l)	
Density (g/l)	3.988E-01
Phase	Vapor

Off-Gas Flow						
Stream Name	Sweep Air	Combined Off-Gas	Dilution Air	Combined Off-Gas	Motive Air	Combined Off-Gas
Units	g/hr	g/hr	g/hr	g/hr	g/hr	g/hr
Stream Number	77	78	79	80	81	82
Gases						
H2O	2.031E+03	2.031E+03		2.031E+03	9.947E+01	2.130E+03
CO						
CO2						
O2	3.297E+04	3.297E+04		3.297E+04	3.041E+04	6.338E+04
N2	1.060E+05	1.060E+05		1.060E+05	1.117E+05	2.177E+05
NOx (NO + NO2)/2						
SO3						
POx (PO2 + PO3)/2						
HCl						
HF						
Temperature (C)	20.00	20.02		25.96	20.00	22.97
Pressure (in. H2O)	0.00	0.00		0.00	0.00	0.00
Volume Flow (l/hr)	1.185E+05	1.185E+05		1.209E+05	1.185E+05	2.398E+05
Mass Flow (g/hr)	1.410E+05	1.410E+05		1.410E+05	1.421E+05	2.832E+05
Solids Flow (g/hr)						
Solids (g/l)						
Density (g/l)	1.190E+00	1.190E+00		1.166E+00	1.199E+00	1.181E+00
Phase	Vapor	Vapor	Vapor	Vapor	Vapor	Vapor
Flow (SCFM)	6.500E+01	6.501E+01		6.501E+01	6.500E+01	1.302E+02
Temperature (K)	2.932E+02	2.932E+02		2.991E+02	2.932E+02	2.961E+02
Molecular Weight	2.861E+01	2.861E+01		2.861E+01	2.884E+01	2.873E+01
Pvap (atm)	2.288E-02	2.296E-02		2.296E-02	1.125E-03	1.204E-02
Psat (atm)	2.288E-02	2.290E-02		3.279E-02	2.288E-02	2.742E-02
Dew Point (C)	1.992E+01	1.997E+01		1.997E+01	-2.080E+01	9.985E+00
Humidity (%)	1.000E+02	1.002E+02		7.000E+01	4.918E+00	4.390E+01
ΔT (C)		4.265E-02		5.985E+00		1.298E+01

APPENDIX B

Am/Cm Material Balance for 6.91 liter Batch – Melter Feed Preparation Steps and Melter Operations

Version 2

Am/Cm Material Balance Spreadsheet Page 17

Batch Precipitation

Stream Name	Batch Tank	MPPF Feed	Oxalic Acid 8 wt%	Converted Composition	Precipitate	Supernate in Tank	Decanted Slurry	Decant Collection	Percent Recovery
Units	grams	g/l	grams	grams	grams	grams	grams	grams	
Stream Number	43	43	44	45	46	47	48	49	
Lan salts									
La(NO3)3	1.981E+02	2.866E+01	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Ce(NO3)3	1.552E+02	2.247E+01	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Pr(NO3)3	1.326E+02	1.919E+01	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Nd(NO3)3	3.762E+02	5.444E+01	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Sm(NO3)3	8.689E+01	1.257E+01	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Eu(NO3)3	1.758E+01	2.545E+00	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Gd(NO3)3	4.385E+01	6.345E+00	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Tb(NO3)3	5.516E+00	7.982E-01	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Dy(NO3)3	5.449E+00	7.885E-01	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Ho(NO3)3	5.405E+00	7.822E-01	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Er(NO3)3	5.364E+00	7.762E-01	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Tm(NO3)3	7.179E+00	1.039E+00	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Yb(NO3)3	5.267E+00	7.622E-01	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Lu(NO3)3	5.236E+00	7.577E-01	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Lan oxalates									
La2(C2O4)3	ZERO	ZERO	ZERO	1.651E+02	1.434E+02	2.180E+01	1.452E+02	1.998E+01	87.90
Ce2(C2O4)3	ZERO	ZERO	ZERO	1.296E+02	1.238E+02	5.736E+00	1.243E+02	5.259E+00	95.94
Pr2(C2O4)3	ZERO	ZERO	ZERO	1.107E+02	1.076E+02	3.058E+00	1.079E+02	2.804E+00	97.47
Nd2(C2O4)3	ZERO	ZERO	ZERO	3.147E+02	3.116E+02	3.071E+00	3.119E+02	2.816E+00	99.11
Sm2(C2O4)3	ZERO	ZERO	ZERO	7.295E+01	7.004E+01	2.905E+00	7.028E+01	2.664E+00	96.35
Eu2(C2O4)3	ZERO	ZERO	ZERO	1.478E+01	1.453E+01	2.412E-01	1.455E+01	2.212E-01	98.50
Gd2(C2O4)3	ZERO	ZERO	ZERO	3.695E+01	3.679E+01	1.600E-01	3.680E+01	1.467E-01	99.60
Tb2(C2O4)3	ZERO	ZERO	ZERO	4.653E+00	3.205E+00	1.448E+00	3.325E+00	1.327E+00	71.47
Dy2(C2O4)3	ZERO	ZERO	ZERO	4.605E+00	3.157E+00	1.448E+00	3.277E+00	1.327E+00	71.18
Ho2(C2O4)3	ZERO	ZERO	ZERO	4.573E+00	3.126E+00	1.448E+00	3.246E+00	1.327E+00	70.98
Er2(C2O4)3	ZERO	ZERO	ZERO	4.544E+00	3.097E+00	1.448E+00	3.217E+00	1.327E+00	70.79
Tm2(C2O4)3	ZERO	ZERO	ZERO	6.087E+00	4.639E+00	1.448E+00	4.760E+00	1.327E+00	78.20
Yb2(C2O4)3	ZERO	ZERO	ZERO	4.475E+00	3.027E+00	1.448E+00	3.148E+00	1.327E+00	70.34
Lu2(C2O4)3	ZERO	ZERO	ZERO	4.453E+00	3.005E+00	1.448E+00	3.126E+00	1.327E+00	70.19
Act salts									
Am(NO3)3	9.041E+01	1.308E+01	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Cm(NO3)3	2.218E+01	3.210E+00	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
NpO2(NO3)	3.630E-03	5.253E-04	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Pu(NO3)4	2.540E+01	3.676E+00	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
UO2(NO3)2	1.521E+00	2.201E-01	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
CsNO3	7.849E-03	1.136E-03	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Act oxalates									
Am2(C2O4)3	ZERO	ZERO	ZERO	7.903E+01	7.889E+01	1.470E-01	7.890E+01	1.348E-01	99.83
Cm2(C2O4)3	ZERO	ZERO	ZERO	1.940E+01	1.931E+01	8.870E-02	1.932E+01	8.133E-02	99.58
Np2O4(C2O4)	ZERO	ZERO	ZERO	3.433E-03	0.000E+00	3.433E-03	2.854E-04	3.147E-03	8.31
Pu(C2O4)2	ZERO	ZERO	ZERO	2.166E+01	2.155E+01	1.038E-01	2.156E+01	9.516E-02	99.56
UO2(C2O4)	ZERO	ZERO	ZERO	1.382E+00	0.000E+00	1.382E+00	1.149E-01	1.267E+00	8.31
Cs2C2O4	ZERO	ZERO	ZERO	7.125E-03	0.000E+00	7.125E-03	5.922E-04	6.532E-03	8.31

Am/Cm Material Balance Spreadsheet Page 18

	Precipitation								
Stream Name	Batch Tank	MPPF Feed	Oxalic Acid 8 wt%	Converted Composition	Precipitate	Supernate in Tank	Decanted Slurry	Decant Collection	Percent Recovery
Units	grams	g/l	grams	grams	grams	grams	grams	grams	
Stream Number	43	43	44	45	46	47	48	49	
Metallic salts									
Al2(SO4)3	6.266E+00	9.068E-01	ZERO	6.266E+00	ZERO	6.266E+00	5.208E-01	5.745E+00	8.31
AlF3	4.614E-01	6.677E-02	ZERO	4.614E-01	ZERO	4.614E-01	3.835E-02	4.230E-01	8.31
Al(NO3)3	4.031E+00	5.833E-01	ZERO	4.031E+00	ZERO	4.031E+00	3.350E-01	3.696E+00	8.31
Ca(NO3)2	4.105E-01	5.940E-02	ZERO	4.105E-01	ZERO	4.105E-01	3.412E-02	3.763E-01	8.31
Cr(NO3)3	2.714E+00	3.928E-01	ZERO	2.714E+00	ZERO	2.714E+00	2.256E-01	2.489E+00	8.31
Fe2(SO4)3	1.266E+01	1.832E+00	ZERO	1.266E+01	ZERO	1.266E+01	1.052E+00	1.161E+01	8.31
FePO4	2.861E+00	4.140E-01	ZERO	2.861E+00	ZERO	2.861E+00	2.378E-01	2.623E+00	8.31
FeCl3	2.228E+00	3.225E-01	ZERO	2.228E+00	ZERO	2.228E+00	1.852E-01	2.043E+00	8.31
Fe2(C2O4)3	2.458E+00	3.557E-01	ZERO	2.458E+00	ZERO	2.458E+00	2.043E-01	2.254E+00	8.31
Fe(NO3)3	5.252E+00	7.601E-01	ZERO	5.252E+00	ZERO	5.252E+00	4.366E-01	4.816E+00	8.31
KNO3	8.446E-01	1.222E-01	ZERO	8.446E-01	ZERO	8.446E-01	7.021E-02	7.744E-01	8.31
Mn(NO3)2	1.349E+02	1.952E+01	ZERO	1.349E+02	ZERO	1.349E+02	1.121E+01	1.237E+02	8.31
NaNO3	9.920E-01	1.436E-01	ZERO	9.920E-01	ZERO	9.920E-01	8.246E-02	9.095E-01	8.31
NaNO2	1.528E+00	2.212E-01	ZERO	1.528E+00	ZERO	1.528E+00	1.270E-01	1.401E+00	8.31
Na2B4O7	5.828E-02	8.434E-03	ZERO	5.828E-02	ZERO	5.828E-02	4.844E-03	5.343E-02	8.31
Na2SiO3	9.618E-02	1.392E-02	ZERO	9.618E-02	ZERO	9.618E-02	7.995E-03	8.818E-02	8.31
Ni(NO3)2	1.351E+00	1.955E-01	ZERO	1.351E+00	ZERO	1.351E+00	1.123E-01	1.239E+00	8.31
Zn(NO3)2	9.245E-02	1.338E-02	ZERO	9.245E-02	ZERO	9.245E-02	7.685E-03	8.477E-02	8.31
Zr(NO3)4	2.277E-02	3.295E-03	ZERO	2.277E-02	ZERO	2.277E-02	1.892E-03	2.087E-02	8.31
Miscellaneous									
insoluble solids	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
HNO3	4.354E+02	6.301E+01	ZERO	1.100E+03	ZERO	1.100E+03	9.142E+01	1.008E+03	
HCOOH	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
H2C2O4	ZERO	ZERO	9.978E+02	5.232E+02	ZERO	5.232E+02	4.349E+01	4.797E+02	
Gases/Water									
CO2	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
O2	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
N2	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
NOx	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
H2O	6.714E+03	9.717E+02	1.148E+04	1.819E+04	ZERO	1.819E+04	1.512E+03	1.668E+04	
Nitric Acid (M)	1.000E+00		ZERO	9.218E-01	ZERO	9.672E-01	6.074E-01	9.672E-01	
Oxalic Acid (M)	ZERO		9.218E-01	3.069E-01	ZERO	3.220E-01	2.022E-01	3.220E-01	
Mn+2 (M)									
Heat (W)	3.527E+01			3.527E+01		3.527E+01	3.512E+01	1.466E-01	
G (H2)	6.575E-01			6.820E-01		6.675E-01	8.023E-01	6.675E-01	
H2 (g-mole/hr)	8.652E-03			8.974E-03		8.784E-03	1.051E-02	3.652E-05	
Air Purge (SCFM)	1.102E-02			1.143E-02		1.119E-02	1.339E-02	4.652E-05	
Volume (l)	6.910E+00		1.202E+01	1.893E+01	8.886E-01	1.804E+01	2.389E+00	1.654E+01	
Mass (kg)	8.518E+00		1.247E+01	2.099E+01	9.508E-01	2.004E+01	2.617E+00	1.837E+01	
Solids (g)	1.369E+03		ZERO	1.179E+03	9.508E+02	2.280E+02	9.698E+02	2.091E+02	
Solids (g/l)	1.981E+02		ZERO	6.226E+01	1.070E+03	1.264E+01	4.060E+02	1.264E+01	
Density (g/ml)	1.233E+00		1.037E+00	1.109E+00	1.070E+00	1.111E+00	1.096E+00	1.111E+00	
Phase	Liquid	Liquid	Liquid	Liquid	Solid	Liquid	Liquid	Liquid	
			Volume Ratio	Moles Precip			Volume Ratio		
			1.740	1.777E+00			8.313E-02		

Am/Cm Material Balance Spreadsheet Page 19

Stream Name	Wash Oxalic Acid 0.1 M	Slurry and Wash	Precipitate	Supernate In Tank	Decanted Slurry	Decant Collection	Percent Recovery
Units	grams	grams	grams	grams	grams	grams	
Stream Number	50	51	52	53	54	55	
Lan salts							
La(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Ce(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Pr(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Nd(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Sm(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Eu(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Gd(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Tb(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Dy(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Ho(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Er(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Tm(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Yb(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Lu(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Lan oxalates							
La2(C2O4)3	ZERO	1.452E+02	1.452E+02	7.347E-03	1.452E+02	6.007E-03	87.90
Ce2(C2O4)3	ZERO	1.243E+02	1.243E+02	4.685E-03	1.243E+02	3.831E-03	95.94
Pr2(C2O4)3	ZERO	1.079E+02	1.079E+02	1.390E-03	1.079E+02	1.136E-03	97.47
Nd2(C2O4)3	ZERO	3.119E+02	3.119E+02	2.127E-03	3.119E+02	1.739E-03	99.10
Sm2(C2O4)3	ZERO	7.028E+01	7.028E+01	2.122E-03	7.028E+01	1.735E-03	96.35
Eu2(C2O4)3	ZERO	1.455E+01	1.455E+01	2.200E-04	1.455E+01	1.799E-04	98.50
Gd2(C2O4)3	ZERO	3.680E+01	3.680E+01	2.776E-04	3.680E+01	2.270E-04	99.60
Tb2(C2O4)3	ZERO	3.325E+00	3.324E+00	1.182E-03	3.324E+00	9.669E-04	71.45
Dy2(C2O4)3	ZERO	3.277E+00	3.276E+00	1.182E-03	3.277E+00	9.669E-04	71.16
Ho2(C2O4)3	ZERO	3.246E+00	3.245E+00	1.182E-03	3.245E+00	9.669E-04	70.96
Er2(C2O4)3	ZERO	3.217E+00	3.216E+00	1.182E-03	3.216E+00	9.669E-04	70.77
Tm2(C2O4)3	ZERO	4.760E+00	4.758E+00	1.182E-03	4.759E+00	9.669E-04	78.18
Yb2(C2O4)3	ZERO	3.148E+00	3.147E+00	1.182E-03	3.147E+00	9.669E-04	70.32
Lu2(C2O4)3	ZERO	3.126E+00	3.125E+00	1.182E-03	3.125E+00	9.669E-04	70.17
Act salts							
Am(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Cm(NO3)3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
NpO2(NO3)	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Pu(NO3)4	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
UO2(NO3)2	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
CsNO3	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
Act oxalates							
Am2(C2O4)3	ZERO	7.890E+01	7.889E+01	1.212E-02	7.889E+01	9.913E-03	99.82
Cm2(C2O4)3	ZERO	1.932E+01	1.931E+01	6.068E-03	1.931E+01	4.962E-03	99.56
Np2O4(C2O4)	ZERO	2.854E-04	0.000E+00	2.854E-04	5.203E-05	2.333E-04	1.52
Pu(C2O4)2	ZERO	2.156E+01	2.149E+01	7.287E-02	2.150E+01	5.959E-02	99.29
UO2(C2O4)	ZERO	1.149E-01	0.000E+00	1.149E-01	2.095E-02	9.393E-02	1.52
Cs2C2O4	ZERO	5.922E-04	0.000E+00	5.922E-04	1.080E-04	4.843E-04	1.52

Am/Cm Material Balance Spreadsheet Page 20

Stream Name	Wash Oxalic Acid 0.1 M	Slurry and Wash	Precipitate	Supernate in Tank	Decanted Slurry	Decant Collection	Percent Recovery
Units	grams	grams	grams	grams	grams	grams	
Stream Number	50	51	52	53	54	55	
Metallic salts							
Al2(SO4)3	ZERO	5.208E-01	ZERO	5.208E-01	9.497E-02	4.259E-01	1.52
AlF3	ZERO	3.835E-02	ZERO	3.835E-02	6.993E-03	3.136E-02	1.52
Al(NO3)3	ZERO	3.350E-01	ZERO	3.350E-01	6.109E-02	2.740E-01	1.52
Ca(NO3)2	ZERO	3.412E-02	ZERO	3.412E-02	6.221E-03	2.790E-02	1.52
Cr(NO3)3	ZERO	2.256E-01	ZERO	2.256E-01	4.114E-02	1.845E-01	1.52
Fe2(SO4)3	ZERO	1.052E+00	ZERO	1.052E+00	1.919E-01	8.605E-01	1.52
FePO4	ZERO	2.378E-01	ZERO	2.378E-01	4.336E-02	1.945E-01	1.52
FeCl3	ZERO	1.852E-01	ZERO	1.852E-01	3.377E-02	1.514E-01	1.52
Fe2(C2O4)3	ZERO	2.043E-01	ZERO	2.043E-01	3.725E-02	1.671E-01	1.52
Fe(NO3)3	ZERO	4.366E-01	ZERO	4.366E-01	7.961E-02	3.570E-01	1.52
KNO3	ZERO	7.021E-02	ZERO	7.021E-02	1.280E-02	5.741E-02	1.52
Mn(NO3)2	ZERO	1.121E+01	ZERO	1.121E+01	2.044E+00	9.168E+00	1.52
NaNO3	ZERO	8.246E-02	ZERO	8.246E-02	1.504E-02	6.743E-02	1.52
NaNO2	ZERO	1.270E-01	ZERO	1.270E-01	2.316E-02	1.039E-01	1.52
Na2B4O7	ZERO	4.844E-03	ZERO	4.844E-03	8.833E-04	3.961E-03	1.52
Na2SiO3	ZERO	7.995E-03	ZERO	7.995E-03	1.458E-03	6.537E-03	1.52
Ni(NO3)2	ZERO	1.123E-01	ZERO	1.123E-01	2.048E-02	9.184E-02	1.52
Zn(NO3)2	ZERO	7.685E-03	ZERO	7.685E-03	1.401E-03	6.284E-03	1.52
Zr(NO3)4	ZERO	1.892E-03	ZERO	1.892E-03	3.451E-04	1.547E-03	1.52
Miscellaneous							
Insoluble solids	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
HNO3	ZERO	9.142E+01	ZERO	9.142E+01	1.667E+01	7.475E+01	
HCOOH	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
H2C2O4	6.221E+01	4.349E+01	ZERO	4.349E+01	7.930E+00	3.556E+01	
Gases/Water							
CO2	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
O2	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
N2	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
NOx	ZERO	ZERO	ZERO	ZERO	ZERO	ZERO	
H2O	6.869E+03	8.381E+03	ZERO	8.381E+03	1.528E+03	6.852E+03	
Nitric Acid (M)	ZERO	1.560E-01	ZERO	1.717E-01	1.107E-01	1.717E-01	
Oxalic Acid (M)	1.000E-01	5.195E-02	ZERO	5.716E-02	3.688E-02	5.716E-02	
Mn+2 (M)							
Heat (W)		3.512E+01		3.512E+01	3.511E+01	1.019E-02	
G (H2)		1.074E+00		1.062E+00	1.112E+00	1.062E+00	
H2 (g-mole/hr)		1.408E-02		1.391E-02	1.457E-02	4.036E-06	
Air Purge (SCFM)		1.793E-02		1.772E-02	1.856E-02	5.141E-06	
Volume (l)	6.910E+00	9.299E+00	8.477E-01	8.451E+00	2.389E+00	6.910E+00	
Mass (kg)	6.931E+00	9.547E+00	9.546E-01	8.531E+00	2.510E+00	6.975E+00	
Solids (g)	ZERO	9.698E+02	9.546E+02	1.513E+01	9.574E+02	1.237E+01	
Solids (g/l)	ZERO	1.043E+02	1.126E+03	1.790E+00	4.008E+02	1.790E+00	
Density (g/ml)	1.003E+00	1.027E+00	1.126E+00	1.009E+00	1.051E+00	1.009E+00	
Phase	Liquid	Liquid	Solid	Liquid	Liquid	Liquid	
		Moles Precip			Volume Ratio		
		1.695E+00			1.823E-01		

Am/Cm Material Balance Spreadsheet Page 21

Stream Name	Total Decant	Rinse Water	Melter Feed	Melter Feed
Units	grams	grams	grams	g/l
Stream Number	56	57	58	58
Lan salts				
La(NO3)3	ZERO	ZERO	ZERO	ZERO
Ce(NO3)3	ZERO	ZERO	ZERO	ZERO
Pr(NO3)3	ZERO	ZERO	ZERO	ZERO
Nd(NO3)3	ZERO	ZERO	ZERO	ZERO
Sm(NO3)3	ZERO	ZERO	ZERO	ZERO
Eu(NO3)3	ZERO	ZERO	ZERO	ZERO
Gd(NO3)3	ZERO	ZERO	ZERO	ZERO
Tb(NO3)3	ZERO	ZERO	ZERO	ZERO
Dy(NO3)3	ZERO	ZERO	ZERO	ZERO
Ho(NO3)3	ZERO	ZERO	ZERO	ZERO
Er(NO3)3	ZERO	ZERO	ZERO	ZERO
Tm(NO3)3	ZERO	ZERO	ZERO	ZERO
Yb(NO3)3	ZERO	ZERO	ZERO	ZERO
Lu(NO3)3	ZERO	ZERO	ZERO	ZERO
Lan oxalates				
La2(C2O4)3	1.999E+01	ZERO	1.452E+02	5.460E+01
Ce2(C2O4)3	5.263E+00	ZERO	1.243E+02	4.675E+01
Pr2(C2O4)3	2.805E+00	ZERO	1.079E+02	4.058E+01
Nd2(C2O4)3	2.818E+00	ZERO	3.119E+02	1.173E+02
Sm2(C2O4)3	2.666E+00	ZERO	7.028E+01	2.644E+01
Eu2(C2O4)3	2.214E-01	ZERO	1.455E+01	5.474E+00
Gd2(C2O4)3	1.469E-01	ZERO	3.680E+01	1.384E+01
Tb2(C2O4)3	1.328E+00	ZERO	3.324E+00	1.250E+00
Dy2(C2O4)3	1.328E+00	ZERO	3.277E+00	1.232E+00
Ho2(C2O4)3	1.328E+00	ZERO	3.245E+00	1.221E+00
Er2(C2O4)3	1.328E+00	ZERO	3.216E+00	1.210E+00
Tm2(C2O4)3	1.328E+00	ZERO	4.759E+00	1.790E+00
Yb2(C2O4)3	1.328E+00	ZERO	3.147E+00	1.184E+00
Lu2(C2O4)3	1.328E+00	ZERO	3.125E+00	1.175E+00
Act salts				
Am(NO3)3	ZERO	ZERO	ZERO	ZERO
Cm(NO3)3	ZERO	ZERO	ZERO	ZERO
NpO2(NO3)	ZERO	ZERO	ZERO	ZERO
Pu(NO3)4	ZERO	ZERO	ZERO	ZERO
UO2(NO3)2	ZERO	ZERO	ZERO	ZERO
CsNO3	ZERO	ZERO	ZERO	ZERO
Act oxalates				
Am2(C2O4)3	1.447E-01	ZERO	7.889E+01	2.967E+01
Cm2(C2O4)3	8.629E-02	ZERO	1.931E+01	7.264E+00
Np2O4(C2O4)	3.381E-03	ZERO	5.203E-05	1.957E-05
Pu(C2O4)2	1.547E-01	ZERO	2.150E+01	8.087E+00
UO2(C2O4)	1.361E+00	ZERO	2.095E-02	7.879E-03
Cs2C2O4	7.017E-03	ZERO	1.080E-04	4.062E-05

Equivalent Feed Oxides

Stream Name	Oxide Feed	Dry Feed Oxides	Glass Frit	25 SrABS Frit Oxides
Units	grams	wt%	grams	wt%
Stream Number	59	59	60	60
Lan oxides				
La2O3	8.728E+01	14.711	3.137E+02	25.000
Ce2O3	7.495E+01	12.633		
Pr2O3	6.519E+01	10.988		
Nd2O3	1.899E+02	32.013		
Sm2O3	4.339E+01	7.314		
Eu2O3	9.018E+00	1.520		
Gd2O3	2.306E+01	3.887		
Tb2O3	2.090E+00	0.352		
Dy2O3	2.075E+00	0.350		
Ho2O3	2.065E+00	0.348		
Er2O3	2.055E+00	0.346		
Tm2O3	3.051E+00	0.514		
Yb2O3	2.032E+00	0.343		
Lu2O3	2.025E+00	0.341		
Act oxides				
Am2O3	5.616E+01	9.466		
Cm2O3	1.376E+01	2.320		
Np2O5	4.604E-05	0.000		
PuO2	1.406E+01	2.369		
UO3	1.673E-02	0.003		
Cs2O	8.601E-05	0.000		
Metallic oxides				
Al2O3	4.717E-02	0.008	3.121E+02	24.870
B2O3	0.000E+00	0.000	1.699E+02	13.540
CaO	2.126E-03	0.000		
Cr2O3	2.627E-02	0.004		
Fe2O3	1.583E-01	0.027		
K2O	5.964E-03	0.001		
MnO	8.104E-01	0.137		
Na2O	1.690E-02	0.003		
NiO	8.373E-03	0.001		
SiO2	0.000E+00	0.000	4.227E+02	33.680
SrO	0.000E+00	0.000	3.652E+01	2.910
ZnO	6.021E-04	0.000		
ZrO2	1.253E-04	0.000		
Water/Acid			Frit (kg)	
HNO3	1.667E+01		1.255	
H2C2O4	7.930E+00			
H2O	1.798E+03			
Volume (l)	2.659E+00			
Mass (kg)	2.416E+00			
Solids (g)	5.933E+02			
Solids (g/l)	2.232E+02			

Glass

Glass	Glass Oxides
grams	wt%
61	61
4.009E+02	21.700
7.488E+01	4.053
6.512E+01	3.525
1.897E+02	10.269
4.335E+01	2.346
9.009E+00	0.488
2.304E+01	1.247
2.088E+00	0.113
2.073E+00	0.112
2.063E+00	0.112
2.053E+00	0.111
3.047E+00	0.165
2.030E+00	0.110
2.023E+00	0.109
5.610E+01	3.036
1.375E+01	0.744
4.600E-05	0.000
1.404E+01	0.760
1.672E-02	0.001
8.592E-05	0.000
3.122E+02	16.895
1.699E+02	9.197
2.124E-03	0.000
2.625E-02	0.001
1.582E-01	0.009
5.958E-03	0.000
8.096E-01	0.044
1.688E-02	0.001
8.365E-03	0.000
4.227E+02	22.876
3.652E+01	1.977
6.015E-04	0.000
1.252E-04	0.000
Glass (kg)	La+Ac (%)
1.848	49.00
Glass (l)	
0.499	

Am/Cm Material Balance Spreadsheet Page 22

Stream Name	Total Decant	Rinse Water	Melter Feed	Melter Feed
Units	grams	grams	grams	g/l
Stream Number	56	57	58	58
Metallic salts				
Al2(SO4)3	6.171E+00	ZERO	9.497E-02	3.572E-02
AlF3	4.544E-01	ZERO	6.993E-03	2.630E-03
Al(NO3)3	3.970E+00	ZERO	6.109E-02	2.298E-02
Ca(NO3)2	4.042E-01	ZERO	6.221E-03	2.340E-03
Cr(NO3)3	2.673E+00	ZERO	4.114E-02	1.548E-02
Fe2(SO4)3	1.247E+01	ZERO	1.919E-01	7.217E-02
FePO4	2.818E+00	ZERO	4.336E-02	1.631E-02
FeCl3	2.194E+00	ZERO	3.377E-02	1.270E-02
Fe2(C2O4)3	2.421E+00	ZERO	3.725E-02	1.401E-02
Fe(NO3)3	5.173E+00	ZERO	7.961E-02	2.994E-02
KNO3	8.318E-01	ZERO	1.280E-02	4.815E-03
Mn(NO3)2	1.328E+02	ZERO	2.044E+00	7.690E-01
NaNO3	9.770E-01	ZERO	1.504E-02	5.655E-03
NaNO2	1.505E+00	ZERO	2.316E-02	8.713E-03
Na2B4O7	5.739E-02	ZERO	8.833E-04	3.322E-04
Na2SiO3	9.472E-02	ZERO	1.458E-03	5.483E-04
Ni(NO3)2	1.331E+00	ZERO	2.048E-02	7.703E-03
Zn(NO3)2	9.105E-02	ZERO	1.401E-03	5.271E-04
Zr(NO3)4	2.242E-02	ZERO	3.451E-04	1.298E-04
Miscellaneous				
Insoluble solids	ZERO	ZERO	ZERO	ZERO
HNO3	1.083E+03	ZERO	1.667E+01	6.270E+00
HCOOH	ZERO	ZERO	ZERO	ZERO
H2C2O4	5.153E+02	ZERO	7.930E+00	2.983E+00
Gases/Water				
CO2	ZERO	ZERO	ZERO	ZERO
O2	ZERO	ZERO	ZERO	ZERO
N2	ZERO	ZERO	ZERO	ZERO
NOx	ZERO	ZERO	ZERO	ZERO
H2O	2.353E+04	2.700E+02	1.798E+03	6.763E+02
Nitric Acid (M)	7.328E-01	ZERO	9.950E-02	
Oxalic Acid (M)	2.440E-01	ZERO	3.313E-02	
Mn+2 (M)				
Heat (W)	1.568E-01		3.511E+01	
G (H2)	7.496E-01		1.122E+00	
H2 (g-mole/hr)	4.386E-05		1.470E-02	
Air Purge (SCFM)	5.586E-05		1.872E-02	
Volume (l)	2.345E+01	2.700E-01	2.659E+00	
Mass (kg)	2.535E+01	2.700E-01	2.780E+00	
Solids (g)	2.215E+02	ZERO	9.574E+02	
Solids (g/l)	9.442E+00	ZERO	3.601E+02	
Density (g/ml)	1.081E+00	1.000E+00	1.046E+00	
Phase	Liquid	Liquid	Liquid	Liquid

Am/Cm Material Balance Spreadsheet Page 23

Melter Off-Gas

Stream Name	Oxide Entrainment
Units	Grams
Stream Number	62
Lan oxides	
La2O3	8.728E-02
Ce2O3	7.495E-02
Pr2O3	6.519E-02
Nd2O3	1.899E-01
Sm2O3	4.339E-02
Eu2O3	9.018E-03
Gd2O3	2.306E-02
Tb2O3	2.090E-03
Dy2O3	2.075E-03
Ho2O3	2.065E-03
Er2O3	2.055E-03
Tm2O3	3.051E-03
Yb2O3	2.032E-03
Lu2O3	2.025E-03
Act oxides	
Am2O3	5.616E-02
Cm2O3	1.376E-02
Np2O5	4.604E-08
PuO2	1.406E-02
UO3	1.673E-05
Cs2O	8.601E-08
Metallic oxides	
Al2O3	4.717E-05
B2O3	0.000E+00
CaO	2.126E-06
Cr2O3	2.627E-05
Fe2O3	1.583E-04
K2O	5.964E-06
MnO	8.104E-04
Na2O	1.690E-05
NiO	8.373E-06
SiO2	0.000E+00
SrO	0.000E+00
ZnO	6.021E-07
ZrO2	1.253E-07
Total Mass (g)	5.933E-01

Off-Gas Flow

Stream Name	Sweep Air	Combined Off-Gas	Dilution Air	Combined Off-Gas	Motive Air	Combined Off-Gas
Units	g/hr	g/hr	g/hr	g/hr	g/hr	g/hr
Stream Number	63	64	65	66	67	68
Lan oxides						
La2O3	ZERO	8.728E-02	ZERO	8.728E-02	ZERO	8.728E-02
Ce2O3	ZERO	7.495E-02	ZERO	7.495E-02	ZERO	7.495E-02
Pr2O3	ZERO	6.519E-02	ZERO	6.519E-02	ZERO	6.519E-02
Nd2O3	ZERO	1.899E-01	ZERO	1.899E-01	ZERO	1.899E-01
Sm2O3	ZERO	4.339E-02	ZERO	4.339E-02	ZERO	4.339E-02
Eu2O3	ZERO	9.018E-03	ZERO	9.018E-03	ZERO	9.018E-03
Gd2O3	ZERO	2.306E-02	ZERO	2.306E-02	ZERO	2.306E-02
Tb2O3	ZERO	2.090E-03	ZERO	2.090E-03	ZERO	2.090E-03
Dy2O3	ZERO	2.075E-03	ZERO	2.075E-03	ZERO	2.075E-03
Ho2O3	ZERO	2.065E-03	ZERO	2.065E-03	ZERO	2.065E-03
Er2O3	ZERO	2.055E-03	ZERO	2.055E-03	ZERO	2.055E-03
Tm2O3	ZERO	3.051E-03	ZERO	3.051E-03	ZERO	3.051E-03
Yb2O3	ZERO	2.032E-03	ZERO	2.032E-03	ZERO	2.032E-03
Lu2O3	ZERO	2.025E-03	ZERO	2.025E-03	ZERO	2.025E-03
Act oxides						
Am2O3	ZERO	5.616E-02	ZERO	5.616E-02	ZERO	5.616E-02
Cm2O3	ZERO	1.376E-02	ZERO	1.376E-02	ZERO	1.376E-02
Np2O5	ZERO	4.604E-08	ZERO	4.604E-08	ZERO	4.604E-08
PuO2	ZERO	1.406E-02	ZERO	1.406E-02	ZERO	1.406E-02
UO3	ZERO	1.673E-05	ZERO	1.673E-05	ZERO	1.673E-05
Cs2O	ZERO	8.601E-08	ZERO	8.601E-08	ZERO	8.601E-08
Metallic oxides						
Al2O3	ZERO	4.717E-05	ZERO	4.717E-05	ZERO	4.717E-05
B2O3	ZERO	0.000E+00	ZERO	0.000E+00	ZERO	0.000E+00
CaO	ZERO	2.126E-06	ZERO	2.126E-06	ZERO	2.126E-06
Cr2O3	ZERO	2.627E-05	ZERO	2.627E-05	ZERO	2.627E-05
Fe2O3	ZERO	1.583E-04	ZERO	1.583E-04	ZERO	1.583E-04
K2O	ZERO	5.964E-06	ZERO	5.964E-06	ZERO	5.964E-06
MnO	ZERO	8.104E-04	ZERO	8.104E-04	ZERO	8.104E-04
Na2O	ZERO	1.690E-05	ZERO	1.690E-05	ZERO	1.690E-05
NiO	ZERO	8.373E-06	ZERO	8.373E-06	ZERO	8.373E-06
SiO2	ZERO	0.000E+00	ZERO	0.000E+00	ZERO	0.000E+00
SrO	ZERO	0.000E+00	ZERO	0.000E+00	ZERO	0.000E+00
ZnO	ZERO	6.021E-07	ZERO	6.021E-07	ZERO	6.021E-07
ZrO2	ZERO	1.253E-07	ZERO	1.253E-07	ZERO	1.253E-07

Am/Cm Material Balance Spreadsheet Page 24

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Am/Cm Material Balance Spreadsheet Page 25

Melter Off-Gas / Drying

Stream Name	Reaction Products
Units	grams
Stream Number	62
Gases	
H2O	1.798E+03
CO	
CO2	
O2	
N2	
NOx (NO + NO2)/2	
SO3	
POx (PO2 + PO3)/2	
HCl	
HF	
Temperature (C)	200.00
Pressure (in. H2O)	-2.00
Volume (l)	3.894E+03
Mass (g)	1.798E+03
Solids (g)	5.933E-01
Solids (g/l)	1.524E-04
Density (g/l)	4.619E-01
Phase	Vapor

Off-Gas Flow

Stream Name	Sweep Air	Combined Off-Gas	Dilution Air	Combined Off-Gas	Motive Air	Combined Off-Gas
Units	g/hr	g/hr	g/hr	g/hr	g/hr	g/hr
Stream Number	63	64	65	66	67	68
Gases						
H2O	2.031E+03	3.829E+03	1.502E+02	3.979E+03	2.497E+02	4.229E+03
CO						
CO2						
O2	3.297E+04	3.297E+04	4.592E+04	7.889E+04	7.633E+04	1.552E+05
N2	1.060E+05	1.060E+05	1.687E+05	2.747E+05	2.804E+05	5.550E+05
NOx (NO + NO2)/2						
SO3						
POx (PO2 + PO3)/2						
HCl						
HF						
Temperature (C)	20.00	24.26	20.00	21.70	20.00	20.85
Pressure (in. H2O)	0.00	0.00	0.00	0.00	0.00	0.00
Volume Flow (l/hr)	1.185E+05	1.227E+05	1.790E+05	3.022E+05	2.975E+05	6.006E+05
Mass Flow (g/hr)	1.410E+05	1.428E+05	2.146E+05	3.575E+05	3.567E+05	7.145E+05
Solids Flow (g/hr)		5.933E-01		5.933E-01		5.933E-01
Solids (g/l)		4.836E-06		1.963E-06		9.878E-07
Density (g/l)	1.190E+00	1.164E+00	1.199E+00	1.183E+00	1.199E+00	1.190E+00
Phase	Vapor	Vapor	Vapor	Vapor	Vapor	Vapor
Flow (SCFM)	6.500E+01	6.633E+01	9.815E+01	1.648E+02	1.632E+02	3.285E+02
Temperature (K)	2.932E+02	2.974E+02	2.932E+02	2.949E+02	2.932E+02	2.940E+02
Molecular Weight	2.861E+01	2.840E+01	2.884E+01	2.866E+01	2.884E+01	2.875E+01
Pvap (atm)	2.288E-02	4.242E-02	1.125E-03	1.777E-02	1.125E-03	9.483E-03
Psat (atm)	2.288E-02	2.963E-02	2.288E-02	2.539E-02	2.288E-02	2.411E-02
Dew Point (C)	1.992E+01	3.027E+01	-2.080E+01	1.592E+01	-2.080E+01	6.488E+00
Humidity (%)	1.000E+02	1.432E+02	4.918E+00	7.000E+01	4.918E+00	3.934E+01
ΔT (C)		-6.015E+00		5.781E+00		1.436E+01

Am/Cm Material Balance Spreadsheet Page 26

Melter Off-Gas | Drying | Off-Gas Flow

Stream Name	Reaction Products	Sweep Air	Combined Off-Gas	Dilution Air	Combined Off-Gas	Motive Air	Combined Off-Gas
Units	grams	g/hr	g/hr	g/hr	g/hr	g/hr	g/hr
Stream Number	62	63	64	65	66	67	68
Gases							
H2O	1.798E+03	2.031E+03	3.829E+03		3.829E+03	9.947E+01	3.928E+03
CO							
CO2							
O2		3.297E+04	3.297E+04		3.297E+04	3.041E+04	6.338E+04
N2		1.060E+05	1.060E+05		1.060E+05	1.117E+05	2.177E+05
NOx (NO + NO2)/2							
SO3							
POx (PO2 + PO3)/2							
HCl							
HF							
Temperature (C)	200.00	20.00	24.26		36.73	20.00	28.39
Pressure (In. H2O)	-2.00	0.00	0.00		0.00	0.00	0.00
Volume (l)	3.894E+03						
Volume Flow (l/hr)		1.185E+05	1.227E+05		1.278E+05	1.185E+05	2.467E+05
Mass (g)	1.798E+03						
Mass Flow (g/hr)		1.410E+05	1.428E+05		1.428E+05	1.421E+05	2.850E+05
Solids (g)	5.933E-01						
Solids Flow (g/hr)			5.933E-01		5.933E-01		5.933E-01
Solids (g/l)	1.524E-04		4.836E-06		4.641E-06		2.405E-06
Density (g/l)	4.619E-01	1.190E+00	1.164E+00		1.117E+00	1.199E+00	1.155E+00
Phase	Vapor	Vapor	Vapor	Vapor	Vapor	Vapor	Vapor
Flow (SCFM)		6.500E+01	6.633E+01		6.633E+01	6.500E+01	1.315E+02
Temperature (K)		2.932E+02	2.974E+02		3.099E+02	2.932E+02	3.015E+02
Molecular Weight		2.861E+01	2.840E+01		2.840E+01	2.884E+01	2.862E+01
Pvap (atm)		2.288E-02	4.242E-02		4.242E-02	1.125E-03	2.198E-02
Psat (atm)		2.288E-02	2.963E-02		6.060E-02	2.288E-02	3.781E-02
Dew Point (C)		1.992E+01	3.027E+01		3.027E+01	-2.080E+01	1.928E+01
Humidity (%)		1.000E+02	1.432E+02		7.000E+01	4.918E+00	5.812E+01
ΔT (C)			-6.015E+00		6.461E+00		9.111E+00

Am/Cm Material Balance Spreadsheet Page 27

Melter Off-Gas	Calcination
Stream Name	Reaction Products
Units	grams
Stream Number	69
Gases	
H2O	3.962E+00
CO	1.434E+02
CO2	2.254E+02
O2	9.923E-01
N2	0.000E+00
NOx (NO + NO2)/2	1.105E+01
SO3	1.819E-01
POx (PO2 + PO3)/2	1.020E-02
HCl	2.277E-02
HF	4.998E-03
Temperature (C)	700.00
Pressure (in. H2O)	-2.00
Volume (l)	8.656E+02
Mass (g)	3.851E+02
Solids (g)	
Solids (g/l)	
Density (g/l)	4.448E-01
Phase	Vapor

Off-Gas Flow

Stream Name	Sweep Air	Combined Off-Gas	Dilution Air	Combined Off-Gas	Motive Air	Combined Off-Gas
Units	g/hr	g/hr	g/hr	g/hr	g/hr	g/hr
Stream Number	70	71	72	73	74	75
Gases						
H2O	2.031E+03	2.035E+03	3.345E+01	2.068E+03	1.329E+02	2.201E+03
CO		1.148E+02		1.148E+02		1.148E+02
CO2		2.705E+02		2.705E+02		2.705E+02
O2	3.297E+04	3.297E+04	1.023E+04	4.320E+04	4.064E+04	8.384E+04
N2	1.060E+05	1.060E+05	3.756E+04	1.436E+05	1.493E+05	2.928E+05
NOx (NO + NO2)/2		5.524E+00		5.524E+00		5.524E+00
SO3		1.819E-01		1.819E-01		1.819E-01
POx (PO2 + PO3)/2		1.020E-02		1.020E-02		1.020E-02
HCl		2.277E-02		2.277E-02		2.277E-02
HF		4.998E-03		4.998E-03		4.998E-03
Temperature (C)	20.00	21.85	20.00	21.38	20.00	20.69
Pressure (in. H2O)	0.00	0.00	0.00	0.00	0.00	0.00
Volume Flow (l/hr)	1.185E+05	1.195E+05	3.986E+04	1.595E+05	1.584E+05	3.184E+05
Mass Flow (g/hr)	1.410E+05	1.414E+05	4.779E+04	1.892E+05	1.899E+05	3.793E+05
Solids Flow (g/hr)						
Solids (g/l)						
Density (g/l)	1.190E+00	1.183E+00	1.199E+00	1.186E+00	1.199E+00	1.191E+00
Phase	Vapor	Vapor	Vapor	Vapor	Vapor	Vapor
Flow (SCFM)	6.500E+01	6.515E+01	2.186E+01	8.708E+01	8.686E+01	1.742E+02
Temperature (K)	2.932E+02	2.950E+02	2.932E+02	2.945E+02	2.932E+02	2.938E+02
Molecular Weight	2.861E+01	2.861E+01	2.884E+01	2.867E+01	2.884E+01	2.876E+01
Pvap (atm)	2.288E-02	2.294E-02	1.125E-03	1.746E-02	1.125E-03	9.299E-03
Psat (atm)	2.288E-02	2.563E-02	2.288E-02	2.490E-02	2.288E-02	2.387E-02
Dew Point (C)	1.992E+01	1.996E+01	-2.080E+01	1.564E+01	-2.080E+01	6.206E+00
Humidity (%)	1.000E+02	8.951E+01	4.918E+00	7.010E+01	4.918E+00	3.896E+01
ΔT (C)		1.890E+00		5.745E+00		1.449E+01

Am/Cm Material Balance Spreadsheet Page 28

Melter Off-Gas | Calcination

Stream Name	Reaction Products
Units	grams
Stream Number	69
Gases	
H2O	3.962E+00
CO	1.434E+02
CO2	2.254E+02
O2	9.923E-01
N2	0.000E+00
NOx (NO + NO2)/2	1.105E+01
SO3	1.819E-01
POx (PO2 + PO3)/2	1.020E-02
HCl	2.277E-02
HF	4.998E-03
Temperature (C)	700.00
Pressure (in. H2O)	-2.00
Volume (l)	8.656E+02
Mass (g)	3.851E+02
Solids (g)	
Solids (g/l)	
Density (g/l)	4.448E-01
Phase	Vapor

Off-Gas Flow

Stream Name	Sweep Air	Combined Off-Gas	Dilution Air	Combined Off-Gas	Motive Air	Combined Off-Gas
Units	g/hr	g/hr	g/hr	g/hr	g/hr	g/hr
Stream Number	70	71	72	73	74	75
Gases						
H2O	2.031E+03	2.035E+03		2.035E+03	9.947E+01	2.134E+03
CO		1.148E+02		1.148E+02		1.148E+02
CO2		2.705E+02		2.705E+02		2.705E+02
O2	3.297E+04	3.297E+04		3.297E+04	3.041E+04	6.338E+04
N2	1.060E+05	1.060E+05		1.060E+05	1.117E+05	2.177E+05
NOx (NO + NO2)/2		5.524E+00		5.524E+00		5.524E+00
SO3		1.819E-01		1.819E-01		1.819E-01
POx (PO2 + PO3)/2		1.020E-02		1.020E-02		1.020E-02
HCl		2.277E-02		2.277E-02		2.277E-02
HF		4.998E-03		4.998E-03		4.998E-03
Temperature (C)	20.00	21.85		25.97	20.00	22.98
Pressure (in. H2O)	0.00	0.00		0.00	0.00	0.00
Volume Flow (l/hr)	1.185E+05	1.195E+05		1.212E+05	1.185E+05	2.401E+05
Mass Flow (g/hr)	1.410E+05	1.414E+05		1.414E+05	1.421E+05	2.836E+05
Solids Flow (g/hr)						
Solids (g/l)						
Density (g/l)	1.190E+00	1.183E+00		1.167E+00	1.199E+00	1.181E+00
Phase	Vapor	Vapor	Vapor	Vapor	Vapor	Vapor
Flow (SCFM)	6.500E+01	6.515E+01		6.515E+01	6.500E+01	1.304E+02
Temperature (K)	2.932E+02	2.950E+02		2.991E+02	2.932E+02	2.961E+02
Molecular Weight	2.861E+01	2.861E+01		2.861E+01	2.884E+01	2.873E+01
Pvap (atm)	2.288E-02	2.294E-02		2.294E-02	1.125E-03	1.204E-02
Psat (atm)	2.288E-02	2.563E-02		3.280E-02	2.288E-02	2.743E-02
Dew Point (C)	1.992E+01	1.996E+01		1.996E+01	-2.080E+01	9.992E+00
Humidity (%)	1.000E+02	8.951E+01		6.992E+01	4.918E+00	4.391E+01
ΔT (C)		1.890E+00		6.003E+00		1.298E+01

Am/Cm Material Balance Spreadsheet Page 29

Melter Off-Gas	Vitrification
Stream Name	Reaction Products
Units	grams
Stream Number	76
Gases	
H2O	
CO	
CO2	
O2	3.653E+00
N2	
NOx (NO + NO2)/2	
SO3	
POx (PO2 + PO3)/2	
HCl	
HF	
Temperature (C)	700.00
Pressure (in. H2O)	-2.00
Volume (l)	9.162E+00
Mass (g)	3.653E+00
Solids (g)	
Solids (g/l)	
Density (g/l)	3.988E-01
Phase	Vapor

Off-Gas Flow						
Stream Name	Sweep Air	Combined Off-Gas	Dilution Air	Combined Off-Gas	Motive Air	Combined Off-Gas
Units	g/hr	g/hr	g/hr	g/hr	g/hr	g/hr
Stream Number	77	78	79	80	81	82
Gases						
H2O	2.031E+03	2.031E+03	4.626E+01	2.077E+03	1.457E+02	2.223E+03
CO						
CO2						
O2	3.297E+04	3.297E+04	1.414E+04	4.712E+04	4.455E+04	9.167E+04
N2	1.060E+05	1.060E+05	5.195E+04	1.580E+05	1.636E+05	3.216E+05
NOx (NO + NO2)/2						
SO3						
POx (PO2 + PO3)/2						
HCl						
HF						
Temperature (C)	20.00	20.02	20.00	20.01	20.00	20.01
Pressure (in. H2O)	0.00	0.00	0.00	0.00	0.00	0.00
Volume Flow (l/hr)	1.185E+05	1.185E+05	5.512E+04	1.738E+05	1.736E+05	3.480E+05
Mass Flow (g/hr)	1.410E+05	1.410E+05	6.609E+04	2.072E+05	2.082E+05	4.155E+05
Solids Flow (g/hr)						
Solids (g/l)						
Density (g/l)	1.190E+00	1.190E+00	1.199E+00	1.192E+00	1.199E+00	1.194E+00
Phase	Vapor	Vapor	Vapor	Vapor	Vapor	Vapor
Flow (SCFM)	6.500E+01	6.501E+01	3.023E+01	9.534E+01	9.523E+01	1.909E+02
Temperature (K)	2.932E+02	2.932E+02	2.932E+02	2.932E+02	2.932E+02	2.932E+02
Molecular Weight	2.861E+01	2.861E+01	2.884E+01	2.868E+01	2.884E+01	2.876E+01
Pvap (atm)	2.288E-02	2.296E-02	1.125E-03	1.602E-02	1.125E-03	8.574E-03
Psat (atm)	2.288E-02	2.290E-02	2.288E-02	2.289E-02	2.288E-02	2.288E-02
Dew Point (C)	1.992E+01	1.997E+01	-2.080E+01	1.431E+01	-2.080E+01	5.042E+00
Humidity (%)	1.000E+02	1.002E+02	4.918E+00	7.000E+01	4.918E+00	3.747E+01
ΔT (C)		4.265E-02		5.699E+00		1.496E+01

Am/Cm Material Balance Spreadsheet Page 30

Melter Off-Gas	Vitrification
Stream Name	Reaction Products
Units	grams
Stream Number	76
Gases	
H2O	
CO	
CO2	
O2	3.653E+00
N2	
NOx (NO + NO2)/2	
SO3	
POx (PO2 + PO3)/2	
HCl	
HF	
Temperature (C)	700.00
Pressure (in. H2O)	-2.00
Volume (l)	9.162E+00
Mass (g)	3.653E+00
Solids (g)	
Solids (g/l)	
Density (g/l)	3.988E-01
Phase	Vapor

Off-Gas Flow						
Stream Name	Sweep Air	Combined Off-Gas	Dilution Air	Combined Off-Gas	Motive Air	Combined Off-Gas
Units	g/hr	g/hr	g/hr	g/hr	g/hr	g/hr
Stream Number	77	78	79	80	81	82
Gases						
H2O	2.031E+03	2.031E+03		2.031E+03	9.947E+01	2.130E+03
CO						
CO2						
O2	3.297E+04	3.297E+04		3.297E+04	3.041E+04	6.338E+04
N2	1.060E+05	1.060E+05		1.060E+05	1.117E+05	2.177E+05
NOx (NO + NO2)/2						
SO3						
POx (PO2 + PO3)/2						
HCl						
HF						
Temperature (C)	20.00	20.02		25.96	20.00	22.97
Pressure (in. H2O)	0.00	0.00		0.00	0.00	0.00
Volume Flow (l/hr)	1.185E+05	1.185E+05		1.209E+05	1.185E+05	2.398E+05
Mass Flow (g/hr)	1.410E+05	1.410E+05		1.410E+05	1.421E+05	2.832E+05
Solids Flow (g/hr)						
Solids (g/l)						
Density (g/l)	1.190E+00	1.190E+00		1.166E+00	1.199E+00	1.181E+00
Phase	Vapor	Vapor	Vapor	Vapor	Vapor	Vapor
Flow (SCFM)	6.500E+01	6.501E+01		6.501E+01	6.500E+01	1.302E+02
Temperature (K)	2.932E+02	2.932E+02		2.991E+02	2.932E+02	2.961E+02
Molecular Weight	2.861E+01	2.861E+01		2.861E+01	2.884E+01	2.873E+01
Pvap (atm)	2.288E-02	2.296E-02		2.296E-02	1.125E-03	1.204E-02
Psat (atm)	2.288E-02	2.290E-02		3.279E-02	2.288E-02	2.742E-02
Dew Point (C)	1.992E+01	1.997E+01		1.997E+01	-2.080E+01	9.985E+00
Humidity (%)	1.000E+02	1.002E+02		7.000E+01	4.918E+00	4.390E+01
ΔT (C)		4.265E-02		5.985E+00		1.298E+01