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Savannah River Technology Center

ESTIMATION OF PHYSICAL PROPERTIES OF AN-107 CESIUM AND TECHNETIUM ELUATE BLEND

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A. S. Choi

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Westinghouse Savannah River Company
Aiken, SC 29808

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APPROVALS

A. S. Choi, Author
Process Development & Hanford RPP
Immobilization Technology Section/SRTC
2-26-01
Date

A. S. Choi for T. B. Calloway per Telecon
T. B. Calloway, Technical Reviewer
Process Development & Hanford RPP
Immobilization Technology Section/SRTC
2-26-01
Date

David A. Crowley
D. A. Crowley, Manager
Process Development & Hanford RPP
Immobilization Technology Section/SRTC
2/27/01
Date

H. F. Sturm
H. F. Sturm, Manager
Hanford RPP Project/SRTC
2/27/01
Date

SUMMARY

Physical property correlations were developed for the concentrated blend of Tank 241-AN-107 cesium and technetium eluates between 20 and 100 ^{o}C. These correlations will be used in the design of the River Protection Project (RPP) Waste Treatment Plant (WTP) evaporator storage vessels. The physical properties thus estimated included density, heat capacity, viscosity, volume expansion coefficient, thermal conductivity, vapor pressure, and bulk solubility. The composition of the eluate blend was calculated using two evaporator models built using the Environmental Simulation Program (ESP) version 6.2 licensed by OLI Systems, Inc. The results of the model runs further provided basic operating data for the WTP evaporators.

The first of the two evaporator models describes the concentration of cesium eluate in a kettle-type evaporator. The evaporation process is to proceed on a semi-batch mode, and was modeled as such. In the model, the cesium eluate feed was introduced to a pot that was initially charged with 7.9 M nitric acid, and the boilup rate was controlled constantly to maintain a constant acidity of 0.5 M nitric acid in the condensate. The contents of the pot were maintained at 50 ^{o}C under vacuum, and the feeding was continued with no bottom withdrawal, until the liquid in the pot reached the target endpoint. Based on the preliminary modeling results, the endpoint of evaporation was set at 80% saturation with respect to sodium nitrate under the nominal storage conditions at 1 atm and 25 ^{o}C.

The technetium eluate is also to be concentrated in the same kettle-type evaporator run on a semi-batch mode at 50 ^{o}C under vacuum. Unlike in the cesium evaporation, however, the pot will be charged initially with water, and there would be no requirement for maintaining a constant concentration in the condensate. Under this operating scheme, the final concentration of liquid in the pot would be the same for both semi-batch and continuous operations, as long as the target endpoints are the same. For this reason, the evaporation of technetium eluate was simply modeled as a continuous process, thereby reducing the computational loads significantly. The subsequent blending of concentrated cesium and technetium eluates was included in this model. In this study, the endpoint of technetium eluate evaporation was not set at 80% saturation. Instead, it was set by a trial-and-error so that the pH of the concentrated blend of cesium and technetium eluates would become close to neutral. Targeting for a specific pH is not a critical issue for the WTP evaporators, since they will be equipped with the capability to add caustic for the pH adjustment, if necessary.

The results of model runs showed that the liquid in the cesium evaporator pot would become 80% saturated with sodium nitrate, when the cumulative volume of cesium eluate fed equals 42 times the volume of the initial acid charge. The concentration of nitric acid in the pot was predicted to drop from 7.9 to 4.2 M during the process, while the total sodium level was predicted to increase from zero to 2.6 M. The model also predicted that sodium nitrate would not precipitate out of the 80% saturated solution, as long as the eluate storage vessel is maintained above 17 ^{o}C. No insoluble solids were predicted to form in the pot, including those of minor constituents, under strongly acidic conditions.

For the evaporation of technetium eluate, the model predicted that after a 50X volume reduction the liquid would be at a pH of 13, and the resulting blend of concentrated cesium and technetium eluates would become slightly basic, i.e., pH = 7.9. Although the 50X concentrated Tc eluate would still be far from saturation with respect to potassium pertechnetate ($KTcO_4$), the model predicted that a small amount of insoluble solids would be present at 0.15 wt%, consisting of hydroxides of Fe and La and calcium fluoride. The concentrated blend of cesium and technetium eluates was predicted to contain more insoluble solids at 1.3 wt%, consisting mainly of dawsonite and hydroxides of Fe, La and Ni. Empirical correlations of various physical properties contained in this report were developed based on this calculated concentration of cesium and technetium eluate blend. A detailed mass balance of the technetium eluate evaporation and the subsequent blending with the 80% saturated cesium eluate is also included in this report.

After this study was completed, a new version of the ESP software was received along with its improved PUBLIC database. The two evaporation models were rerun with this new database, and the results turned out to be somewhat different. For example, the new results of the cesium eluate model showed that the concentrated cesium eluate (Stream 10) would be more like 95% saturated, instead of 80%, with respect to sodium nitrate. It was also shown that the lowest storage temperature to preclude the formation of sodium nitrate crystals would be 20 ^{o}C, instead of 17 ^{o}C, for the cesium eluate concentrate. This means that the physical property correlations presented in this report would be conservative from the design perspective, since they are based on a solution more concentrated than the flowsheet target.

On the other hand, the new results of the technetium eluate model were nearly identical to the old results with two key exceptions. First, the bulk solubility of technetium eluate would be determined by sodium nitrate rather than by potassium pertechnetate and, secondly, the solubility of silica was predicted to be considerably lower than the earlier prediction. The latter resulted in a slightly higher insoluble solids content in the eluate blend, since some of Si was predicted to precipitate out. However, these results would have little impact on the calculated physical properties, since the 50X concentrated technetium eluate would still be so far from the solubility limit of either sodium nitrate or potassium pertechnetate.

It was also discovered during a recent validation study that some of the regression parameters contained even in the new PUBLIC database adequately predicted neither the in-house nor the literature data for the nitric acid-water system. The physical properties in question are the density and heat capacity. Regression of the heat capacity data is not trivial, since heat capacity is calculated as the second derivative of the activity coefficient. The OLI personnel are currently working to fix these problems. Since the molar concentrations depend on the solution density, it is expected that the corrected nitric acid database would somewhat alter the required acidity of the initial acid charge for the semi-batch evaporation and the exact molarities of sodium and nitric acid at the target endpoint of 80% saturation. However, all the physical property correlations reported here should remain valid, as long as the composition of the concentrated cesium eluate, especially the total salt content, does not change appreciably.

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INTRODUCTION

The baseline low activity waste (LAW) flowsheet for the River Protection Project (RPP) Waste Treatment Plant (WTP) at the Department of Energy's Hanford Site includes pretreatment of Envelope A, B and C supernate first by removing entrained solids using ultrafiltration. For the Envelope C waste only, an additional process step is conducted to precipitate strontium and transuranic elements by addition of nonradioactive strontium nitrate and sodium permanganate reagents. The resulting precipitate and entrained solids are separated from the Envelope C solution using ultrafiltration. The clarified Envelope A, B and C solutions are then processed through a series of ion-exchange columns to remove cesium (Cs) and technetium (Tc). The ion-exchange effluents are sent to the LAW melter feed evaporator, before being blended with glass formers and fed to a LAW melter. On the other hand, the ion-exchange resins are eluted with either nitric acid (for cesium) or water (for technetium), and each eluate is concentrated in a separate kettle-type evaporator operating under vacuum. The spent ion-exchange resins are conditioned with sodium hydroxide solution and used again in the next processing cycle. The concentrated eluates are sent to a common interim storage tank, before being fed to a high-level waste (HLW) melter along with the HLW sludge and glass formers.

The design goal of the Tc eluate evaporator is to minimize the required storage tank volume by removing as much water as possible without forming precipitates of any major salt species present. Similarly, the design goal of the Cs eluate evaporator is to remove nitric acid solution for re-use in the next elution cycle and to minimize the required storage tank volume for the cesium eluate concentrate. Therefore, it is of great practical interest to know the optimum endpoint of evaporation that would give a close-to-the-maximum volume reduction ratio, while maintaining a reasonable distance away from the bulk saturation point of the solution. The bulk saturation point is defined here as the point where the major salt species first begin to precipitate out. It was found during an earlier bench-scale run that at a fixed operating vacuum, a simultaneous tracking of both liquid density and temperature is a good way of controlling the concentration level in the pot.[1] Furthermore, a sound design of the concentrate storage and transport facilities requires accurate information on additional physical properties such as heat capacity, viscosity, volume expansion coefficient, etc.

The objective of this study, as defined in the associated test specifications and task technical and quality assurance plan, was to estimate all the physical properties that are required to design the storage and transport facilities for the concentrated cesium and technetium eluates.[2,3] Specifically, the scope of this study included: (1) modeling of the

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1 Calloway, T. B., Jr., Choi, A. S., and Monson, P. R., "Evaporation of Hanford Envelope B Simulant (AZ-101) Preliminary Report," **BNF-003-98-0166 (Revision 1)**, Westinghouse Savannah River Co., Aiken, SC, January 6, 2000.

2 Johnson, M. E., "Eluate Physical Properties and Evaporation Test Specification," **TSP-W375-99-00008**, Rev. 3, BNFL, Inc., Richland, WA, December 6, 1999.

3 Baich, M. A., "Task Technical and Quality Assurance Plan in Support of BNFL Part B: Determination of Cesium Eluate Physical Properties," **BNF-003-98-0176**, Westinghouse Savannah River Co., Aiken, SC, October 16, 1999.

aqueous electrolyte chemistry of Tank 241-AN-107 Cs and Tc eluate evaporators, (2) process modeling of semi-batch and continuous evaporation operations, (3) determination of the operating vacuum and target endpoint of each evaporator, (4) calculation of the physical properties of the concentrated Cs and Tc eluate blend, and (5) development of the empirical correlations for the physical properties thus estimated.

AN-107 CHEMISTRY MODEL

The compositions of the Cs and Tc eluate feeds used in the models are shown in Table 1; they were developed based on the analytical results of a Part A ion-exchange study with the Tank 241-AN-107 (henceforth referred to as AN-107) supernate sample.[4] Since the free hydroxide level of the Tc eluate was not measured, it was set at 0.0033 molar to achieve the charge balance. Furthermore, the silicate concentration of 0.002 molar shown for the Tc eluate appears to be mostly due to leaching of the glassware used in the test, since the untreated AN-107 sample did not contain any appreciable quantity of Si.[4] Higher-than-expected concentrations of Si were also observed in the AN-107 Tc eluate elsewhere.[5] Furthermore, subsequent to conducing this modeling assessment, the chloride concentrations of the AN-107 Cs and Tc eluates were called into question due to uncertainty in the analytical methods used for analysis of these eluates, particularly the ion selective electrode (ISE) method. Accurate determination of chloride concentration is important, since it can volatilize as hydrogen chloride during the Cs eluate evaporation. The input concentrations of the Cs and Tc eluate models will need to be re-visited once analytical discrepancies are resolved.

The aqueous electrolyte chemistry of the AN-107 Cs and Tc eluates was modeled using the Environmental Simulation Program (ESP) version 6.2 licensed by OLI Systems, Inc.[6] The ESP default database, called PUBLIC, was used along with several private databases including GIBBSITE, CARBONAT, NEWTC and URANIUM. The PUBLIC database used was received from the vendor in September 1999. The private databases, GIBBSITE and CARBONAT, were created by importing the data for gibbsite and sodium carbonate and its hydrates, respectively, from the PUBLIC database and adjusting the equilibrium constant parameters to match the in-house data.[1]

Table 1 also lists the chemical species included in the AN-107 chemistry model covering the entire pH range from 0 to 14. The aqueous speciation of the 198 species was calculated using 176 equilibrium relations. Table 2 shows the breakdown of all 198 species into gaseous, neutral, ionic and solid species and further compares them against the current software limits. Beside those 29 solid species shown in Table 1, 93 additional solid species were checked for their scaling tendency, and the likelihood of their formation was determined to be remote by the model.

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4 Hassan, N. M., and McCabe, D. J., "Hanford Envelope C Tank Waste Ion Exchange Column Study (U)," **SRTC-BNFL-018 (Revision 0)**, Westinghouse Savannah River Co., Aiken, SC, October 24, 1997.

5 Blanchard, Jr., D. L., Kurath, D. E., and Rapko, B. M., "Small Column Testing of Superlig 639 for Removing ^{99}Tc from Hanford Tank Waste Envelope C (Tank 241-AN-107)," **PNWD-3028**, **BNFL-RPT-022 Rev. 0**, Battelle, Pacific Northwest Division, Richland, WA, June 2000.

6 OLI Software Manual, OLI Systems, Inc., Morris Plains, NJ (1999).

TABLE 1. Compositions of Tank 241-AN-107 Cs and Tc Eluate Feeds and Species Included in AN-107 Chemistry Model.

Species	Cs Eluate Conc (M)	Tc Eluate Conc (M)
NaNO2		3.7295E-03
NaNO3	4.3563E-02	8.8696E-03
NaOH		3.3000E-03
NaAlO2		1.0163E-03
NaF		1.7117E-03
NaCl	4.0502E-03	1.2622E-02
Na2CO3		1.0834E-02
NaBO2		7.2109E-04
Na2CrO4	1.9232E-04	
Na2SiO3		2.0267E-03
NaTcO4		7.4566E-06
B(OH)3	4.2461E-03	
H2SiO4	4.9492E-04	
HNO3	3.9462E-01	
HCl	5.7092E-03	
Al(NO3)3	1.3231E-03	
Ca(NO3)2	2.9940E-04	1.1589E-04
CsNO3	3.9893E-04	
Cu(NO3)2	3.0686E-04	
Fe(NO3)3	1.3358E-03	6.4370E-05
KNO3	1.0103E-03	4.5680E-04
La(NO3)3		1.0240E-04
Mn(NO3)2	9.9203E-04	
Ni(NO3)2	7.1368E-04	
Pb(NO3)2	4.9228E-05	
UO2(NO3)2	1.0083E-03	

Gases	HF	AlF	Fe(OH)2	NiCl	***Precipitates***
CO2	HNO2	Al	Fe(OH)4	NiF	Al(OH)3
H2F2 (g)	HNO3	Al(OH)2	FeOH	Ni	CaCO3
H2O (g)	KCl	Al(OH)4	F	NiNO3	CaF2
HCl (g)	LaCl3	AlOH	H2SiO4	Ni(OH)3	Cs2CO3
HF (g)	LaF3	B(OH)4	H3SiO4	NiOH	CsNO2
HNO2 (g)	La(OH)3	CaF	HCO3	NO2	CsNO3
HNO3 (g)	Mn(NO3)2	CaH2BO3	HCrO4	NO3	CsTcO4
N2	Mn(OH)2	CaHCO3	HF2	OH	CuF2
O2	N2	CaHSiO3	H	PbCl3	Cu(OH)2
SiCl4 (g)	NaB(OH)4	Ca	HPbO2	PbCl4	Fe(OH)3
SiF4 (g)	NaF	CaNO3	HSiO3	PbCl	KTcO4
Tc2O7 (g)	NaHCO3	CaOH	K	PbF3	La(OH)3
	NaHSiO3	Cl	LaCl2	PbF4	MnCO3
Neutral	NaNO3	CO3	LaCl4	PbF	Mn(OH)2
H2O	Ni(OH)2	Cr2O7	LaCl	Pb	Na2CO3
AlF3	O2	CrO4	LaCO3	Pb(NO2)3	Na2U2O7
AlOH3	PbCl2	Cs	LaF2	PbNO2	NaAlCO3(OH)2
B(OH)3	PbF2	CuCl3	LaF4	Pb(NO3)3	NaNO2
CaCO3	Pb(NO2)2	CuCl	LaF	PbNO3	NaNO3
CaH2SiO4	Pb(NO3)2	Cu(CO3)2	LaHCO3	PbOH	NaTcO4
CO2 (l)	PbO	Cu	La	SiF6	NiCO3
CsCl	SiCl4	CuNO2	LaNO3	SiO3	Ni(OH)2
CsNO3	SiF4	CuNO3	La(OH)2	TcO4	PbCO3
CuCl2	SiO2	Cu(OH)3	La(OH)4	(UO2)2(OH)2	Tc2O7
CuCO3	UO2Cl2	Cu(OH)4	LaOH	(UO2)3(OH)5	UCl6
Cu(NO2)2	UO2CO3	CuOH	MnCl	UO2Cl	
Cu(NO3)2	UO2F2	Fe2(OH)2	Mn	UO2(CO3)2	***Hydrates***
Cu(OH)2	UO2(OH)2	FeCl2	MnNO3	UO2(CO3)3	Na2CO3.10H2O
FeCl3		FeCl4	Mn(OH)3	UO2F3	Na2CO3.1H2O
FeF3	***Ions***	FeCl	Mn(OH)4	UO2F4	Na2CO3.7H2O
Fe(OH)3	AlF2	FeF2	MnOH	UO2F	NaAlO2.2.5H2O
H2F2	AlF4	FeF	Na2F	UO2	
H2SiO3	AlF5	Fe	NaCO3	UO2OH	
HCl	AlF6	FeNO3	Na		

TABLE 2. Breakdown of Species Included in AN-107 Chemistry Model.

	Model	Software Limits
Total species	198	300
- Ionic	108	150
- Neutral	49	50
- Gaseous	12	-
- Solids	29	-
Solids (for scaling tendencies only)	93	-

EVAPORATION MODELS

The Cs eluate evaporation was modeled as a semi-batch process, and the Tc eluate evaporation as a continuous process. In the semi-batch evaporation of Cs eluate, a pot is initially charged with a high-strength acid solution, and the eluate containing ~0.4 M nitric acid is fed to the pot at the same rate as the boilup at 50 ^{o}C under vacuum. The design calls for recycling the condensate to re-elute the column. So, the boilup rate has to be controlled so that the condensate would be at a constant acidity of ~0.5 M nitric acid. The feeding and boilup would continue with no bottom product being drawn out of the pot, until the liquid reaches 80% of the bulk saturation point. In Table 1, the major salt species in the Cs eluate is shown to be $NaNO_3$. Therefore, the boilup would be terminated, when the liquid reaches 80% of the solubility limit of $NaNO_3$ in the solution.

Since the ESP software is a steady state process simulator, the semi-batch evaporation operation described above was approximated by a series of continuous still pots, as shown in Figure 1. The feed ratio of the initial acid charge-to-Cs eluate to the 1st stage was set at 5:1. Additional stages were added to the existing model one-by-one, until the concentrate from the final stage became 100% saturated with respect to $NaNO_3$ at 25 ^{o}C and 1 atm. The number of stages required to reach the 80% saturation endpoint was then calculated by backing off stages until the target $NaNO_3$ concentration was found.

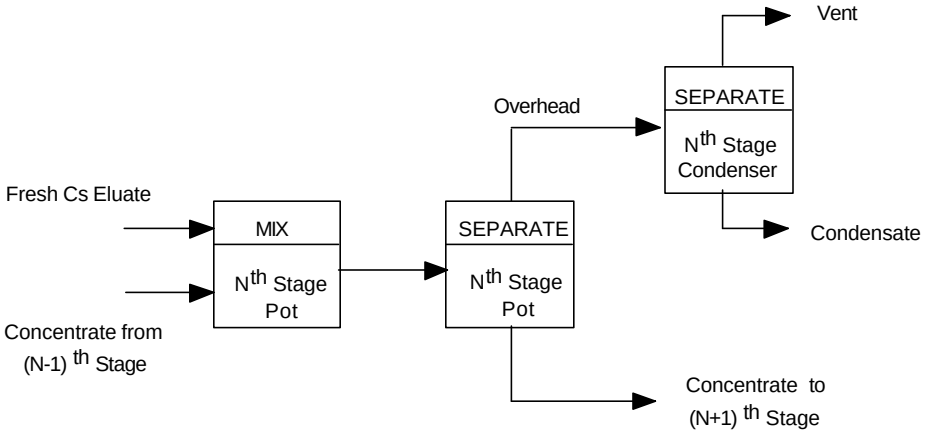

FIGURE 1. Schematic of Nth Stage Evaporation of Cs Eluate Model.

In order to confirm the validity of approximating the semi-batch evaporator as a series of continuous still pots, the Cs eluate evaporator model was run to simulate the batch distillation experiment performed earlier at 1 atm.[7] In Figure 2, the calculated acidity of the condensate is compared with the data taken during the batch distillation of 4 M nitric acid to complete dryness in 10 equal volume increments. It can be seen that the model predicted the data well except at the 70% volume reduction mark, while the discrepancy at the 100% volume reduction mark or at the point of complete dryness, was expected.

[7] Ryan, P., "The Concentration of Technetium-99 by Acid Distillation," **DPST-83-386**, E. I. du Pont de Nemours & Co., Aiken, SC, March 23, 1983.

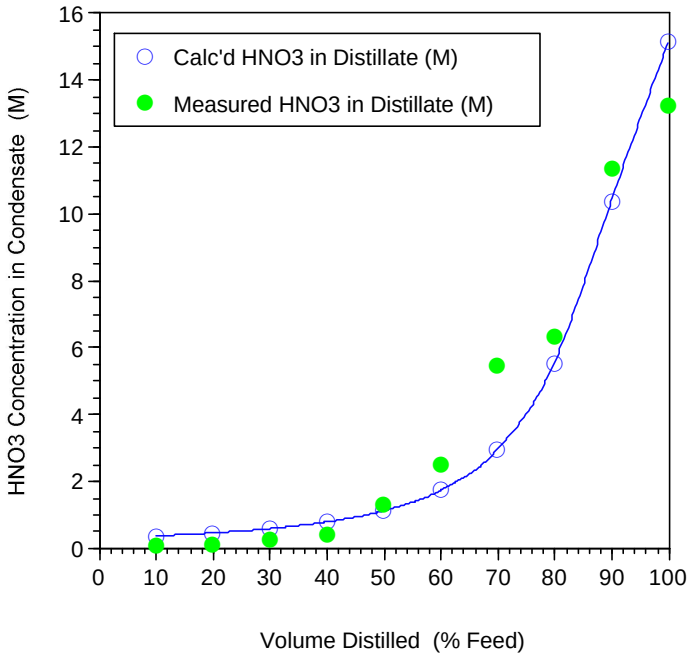

FIGURE 2. Calculated vs. Measured HNO_3 Concentrations in Condensate during Batch Distillation of 4 M Nitric Acid - Data by P. Ryan [7].

The complexity of Cs eluate evaporation lies in the fact that both nitric acid and water evaporate simultaneously from the pot, and the mass or molar ratio of the two in the overhead changes constantly with changing acidity and salt content in the pot. In order to check the adequacy of the PUBLIC database in predicting the thermodynamics of the nitric acid solution, a simple chemistry model was set up for the HNO_3-H_2O system and run to calculate the vapor-liquid equilibria at 50 ^oC up to the azeotrope. The calculated equilibrium pressures are compared in Figure 3 with the available literature data on a P-x-y diagram.[8] The agreement between the calculated and measured vapor compositions is seen to be excellent, while the calculated liquid compositions deviate significantly from the measured values between $0.1 < x < 0.3$. Nevertheless, since the mole fraction of nitric acid in the pot will be much less than 0.1 near the 80% saturation endpoint, the current PUBLIC database appears to be acceptable.

A schematic of the Tc eluate evaporation and storage model is shown in Figure 4. The model simulates a continuous, forced-circulation evaporator by recycling most of the liquid in the pot and is built on five ESP software blocks; a MIX block representing the evaporator pot, a SEPARATE block used to separate the overhead vapor from the liquid, a SPLIT block to split the recycle off the remaining liquid in the pot, a SEPARATE block to condense steam and other condensables in the overhead, and a MIX block to cool and store the concentrate. The storage block is also shown to receive the concentrated Cs eluate from the Cs eluate evaporator model.

[8] Yakimov, M. A., and Mishin, V. Ya., Chisa-Congress, Prague 6th, 6, 543 (1964).

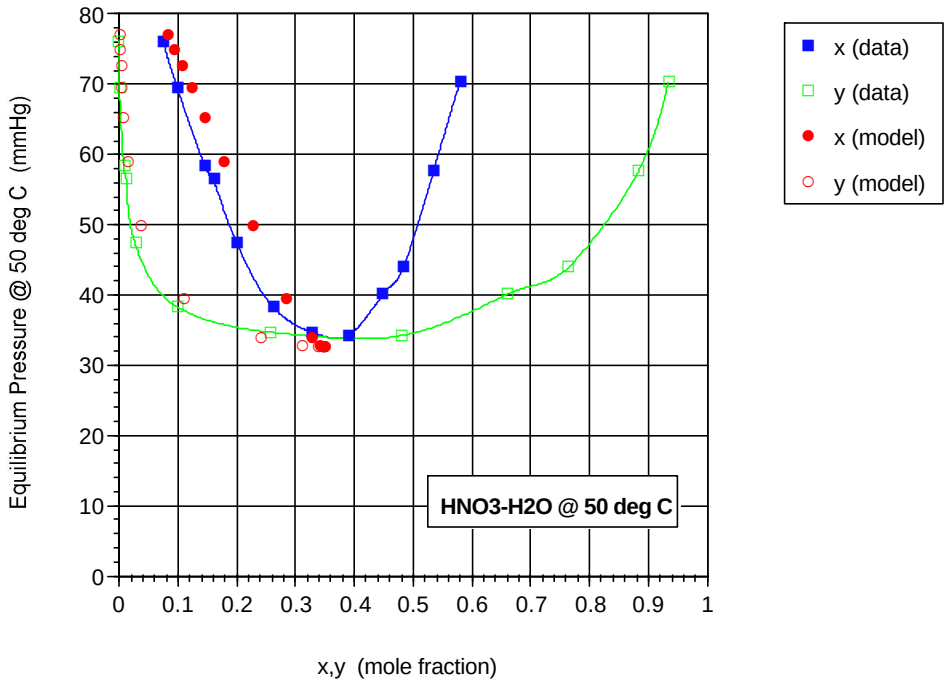

FIGURE 3. Calculated vs. Measured Vapor-Liquid Equilibria of HNO_3 and H_2O System at 50 °C - Data by Yakimov and Mishin [8].

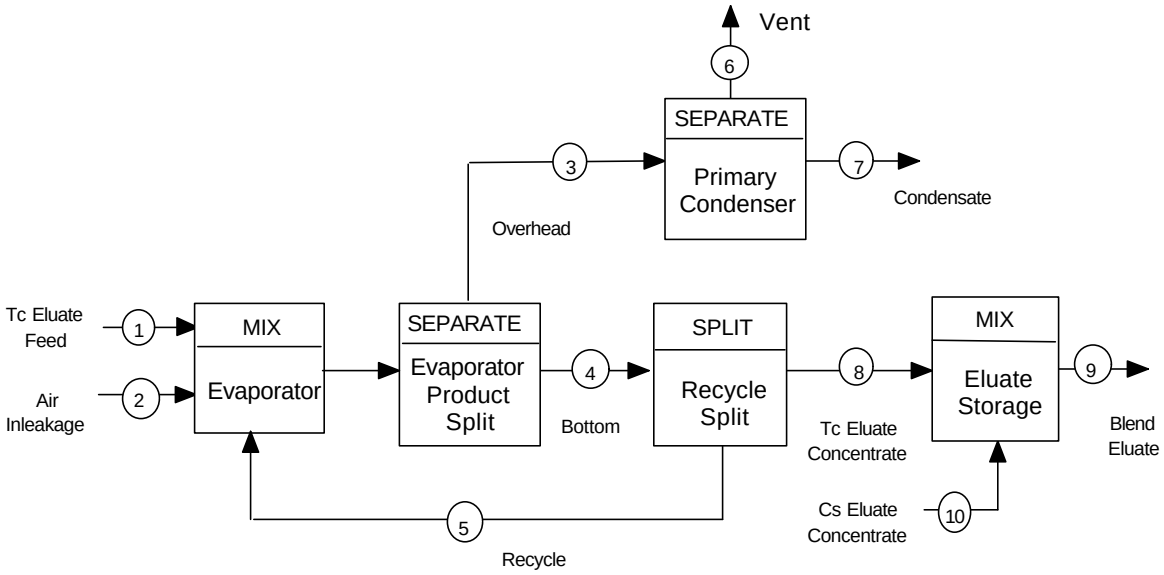

FIGURE 4. Schematic of Tc Eluate Evaporator and Storage Model.

The feed rates of Tc and Cs eluates shown by Streams 1 and 10, respectively, were set at the time-averaged, instantaneous flows that would support 100% attainment in glass production. In other words, they were calculated from the time-averaged, instantaneous feed rate of the clarified Envelope C liquid to the ion-exchange columns that is required to produce 30 metric tons of Envelope C LAW glass per day at 17 wt% Na_2O based on the waste contributions only. The resulting full-scale, instantaneous flow of sodium in the ion-exchange effluent was calculated to be 157,661 g/hr.

At a given feed rate, the condensable overhead flow is determined by the desired degree of saturation in the final concentrate. Since the pretreatment evaporators have no design air purges, the flow rate of the noncondensable overhead is likely to be determined by the air leakage into the system. The rate of air inleakage to the Tc eluate evaporator was set at 135 gmoles/hr, which was estimated earlier by the WTP designers for the full-scale LAW evaporators based on the procedures recommended by SRTC.[9] It was shown in the previous study that the air inleakage rate has a profound effect on the emission of volatile organics and heavy metals in systems operating under vacuum.[10]

BASES AND ASSUMPTIONS

Some of the key bases and assumptions used in the AN-107 Cs and Tc eluate evaporation models include the following, which are consistent with the design basis assumptions for the RPP-WTP eluate evaporators:

- The mass ratio of ^{137}Cs to total Cs is 0.25.

- The mass ratio of pertechnetate (TcO_4^-) to total Tc is 0.3.

- The full-scale flow rates of Cs and Tc eluate feeds are set based on the following mass ratios with respect to sodium, which were derived from the analytical results of a Part A study (Table 1, Ref. [4]):

  $$Cs / Na = (2.1602 E\text{-}5)(4) = 8.6407 E\text{-}5$$
  $$Tc / Na = (2.2895 E\text{-}5)(0.3) = 6.8685 E\text{-}6$$

  As noted earlier, the instantaneous flow of sodium in the ion-exchange effluent that would support 100% attainment in glass production is 157,661 g/hr.

- The free hydroxide concentration of the Tc eluate is set at 0.0033 M to achieve the charge balance.

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[9] Letter from C. T. Randall to M. E. Johnson, "TWRS Privatization Part B, SRTC WFO-98-003, LAW Evaporator: Estimating Air In-Leakage (U)," **BNF-003-98-0075**, Westinghouse Savannah River Co., Aiken, SC, March 12, 1999.

[10] Choi, A. S., "Preliminary Modeling Results of Pretreated LAW Evaporator," BNF-003-98-0080 (Revision 0), Westinghouse Savannah River Co., Aiken, South Carolina, June 1, 1999.

- Both Cs and Tc evaporators are operated at 50 ^{o}C under vacuum, and their primary condensers at 40 ^{o}C with no pressure drop between the evaporator and the condenser.

- The Cs eluate evaporator is operated on a semi-batch mode; the bottom liquid will not be discharged, until it is concentrated to 80% saturation with respect to $NaNO_3$.

- The Tc eluate evaporator is of a continuous, forced-circulation type and is simulated by recycling 90% of the evaporator bottom.

- The target endpoint of the Tc eluate evaporation is determined by a trial-and-error so that the pH of the concentrated blend of Cs and Tc eluate solutions would become close to neutral.

- The air inleakage to the Tc eluate evaporator is 135 gmole/hr.

- The maximum allowable insoluble solids level in the storage tank is 1.0 wt% and must contain no solids of any major salts.

- The blending of Cs and Tc eluate concentrates is done adiabatically.

MODEL RESULTS

The results of the Cs eluate evaporation model are shown in Figure 5. The pot was initially charged with 7.9 M nitric acid, and the boilup rate was controlled so that the acidity of the condensate remained constant at 0.5 M. Since the acidity of the Cs eluate feed was lower at 0.4 M (Table 1), the acidity of the pot is shown to decrease steadily as more and more feed was introduced. As expected, the concentration of total dissolved solids (TDS) in the pot increased linearly with increasing cumulative feed volume. Finally, the pot would become saturated with $NaNO_3$ when the cumulative volume of the Cs eluate fed equaled about 49 times the volume of acid initially charged to the pot.

At 100% saturation, the acidity of the pot was reduced to 3.5 M, while the concentration of TDS increased to 30 wt%. At the 5:1 feed ratio of initial acid charge-to-Cs eluate, a total of 254 evaporation stages were required to reach 100% saturation. A schematic of a single evaporation stage is shown in Figure 1. The model also predicted that at 100% saturation the volume of liquid remaining in the pot would be only 70% of that of the initial acid charge. Figure 5 also shows that the required vacuum at 50 ^{o}C would remain practically constant at about 65 mmHg.

The solubility of $NaNO_3$ in the concentrated Cs eluate was calculated to be about 3.3 M, and the 80% saturation would then occur at: (3.3)(0.8) = 2.64 M sodium. It turns out that a total of 220 evaporation stages were required to reach the target endpoint of 80% saturation. The composition of this 80% saturated Cs eluate was next fed to the Tc eluate evaporation and storage model as Stream 10 in Figure 4. Some of the key results of the Tc eluate model run included:

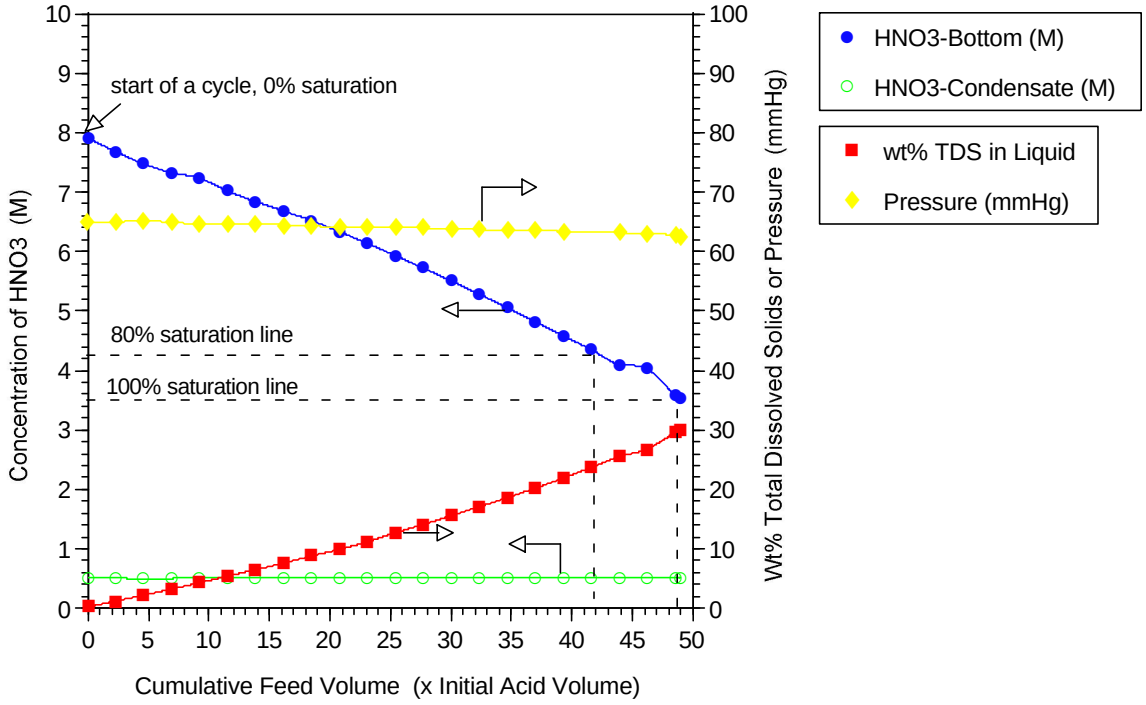

FIGURE 5. Results of Semi-batch Cs Eluate Evaporation Model.

- The Tc eluate feed to the evaporator (Stream 1) was predicted to be at a pH of 11.6 and contain practically no insoluble solids.

- When the volume of the Tc eluate feed was reduced by a factor of 50, the resulting Tc eluate concentrate was at a pH of 13, and the blend of concentrated Cs and Tc eluate solutions became slightly basic, i.e., pH ≈ 8.

- The 50X concentrated Tc eluate solution was predicted to contain 0.15 wt% insoluble solids, consisting of CaF_2 and hydroxides of Fe and La.

- The final Cs/Tc eluate concentrate blend was predicted to contain 1.3 wt% insoluble solids, consisting of $NaAlCO_3(OH)_2$, $Ni(OH)_2$, $Fe(OH)_3$, $La(OH)_3$ and CaF_2.

- The sodium concentration in the final Cs/TC eluate concentrate blend was calculated to be 2.67 M.

- The adiabatic temperature rise during the blending of Cs and Tc eluate concentrates was predicted to be 5 ^{o}C.

The full results of the Cs/Tc eluate model runs are given in the attached material balance table for those ten streams shown in Figure 4.

PHYSICAL PROPERTY ESTIMATION

The RPP project management plans to store the Cs/Tc eluate concentrate blend at 113 ^{o}F (45 ^{o}C) and desires to have their physical properties estimated at two bounding temperatures, 100 ^{o}F (38 ^{o}C) and 180 ^{o}F (82 ^{o}C).[11] So, the composition of the Cs/Tc eluate concentrate blend just calculated was next used in the OLI EXPRESS module to perform a temperature survey from 30 to 85 ^{o}C at 1 ^{o}C increments. Prior to the survey calculations, the total flow of the blend eluate stream was scaled down to 1 gmole/hr, which is ~1/2,000th of the full-scale, since the accurate estimation of all the requested physical properties required the evaluation to several decimal places. For those physical properties other than density and viscosity, the survey results were further manipulated using correlations available in the literature. All the physical properties reported here were estimated at 1 atm.

Density

The survey results were taken directly and fitted into the following linear equations:

$$\begin{aligned} r &= 1.1554 - 6.731\,E-4\,T \quad \textit{for liquid-only} \\ &= 1.1649 - 6.726\,E-4\,T \quad \textit{including solids} \end{aligned} \tag{1}$$

where ρ is in g/ml, and T in ^{o}C.

Volume Expansion Coefficient

The volume expansion coefficient, which has the dimension of the reciprocal of temperature, was fitted into the following linear equation:

$$a + b\,T = \frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_p \tag{2}$$

where the specific volume V is in ml/g, and the calculated values of α and β are given in Table 3.

TABLE 3. Regression Results for Volume Expansion Coefficients.

	$\alpha * 10^4$ (1/^{o}C)	$\beta * 10^7$ (1/^{o}C^2)
liquid-only	5.8430	3.1879
including solids	5.7953	3.1322

Note that the regression coefficients for the total slurry including the solids scattered much less than those for the liquid-only.

[11] Johnson, M. E., Attachment to Electronic Message to A. S. Choi and T. B. Calloway, February 1, 2000.

Eq. (2) can be integrated easily to give a more useful form:

$$V_2 = V_1 \exp\left[a\,(T_2 - T_1) + \frac{b}{2}\left(T_2^2 - T_1^2\right)\right] \qquad (3)$$

Heat Capacity

The calculated enthalpies were used along with the mass flow data to estimate the heat capacities, which were then fitted into the following linear equations:

$$\begin{aligned} C_p &= 0.8223 + 1.088\,E-4\,T \quad \textit{for liquid-only} \\ &= 0.8105 + 9.21\,E-5\,T \quad \textit{including solids} \end{aligned} \qquad (4)$$

where C_p is in cal/g/^{o}C. As shown in Eq. (4), both correlations are a very weak function of temperature, and the data scatter was also very large. Therefore, it may be equally appropriate to regard the heat capacity as a constant between $30 \le T \le 85$ ^{o}C:

$$\begin{aligned} C_p &= 0.8285 \pm 0.0055 \quad \textit{for liquid-only} \\ &= 0.8158 \pm 0.0115 \quad \textit{including solids} \end{aligned} \qquad (5)$$

Viscosity

The survey results were taken directly and fitted into the following quadratic equation:

$$Abs.Viscosity = 1.8479 - 0.0274\,T + 1.387\,E-4\,T^2 \qquad (6)$$

where the absolute viscosity is in centipoise (cP), and is for the liquid-phase only. The absolute viscosities of Envelope A and B supernate simulants were measured recently at 25 and 50 ^{o}C,[12] and the measured data were fitted into the following cubic functions of sodium concentration:

$$\begin{aligned} Abs.Viscosity \\ &= 0.009432\,[Na]^3 - 0.01456\,[Na]^2 + 0.23144\,[Na] + 0.89832 \quad @\ 25\,^oC \\ &= 0.004342\,[Na]^3 - 0.01607\,[Na]^2 + 0.19356\,[Na] + 0.556 \quad @\ 50\,^oC \end{aligned} \qquad (7)$$

where [Na] is in molar, and its upper bound is 10 M. In order to validate the accuracy of the viscosities now predicted by the OLI/ESP software, the models developed earlier for the AN-105 (Envelope A) and AZ-101 (Envelope B) evaporation studies were re-run at the sodium concentrations between 4 and 8 M. The absolute viscosities of these simulants thus calculated are next compared in Figures 6 and 7 against the measured data used to generate Eq. (7); the calculated values were within ±17% of the measured data.

[12] Eibling, R. E, Unpublished Data, Westinghouse Savannah River Co., Aiken, SC, February 7, 2000.

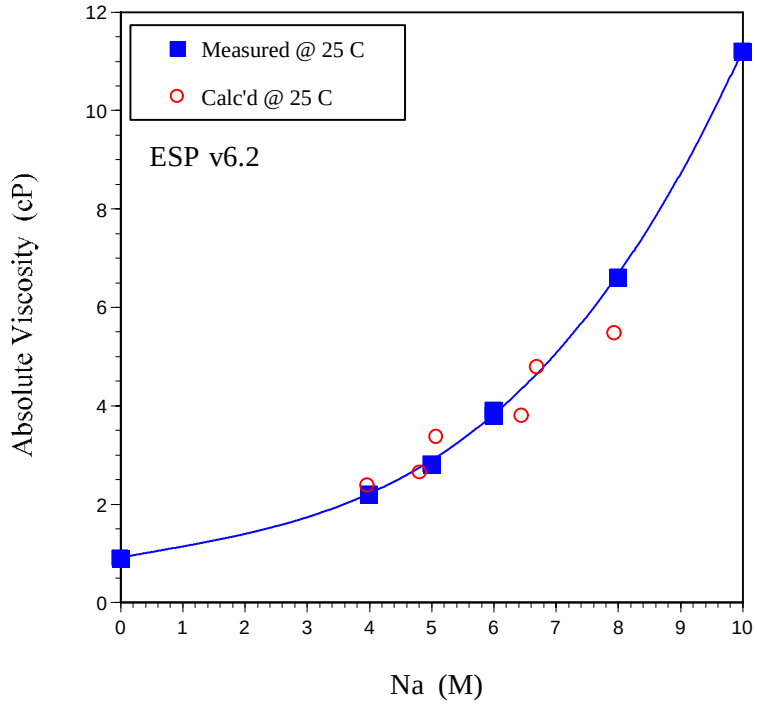

FIGURE 6. Calculated vs. Measured Absolute Viscosities of Envelope A & B Simulants at 25 °C.

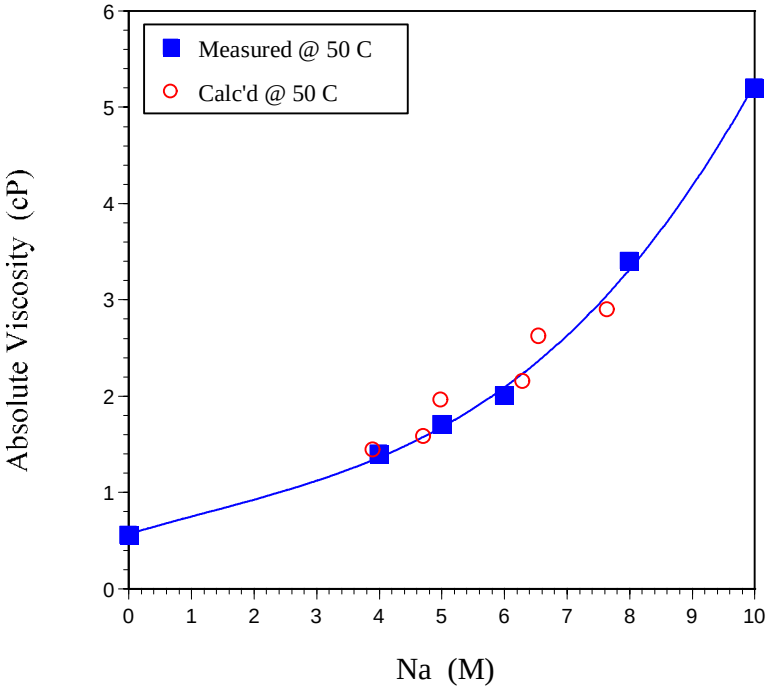

FIGURE 7. Calculated vs. Measured Absolute Viscosities of Envelope A & B Simulants at 50 °C.

Thermal Conductivity

The OLI/ESP software does not provide the data necessary to estimate the thermal conductivity. As a result, the following correlation for the thermal conductivity of dilute ionic solutions was used:[13]

$$l_{mix}(20^{o}C) = l_{H2O}(20^{o}C) + \frac{1}{4.186}\sum_{i} s_i C_i \qquad (8)$$

where λ_{mix} and λ_{H2O} are the thermal conductivities of ionic solutions and water, respectively, in cal/(cm.sec.K), and C_i the concentration of the electrolyte in gmole/liter. The coefficient σ_i in Eq. (8) is characteristic of each electrolyte, and the values of σ_i's for those electrolytes included in the calculation are tabulated in Table 4. The thermal conductivities at temperatures different from 20 ^{o}C were estimated using the following correlation:[13]

$$l_{mix}(T) = l_{mix}(20^{o}C)\frac{l_{H2O}(T)}{l_{H2O}(20^{o}C)} \qquad (9)$$

Table 5 lists the calculated thermal conductivities of the Cs and Tc eluate blend at three different temperatures along with those of water taken also from Reference 13.

TABLE 4. Values of s_i's Used in Calculations [Ref. 13].

anions		cations	
OH-	2.093E-04	H+	-9.071E-05
F-	2.093E-05	Na+	0.000E+00
Cl-	-5.466E-05	K+	-7.560E-05
NO2-	-4.652E-05	Ca+2	-5.815E-06
NO3-	-6.978E-05	Ba+2	-7.676E-05
CO3-2	-7.560E-05	Pb+2	-9.304E-05
SiO3-2	-9.300E-05	Al+3	-3.256E-04
SO4-2	1.163E-05	Cu+2	-1.628E-04
PO4-3	-2.093E-04		
CrO4-2	-1.16E-05		
oxalate-2	-3.489E-05		
acetate	-2.291E-04		

[13] Perry's Chemical Engineers' Handbook, 6th Ed., p 3-285, McGraw-Hill Book Co., New York (1984).

TABLE 5. Calculated Thermal Conductivities of AN-107 Cs/Tc Eluate Blend.

T (^oC)	$\lambda_{H2O} \times 10^3$ (cal/(cm.sec.K)	$\lambda_{mix} \times 10^3$ (cal/(cm.sec.K)
20	1.4592	1.4231
38	1.5006	1.4634
93	1.6246	1.5843

Vapor Pressure

The vapor pressures of the Cs and Tc eluate concentrates and the blend of the two eluate solutions were calculated at temperatures between 20 and 100 ^oC at 10 ^oC increments. Since these solutions are well below the saturation points, no salt species were predicted to be present in the vapor space in the same temperature interval. The estimated vapor pressures and vapor phase compositions are summarized in Tables 7, 8 and 9. These estimated vapor pressures were next fitted into the following equations:

For Cs and Tc Eluate Solutions:

$$Ln\, P^{sat}\,(mmHg) \;=\; A \;+\; \frac{B}{T\,(K)} \qquad (10)$$

For Blend Eluate Solution:

$$Ln\, P^{sat}\,(mmHg) \;=\; A \;+\; B\,T\,(K) \qquad (11)$$

Table 6 includes the values of the constants A and B from the regression analysis along with the maximum error bounds. It is noted that in Table 9 the calculated vapor pressure of the concentrated blend exceeds that of pure water.

TABLE 6. Values of Constants A and B in Eqs. (1) and (2) and Maximum Error Bounds.

Eluate	A	B	R^2	Error Bound (%)
Cs	20.4238	-5268.444	1.0000	± 1
Tc	20.3247	-5130.420	0.9999	± 2
Blend	-3.0165	0.0264	0.9961	± 3

TABLE 7. Calculated Vapor Pressures of AN-107 Cs Eluate Concentrate.

T (^oC)	VP (mmHg)	H_2O (mole %)	HNO_3 (mole %)	HCl (mole %)
20	11.4	99.069	0.923	0.008
30	20.8	99.050	0.940	0.010
40	36.5	98.990	0.998	0.012
50	61.5	98.905	1.080	0.015
60	100.3	98.780	1.202	0.018
70	158.6	98.614	1.365	0.021
80	244.3	98.410	1.566	0.024
90	367.4	98.170	1.805	0.025
100	541.4	97.913	2.060	0.027

TABLE 8. Calculated Vapor Pressures of AN-107 Tc Eluate Concentrate.

T (^oC)	VP (mmHg)	H_2O (mole %)	N_2 (mole %)	O_2 (mole %)
20	16.4	99.392	0.483	0.125
30	29.6	99.612	0.309	0.079
40	51.5	99.748	0.200	0.052
50	85.9	99.835	0.130	0.035
60	138.5	99.891	0.086	0.023
70	216.4	99.927	0.057	0.016
80	328.5	99.951	0.038	0.011
90	485.5	99.967	0.026	0.007
100	700.6	99.977	0.018	0.005

TABLE 9. Calculated Vapor Pressures of Concentrated Blend of AN-107 Cs and Tc Eluate Solutions.

T (^oC)	VP (mmHg)	H_2O (mole %)	CO_2 (mole %)
20	112.8	14.3	85.7
30	145.9	20.0	80.0
40	188.1	27.0	73.0
50	243.5	34.9	65.1
60	317.5	43.1	56.9
70	415.6	51.5	48.5
80	546.1	59.5	40.5
90	720.2	66.7	33.3
100	950.5	73.0	27.0

Solubilities

The bulk solubilities of the concentrated blend of the AN-107 Cs and Tc eluate solutions were calculated at temperatures between 20 and 100 ^{o}C at 10 ^{o}C increments. The model predicted that cesium pertechnetate (CsTcO4) would precipitate first at T < 100 ^{o}C, whereas at T = 100 ^{o}C potassium pertechnetate ($KTcO_4$) was predicted to precipitate first. That is, based on the PUBLIC database that came with the OLI/ESP v6.2d, the pertechnetate salts, not the nitrate salts, would determine the bulk solubility of the blend eluate solution. The calculated bulk solubilities (S) are given in Table 10 in two different units; g total solids (TS) per liter of solution and g TS per 100 g of H_2O. These bulk solubilities were next fitted into the following equations:

$$S\ (g\ TS/liter) = 415.9219 + 4.1771\,T - 0.009\,T^2,\ R^2 = 0.9992 \quad (12)$$

$$S\ (g\ TS/100\,g\ H_2O) = 45.6049 + 0.7173 - 0.0003\,T^2,\ R^2 = 0.9988 \quad (13)$$

where T is in degrees Celsius.

TABLE 10. Calculated Bulk Solubilities of Concentrated Blend of AN-107 Cesium and Technetium Eluate Solutions (OLI/ESP v6.2d).

T (deg C)	S (g TS/liter)	S from Eq.1	% Diff.	S (g TS/100 g H2O)	S from Eq.2	% Diff.
20	496.80	495.86	-0.19	60.22	59.83	-0.65
30	533.33	533.13	-0.04	66.74	66.85	0.17
40	568.10	568.61	0.09	73.46	73.82	0.49
50	600.26	602.28	0.34	80.22	80.72	0.62
60	632.64	634.15	0.24	87.13	87.56	0.50
70	663.85	664.22	0.06	94.18	94.35	0.18
80	694.02	692.49	-0.22	101.34	101.07	-0.27
90	723.25	718.96	-0.59	108.60	107.73	-0.80
100	739.18	743.63	0.60	112.89	114.33	1.28

CONCLUSION

The aqueous electrolyte chemistry of Tank 241-AN-107 Cs and Tc eluate evaporation was modeled using the ESP version 6.2 that was received in September 1999. The Cs eluate evaporation model was run on a semi-batch mode, until the target endpoint of 80% saturation with respect to sodium nitrate was reached in the pot. On the other hand, the characteristics of the semi-batch Tc eluate evaporation allowed it to be modeled as a continuous process, and its target endpoint was determined by a trial-and-error so that the pH of the concentrated Cs and Tc eluate blend would be close to neutral. For the WTP evaporators, however, targeting for a specific pH will not be a critical issue, since they will be equipped with the capability to add caustic for the pH adjustment, if necessary.

The results of model runs showed that the liquid in the cesium evaporator pot would become 80% saturated with sodium nitrate, when the cumulative volume of cesium eluate fed equals 42 times the volume of the initial acid charge. It was predicted that sodium nitrate would not precipitate out of the 80% saturated solution, as long as the eluate storage vessel is maintained above 17 ^{o}C. It was also predicted that when the Tc eluate is concentrated by a factor of 50, i.e., a 50X volume reduction, the resulting blend of concentrated Tc eluate and the 80% saturated Cs eluate would become slightly basic, i.e., pH $\approx$ 8. The first major salt to precipitate from the Tc eluate solution was predicted to be potassium pertechnetate ($KTcO_4$). Although the 50X concentrated Tc eluate would still be far from saturation with respect to potassium pertechnetate, the model predicted that a small amount of insoluble solids would be present at 0.15 wt%, consisting of hydroxides of Fe and La and calcium fluoride. The concentrated blend of cesium and technetium eluates was predicted to contain more insoluble solids at 1.3 wt%, consisting mainly of dawsonite and hydroxides of Fe, La and Ni.

When the evaporation models were rerun with the new PUBLIC database that was received after this study was completed, the results of new model runs showed that the concentrated Cs eluate (Stream 10) would be more like 95% saturated, instead of 80%, with respect to sodium nitrate. The new model runs also showed that the lowest storage temperature to preclude the formation of sodium nitrate crystals in the Cs eluate would be 20 ^{o}C, instead of 17 ^{o}C. This means that the physical property correlations presented in this report would be conservative from the design perspective, since they are based on a solution more concentrated than the flowsheet target 80% saturation. One key result of the new Tc eluate model run was that the bulk solubility would be determined by sodium nitrate rather than by potassium pertechnetate. However, this would have little impact on the calcuated physical properties, since the 50X concentrated Tc eluate would still be so far from the solubility limit of either sodium nitrate or potassium pertechnetate.

It was also found after the completion of this study that the new PUBLIC database adequately predicted neither the in-house nor the literature data for the nitric acid-water system. The physical properties in question are the density and heat capacity. However, the impact of this database inadequacy on the physical property correlations reported here should be minimal, since they were developed for the blend eluate solution whose pH is near neutral, i.e., far away from being acidic.

QUALITY ASSURANCE

The quality assurance plan for the ESP software used in this study is described in the software quality assurance plan (SQAP) for the RPP-WTP evaporator modeling work.[14] This SQAP was developed in accordance with the Savannah River Technology Center (SRTC) quality assurance program plan developed for the Work-for-Others Agreement WFO 98-003.[15] The software classification of the ESP is documented as the Level D software, and the requirements specification for software (RSS) is also documented in this SQAP.

The verification of the proper installation and the validation of the adequacy of the ESP software for the RPP-WTP evaporator modeling work, including the private database management, are documented in a separate report.[16] Additional validation runs were made during this study, and the results are shown in Figures 2, 3, 6 and 7.

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[14] Choi, A. S., "Software Quality Assurance Plan for Hanford RPP-WTP Evaporator Modeling (U)," **WSRC-RP-2001-00337, Rev. 0**, Westinghouse Savannah River Co., Aiken, SC, February 24, 2001.

[15] Savannah River Technology Center Quality Assurance Program Plan for British Nuclear Fuels Limited Work For Others Agreement (WFO 98-003) (U), **BNF-003-98-0008**, **Rev. 1**, Westinghouse Savannah River Co., Aiken, SC, November 8, 1999

[16] Choi, A. S., "Verification and Validation of the Environmental Simulation Program for RPP-WTP Evaporator Modeling Work (U)," **WSRC-RP-2001-00343, Rev. 0**, Westinghouse Savannah River Co., Aiken, SC, February 24, 2001.

APPENDIX

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      E N V I R O N M E N T A L   S I M U L A T I O N   P R O G R A M

                        V - 6.2   July 1, 1999

                             PROCESS: Eluate Conc & Blending

                       CHEMISTRY MODEL: ELUATE_BLEND

                        THIS FILE NAME: CS_TC_ELU_C.LIS

                                 DATE: 02/17/2000

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```

STREAM: Tc IX Eluate Feed (1)
TO : Tc Eluate Evaporator
FROM :

Phases---------->	Aqueous	Solid	Vapor	Organic
Temperature, C	25.	25.	25.	25.
Pressure, atm	1.	1.	1.	1.
pH	11.5653			
Total mol/hr	82987.	0.395613	0.0	0.0
----------	mol/hr--------	mol/hr--------	mol/hr--------	mol/hr--
H2O	82834.8	0.0	0.0	0.0
H2F2	9.5397E-25	0.0	0.0	0.0
CO2	1.9247E-06	0.0	0.0	0.0
HCL	2.3707E-17	0.0	0.0	0.0
HF	8.4842E-09	0.0	0.0	0.0
HNO2	1.9472E-08	0.0	0.0	0.0
HNO3	1.5510E-12	0.0	0.0	0.0
FEIIIF3	5.3870E-27	0.0	0.0	0.0
FEIIIOH3	4.4633E-05	0.0892195	0.0	0.0
ALF3	1.0244E-16	0.0	0.0	0.0
H2SIO3	0.00513631	0.0	0.0	0.0
BOH3	0.00387358	0.0	0.0	0.0
CACO3	0.0102931	0.156048	0.0	0.0
CAH2SIO4	3.8441E-04	0.0	0.0	0.0
ALOH3	1.2787E-05	0.0	0.0	0.0
KCL	4.3803E-05	0.0	0.0	0.0
LACL3	2.9183E-24	0.0	0.0	0.0
LAF3	8.2168E-18	0.0	0.0	0.0
LAOH3	4.4715E-11	0.150346	0.0	0.0
NABOH4	0.0232492	0.0	0.0	0.0
NAF	0.0656815	0.0	0.0	0.0
NAHCO3	0.00591094	0.0	0.0	0.0
NAHSIO3	1.44665	0.0	0.0	0.0
NANO3	0.00936068	0.0	0.0	0.0
SIO2	0.00512308	0.0	0.0	0.0
OHION	6.88299	0.0	0.0	0.0
ALF4ION	4.2300E-17	0.0	0.0	0.0
ALF5ION	2.4824E-18	0.0	0.0	0.0
ALF6ION	3.3926E-20	0.0	0.0	0.0
ALFION	3.3034E-20	0.0	0.0	0.0
ALION	7.7094E-24	0.0	0.0	0.0
ALOH2ION	8.0920E-12	0.0	0.0	0.0
ALOH4ION	1.49224	0.0	0.0	0.0
ALOHION	9.3904E-18	0.0	0.0	0.0
BOH4ION	1.03161	0.0	0.0	0.0
CAFION	1.6032E-07	0.0	0.0	0.0
CAH2BO3ION	5.1665E-05	0.0	0.0	0.0
CAHCO3ION	3.9984E-06	0.0	0.0	0.0
CAHSIO3ION	4.7304E-06	0.0	0.0	0.0
CAION	0.00323279	0.0	0.0	0.0
CANO3ION	2.9157E-05	0.0	0.0	0.0
CAOHION	1.0354E-04	0.0	0.0	0.0
CLION	18.5329	0.0	0.0	0.0
CO3ION	14.2448	0.0	0.0	0.0
FEIIICL2ION	0.0	0.0	0.0	0.0

FEIIICLION	3.3011E-30	0.0	0.0	0.0
FEIIIF2ION	2.5406E-26	0.0	0.0	0.0
FEIIIFION	4.7490E-27	0.0	0.0	0.0
FEIIIION	7.1466E-27	0.0	0.0	0.0
FEIIINO3ION	1.4043E-30	0.0	0.0	0.0
FEIIIOH2ION	1.9968E-11	0.0	0.0	0.0
FEIIIOH4ION	0.00524497	0.0	0.0	0.0
FEIIIOHION	5.3541E-18	0.0	0.0	0.0
FION	2.44767	0.0	0.0	0.0
H2SIO4ION	0.017612	0.0	0.0	0.0
H3SIO4ION	0.341951	0.0	0.0	0.0
HCO3ION	0.408875	0.0	0.0	0.0
HF2ION	3.3959E-12	0.0	0.0	0.0
HION	5.0269E-09	0.0	0.0	0.0
HSIO3ION	0.540751	0.0	0.0	0.0
KION	0.670647	0.0	0.0	0.0
LACL2ION	8.3779E-22	0.0	0.0	0.0
LACL4ION	1.4227E-26	0.0	0.0	0.0
LACLION	3.7855E-19	0.0	0.0	0.0
LACO3ION	4.6238E-13	0.0	0.0	0.0
LAF2ION	7.6316E-17	0.0	0.0	0.0
LAF4ION	6.2315E-19	0.0	0.0	0.0
LAFION	1.7883E-16	0.0	0.0	0.0
LAHCO3ION	4.0125E-19	0.0	0.0	0.0
LAION	5.9422E-17	0.0	0.0	0.0
LANO3ION	5.6063E-19	0.0	0.0	0.0
LAOH2ION	8.4033E-13	0.0	0.0	0.0
LAOH4ION	2.7104E-12	0.0	0.0	0.0
LAOHION	1.5058E-14	0.0	0.0	0.0
NA2FION	3.4170E-05	0.0	0.0	0.0
NACO3ION	1.08327	0.0	0.0	0.0
NAION	82.0992	0.0	0.0	0.0
NO2ION	5.47646	0.0	0.0	0.0
NO3ION	14.7601	0.0	0.0	0.0
ALF2ION	8.8318E-18	0.0	0.0	0.0
SIO3ION	0.618345	0.0	0.0	0.0
TCVIIO4ION	0.0109487	0.0	0.0	0.0
Total g/hr	1.4977E+06	53.708	0.0	0.0
Volume, L/hr	1497.87	0.008567	0.0	0.0
Enthalpy, cal/hr	-5.6701E+09	-1.1491E+05	0.0	0.0
Density, g/L	999.86	6269.2		
Vapor fraction	0.0	0.0	0.0	0.0
Solid fraction	0.0	1.	0.0	0.0
Organic fraction	0.0	0.0	0.0	0.0
Osmotic Pres, atm	2.16712			
Redox Pot, volts	0.0			
E-Con, 1/ohm-cm	0.00615854			
E-Con, cm2/ohm-mol	137.818			
Abs Visc, cP	0.900562			
Rel Visc	1.01105			
Ionic Strength	0.0654435			

STREAM: Bottom Recycle (5)
TO : Tc Eluate Evaporator
FROM : Recycle Split

Phases---------->	Aqueous	Solid	Vapor	Organic
Temperature, C	50.	50.	50.	50.
Pressure, atm	0.113058	0.113058	0.113058	0.113058
pH	12.5361			
Total mol/hr	15922.1	3.27692	0.0	0.0
----------	mol/hr	mol/hr	mol/hr	mol/hr
H2O	14590.4	0.0	0.0	0.0
H2F2	2.2461E-24	0.0	0.0	0.0
CO2	7.7537E-09	0.0	0.0	0.0
HCL	5.7223E-17	0.0	0.0	0.0
HF	2.7077E-09	0.0	0.0	0.0
HNO2	4.9561E-09	0.0	0.0	0.0
HNO3	7.2777E-13	0.0	0.0	0.0
N2	1.2329E-05	0.0	0.0	0.0
O2	6.0031E-06	0.0	0.0	0.0
FEIIIF3	1.5486E-27	0.0	0.0	0.0
FEIIIOH3	2.5458E-05	0.393763	0.0	0.0
ALF3	7.2381E-18	0.0	0.0	0.0
H2SIO3	1.8504E-04	0.0	0.0	0.0
BOH3	9.6829E-04	0.0	0.0	0.0
CACO3	5.9323E-04	0.0	0.0	0.0
CAH2SIO4	3.2561E-04	0.0	0.0	0.0
ALOH3	2.3631E-06	0.0	0.0	0.0
KCL	0.0127172	0.0	0.0	0.0
LACL3	4.3192E-24	0.0	0.0	0.0
LAF3	1.2497E-18	0.0	0.0	0.0
LAOH3	4.5183E-10	1.3531	0.0	0.0
NABOH4	2.82295	0.0	0.0	0.0
NAF	5.44687	0.0	0.0	0.0
NAHCO3	0.016597	0.0	0.0	0.0
NAHSIO3	21.0193	0.0	0.0	0.0
NANO3	0.998661	0.0	0.0	0.0
SIO2	2.9608E-04	0.0	0.0	0.0
OHION	57.9461	0.0	0.0	0.0
ALF4ION	1.6308E-16	0.0	0.0	0.0
ALF5ION	1.0370E-15	0.0	0.0	0.0
ALF6ION	3.7481E-15	0.0	0.0	0.0
ALFION	3.1474E-23	0.0	0.0	0.0
ALION	3.3874E-28	0.0	0.0	0.0
ALOH2ION	8.8594E-14	0.0	0.0	0.0
ALOH4ION	13.4306	0.0	0.0	0.0
ALOHION	5.9284E-21	0.0	0.0	0.0
BOH4ION	6.70276	0.0	0.0	0.0
CAFION	2.6883E-07	0.0	0.0	0.0
CAH2BO3ION	2.6010E-05	0.0	0.0	0.0
CAHCO3ION	2.7146E-08	0.0	0.0	0.0
CAHSIO3ION	4.8472E-08	0.0	0.0	0.0
CAION	1.2132E-04	0.0	0.0	0.0
CANO3ION	1.2131E-06	0.0	0.0	0.0
CAOHION	8.8886E-05	0.0	0.0	0.0
CLION	166.787	0.0	0.0	0.0
CO3ION	116.504	0.0	0.0	0.0

FEIIICL2ION	0.0	0.0	0.0	0.0
FEIIICLION	0.0	0.0	0.0	0.0
FEIIIF2ION	2.2484E-27	0.0	0.0	0.0
FEIIIFION	5.2863E-29	0.0	0.0	0.0
FEIIIION	6.5662E-30	0.0	0.0	0.0
FEIIIOH2ION	7.5931E-13	0.0	0.0	0.0
FEIIIOH4ION	0.456645	0.0	0.0	0.0
FEIIIOHION	1.7976E-20	0.0	0.0	0.0
FION	14.085	0.0	0.0	0.0
H2SIO4ION	0.3284	0.0	0.0	0.0
H3SIO4ION	0.905926	0.0	0.0	0.0
HCO3ION	0.0481102	0.0	0.0	0.0
HF2ION	6.0801E-11	0.0	0.0	0.0
HION	9.6963E-11	0.0	0.0	0.0
HSIO3ION	0.092321	0.0	0.0	0.0
KION	6.02345	0.0	0.0	0.0
LACL2ION	8.9252E-23	0.0	0.0	0.0
LACL4ION	1.2552E-24	0.0	0.0	0.0
LACLION	2.4176E-21	0.0	0.0	0.0
LACO3ION	5.1672E-17	0.0	0.0	0.0
LAF2ION	2.5595E-18	0.0	0.0	0.0
LAF4ION	1.5677E-18	0.0	0.0	0.0
LAFION	1.4223E-18	0.0	0.0	0.0
LAHCO3ION	2.4833E-23	0.0	0.0	0.0
LAION	5.3233E-20	0.0	0.0	0.0
LANO3ION	7.0537E-22	0.0	0.0	0.0
LAOH2ION	2.1100E-13	0.0	0.0	0.0
LAOH4ION	4.4555E-09	0.0	0.0	0.0
LAOHION	7.9094E-17	0.0	0.0	0.0
NA2FION	0.0300707	0.0	0.0	0.0
NACO3ION	27.0012	0.0	0.0	0.0
NAION	705.275	0.0	0.0	0.0
NO2ION	49.2889	0.0	0.0	0.0
NO3ION	131.935	0.0	0.0	0.0
ALF2ION	5.6455E-20	0.0	0.0	0.0
SIO3ION	4.4435	0.0	0.0	0.0
TCVIIO4ION	0.0985374	0.0	0.0	0.0
CAF2	0.0	1.53006	0.0	0.0
Total g/hr	3.1120E+05	418.531	0.0	0.0
Volume, L/hr	279.32	0.049924	0.0	0.0
Enthalpy, cal/hr	-1.0922E+09	-9.9733E+05	0.0	0.0
Density, g/L	1114.1	8383.4		
Vapor fraction	0.0	0.0	0.0	0.0
Solid fraction	0.0	1.	0.0	0.0
Organic fraction	0.0	0.0	0.0	0.0
Osmotic Pres, atm	118.151			
Redox Pot, volts	0.0			
E-Con, 1/ohm-cm	0.209536			
E-Con, cm2/ohm-mol	79.5792			
Abs Visc, cP	0.961201			
Rel Visc	1.75653			
Ionic Strength	3.16762			

STREAM: Air Inleakage (2)
TO : Tc Eluate Evaporator
FROM :

Phases---------->	Aqueous	Solid	Vapor	Organic
Temperature, C	25.	25.	25.	25.
Pressure, atm	1.	1.	1.	1.
pH	0.0			
Total mol/hr	0.0	0.0	135.18	0.0
----------	mol/hr	mol/hr	mol/hr	mol/hr
H2O	0.0	0.0	1.00965	0.0
CO2	0.0	0.0	0.0443387	0.0
N2	0.0	0.0	106.017	0.0
O2	0.0	0.0	28.1091	0.0
Total g/hr	0.0	0.0	3889.49	0.0
Volume, L/hr	0.0	0.0	3306.71	0.0
Enthalpy, cal/hr	0.0	0.0	-62752.6	0.0
Density, g/L			1.17624	
Vapor fraction	0.0	0.0	1.	0.0
Solid fraction	0.0	0.0	0.0	0.0
Organic fraction	0.0	0.0	0.0	0.0
Osmotic Pres, atm	0.0			
Redox Pot, volts	0.0			
E-Con, 1/ohm-cm	0.0			
E-Con, cm2/ohm-mol	0.0			
Abs Visc, cP	0.0			
Rel Visc	0.0			
Ionic Strength	0.0			

STREAM: Total Pot Content
TO : Evaporator Content Split
FROM : Tc Eluate Evaporator

Phases---------->	Aqueous	Solid	Vapor	Organic
Temperature, C	50.	50.	50.	50.
Pressure, atm	0.113058	0.113058	0.113058	0.113058
pH	12.5361			
Total mol/hr	17691.2	3.64102	81350.	0.0
----------	mol/hr	mol/hr	mol/hr	mol/hr
H2O	16211.5	0.0	81215.9	0.0
H2F2	2.4956E-24	0.0	2.2204E-24	0.0
CO2	8.6153E-09	0.0	0.00203477	0.0
HCL	6.3581E-17	0.0	5.8755E-13	0.0
HF	3.0085E-09	0.0	3.0011E-09	0.0
HNO2	5.5068E-09	0.0	8.4555E-06	0.0
HNO3	8.0863E-13	0.0	7.6304E-13	0.0
N2	1.3698E-05	0.0	106.017	0.0
O2	6.6701E-06	0.0	28.1091	0.0
FEIIIF3	1.7207E-27	0.0	0.0	0.0
FEIIIOH3	2.8286E-05	0.437514	0.0	0.0
ALF3	8.0423E-18	0.0	0.0	0.0
H2SIO3	2.0560E-04	0.0	0.0	0.0
BOH3	0.00107588	0.0	0.0	0.0
CACO3	6.5915E-04	0.0	0.0	0.0
CAH2SIO4	3.6179E-04	0.0	0.0	0.0
ALOH3	2.6256E-06	0.0	0.0	0.0
KCL	0.0141303	0.0	0.0	0.0
LACL3	4.7991E-24	0.0	0.0	0.0
LAF3	1.3885E-18	0.0	0.0	0.0
LAOH3	5.0204E-10	1.50344	0.0	0.0
NABOH4	3.13661	0.0	0.0	0.0
NAF	6.05207	0.0	0.0	0.0
NAHCO3	0.0184411	0.0	0.0	0.0
NAHSIO3	23.3548	0.0	0.0	0.0
NANO3	1.10962	0.0	0.0	0.0
SIO2	3.2898E-04	0.0	0.0	0.0
OHION	64.3846	0.0	0.0	0.0
ALF4ION	1.8120E-16	0.0	0.0	0.0
ALF5ION	1.1523E-15	0.0	0.0	0.0
ALF6ION	4.1645E-15	0.0	0.0	0.0
ALFION	3.4971E-23	0.0	0.0	0.0
ALION	3.7638E-28	0.0	0.0	0.0
ALOH2ION	9.8437E-14	0.0	0.0	0.0
ALOH4ION	14.9228	0.0	0.0	0.0
ALOHION	6.5871E-21	0.0	0.0	0.0
BOH4ION	7.44751	0.0	0.0	0.0
CAFION	2.9870E-07	0.0	0.0	0.0
CAH2BO3ION	2.8900E-05	0.0	0.0	0.0
CAHCO3ION	3.0162E-08	0.0	0.0	0.0
CAHSIO3ION	5.3857E-08	0.0	0.0	0.0
CAION	1.3480E-04	0.0	0.0	0.0
CANO3ION	1.3479E-06	0.0	0.0	0.0
CAOHION	9.8762E-05	0.0	0.0	0.0
CLION	185.319	0.0	0.0	0.0
CO3ION	129.448	0.0	0.0	0.0

FEIIICL2ION	0.0	0.0	0.0	0.0
FEIIICLION	0.0	0.0	0.0	0.0
FEIIIF2ION	2.4982E-27	0.0	0.0	0.0
FEIIIFION	5.8737E-29	0.0	0.0	0.0
FEIIIION	7.2958E-30	0.0	0.0	0.0
FEIIIOH2ION	8.4368E-13	0.0	0.0	0.0
FEIIIOH4ION	0.507383	0.0	0.0	0.0
FEIIIOHION	1.9974E-20	0.0	0.0	0.0
FION	15.65	0.0	0.0	0.0
H2SIO4ION	0.364889	0.0	0.0	0.0
H3SIO4ION	1.00658	0.0	0.0	0.0
HCO3ION	0.0534558	0.0	0.0	0.0
HF2ION	6.7557E-11	0.0	0.0	0.0
HION	1.0774E-10	0.0	0.0	0.0
HSIO3ION	0.102579	0.0	0.0	0.0
KION	6.69272	0.0	0.0	0.0
LACL2ION	9.9169E-23	0.0	0.0	0.0
LACL4ION	1.3946E-24	0.0	0.0	0.0
LACLION	2.6862E-21	0.0	0.0	0.0
LACO3ION	5.7414E-17	0.0	0.0	0.0
LAF2ION	2.8439E-18	0.0	0.0	0.0
LAF4ION	1.7419E-18	0.0	0.0	0.0
LAFION	1.5803E-18	0.0	0.0	0.0
LAHCO3ION	2.7593E-23	0.0	0.0	0.0
LAION	5.9148E-20	0.0	0.0	0.0
LANO3ION	7.8374E-22	0.0	0.0	0.0
LAOH2ION	2.3444E-13	0.0	0.0	0.0
LAOH4ION	4.9506E-09	0.0	0.0	0.0
LAOHION	8.7882E-17	0.0	0.0	0.0
NA2FION	0.0334119	0.0	0.0	0.0
NACO3ION	30.0014	0.0	0.0	0.0
NAION	783.639	0.0	0.0	0.0
NO2ION	54.7654	0.0	0.0	0.0
NO3ION	146.594	0.0	0.0	0.0
ALF2ION	6.2727E-20	0.0	0.0	0.0
SIO3ION	4.93722	0.0	0.0	0.0
TCVIIO4ION	0.109486	0.0	0.0	0.0
CAF2	0.0	1.70007	0.0	0.0
	==========	==========	==========	==========
Total g/hr	3.4578E+05	465.034	1.4670E+06	0.0
Volume, L/hr	310.356	0.055471	1.9054E+07	0.0
Enthalpy, cal/hr	-1.2136E+09	-1.1081E+06	-4.6779E+09	0.0
Density, g/L	1114.1	8383.4	0.0769899	
Vapor fraction	0.0	0.0	1.	0.0
Solid fraction	0.0	1.	0.0	0.0
Organic fraction	0.0	0.0	0.0	0.0
Osmotic Pres, atm	118.151			
Redox Pot, volts	0.0			
E-Con, 1/ohm-cm	0.209536			
E-Con, cm2/ohm-mol	79.6455			
Abs Visc, cP	0.961201			
Rel Visc	1.75653			
Ionic Strength	3.16762			

STREAM: Evaporator Overhead (3)
TO : Primary Condenser
FROM : Evaporator Content Split

Phases---------->	Aqueous	Solid	Vapor	Organic
Temperature, C	50.	50.	50.	50.
Pressure, atm	0.113058	0.113058	0.113058	0.113058
pH	0.0			
Total mol/hr	0.0	0.0	81350.	0.0
----------	mol/hr	mol/hr	mol/hr	mol/hr
H2O	0.0	0.0	81215.9	0.0
H2F2	0.0	0.0	2.2204E-24	0.0
CO2	0.0	0.0	0.00203477	0.0
HCL	0.0	0.0	5.8755E-13	0.0
HF	0.0	0.0	3.0011E-09	0.0
HNO2	0.0	0.0	8.4555E-06	0.0
HNO3	0.0	0.0	7.6304E-13	0.0
N2	0.0	0.0	106.017	0.0
O2	0.0	0.0	28.1091	0.0
Total g/hr	0.0	0.0	1.4670E+06	0.0
Volume, L/hr	0.0	0.0	1.9054E+07	0.0
Enthalpy, cal/hr	0.0	0.0	-4.6779E+09	0.0
Density, g/L			0.0769899	
Vapor fraction	0.0	0.0	1.	0.0
Solid fraction	0.0	0.0	0.0	0.0
Organic fraction	0.0	0.0	0.0	0.0
Osmotic Pres, atm	0.0			
Redox Pot, volts	0.0			
E-Con, 1/ohm-cm	0.0			
E-Con, cm2/ohm-mol	0.0			
Abs Visc, cP	0.0			
Rel Visc	0.0			
Ionic Strength	0.0			

STREAM: Evaporator Bottom (4)
TO : Recycle Split
FROM : Evaporator Content Split

Phases---------->	Aqueous	Solid	Vapor	Organic
Temperature, C	50.	50.	50.	50.
Pressure, atm	0.113058	0.113058	0.113058	0.113058
pH	12.5361			
Total mol/hr	17691.2	3.64102	0.0	0.0
----------	mol/hr	mol/hr	mol/hr	mol/hr
H2O	16211.5	0.0	0.0	0.0
H2F2	2.4956E-24	0.0	0.0	0.0
CO2	8.6153E-09	0.0	0.0	0.0
HCL	6.3581E-17	0.0	0.0	0.0
HF	3.0085E-09	0.0	0.0	0.0
HNO2	5.5068E-09	0.0	0.0	0.0
HNO3	8.0863E-13	0.0	0.0	0.0
N2	1.3698E-05	0.0	0.0	0.0
O2	6.6701E-06	0.0	0.0	0.0
FEIIIF3	1.7206E-27	0.0	0.0	0.0
FEIIIOH3	2.8286E-05	0.437514	0.0	0.0
ALF3	8.0423E-18	0.0	0.0	0.0
H2SIO3	2.0560E-04	0.0	0.0	0.0
BOH3	0.00107588	0.0	0.0	0.0
CACO3	6.5915E-04	0.0	0.0	0.0
CAH2SIO4	3.6179E-04	0.0	0.0	0.0
ALOH3	2.6256E-06	0.0	0.0	0.0
KCL	0.0141303	0.0	0.0	0.0
LACL3	4.7991E-24	0.0	0.0	0.0
LAF3	1.3885E-18	0.0	0.0	0.0
LAOH3	5.0204E-10	1.50344	0.0	0.0
NABOH4	3.13661	0.0	0.0	0.0
NAF	6.05207	0.0	0.0	0.0
NAHCO3	0.0184411	0.0	0.0	0.0
NAHSIO3	23.3548	0.0	0.0	0.0
NANO3	1.10962	0.0	0.0	0.0
SIO2	3.2898E-04	0.0	0.0	0.0
OHION	64.3846	0.0	0.0	0.0
ALF4ION	1.8120E-16	0.0	0.0	0.0
ALF5ION	1.1523E-15	0.0	0.0	0.0
ALF6ION	4.1645E-15	0.0	0.0	0.0
ALFION	3.4971E-23	0.0	0.0	0.0
ALION	3.7638E-28	0.0	0.0	0.0
ALOH2ION	9.8437E-14	0.0	0.0	0.0
ALOH4ION	14.9228	0.0	0.0	0.0
ALOHION	6.5871E-21	0.0	0.0	0.0
BOH4ION	7.44751	0.0	0.0	0.0
CAFION	2.9870E-07	0.0	0.0	0.0
CAH2BO3ION	2.8900E-05	0.0	0.0	0.0
CAHCO3ION	3.0162E-08	0.0	0.0	0.0
CAHSIO3ION	5.3857E-08	0.0	0.0	0.0
CAION	1.3480E-04	0.0	0.0	0.0
CANO3ION	1.3479E-06	0.0	0.0	0.0
CAOHION	9.8762E-05	0.0	0.0	0.0
CLION	185.319	0.0	0.0	0.0
CO3ION	129.448	0.0	0.0	0.0

FEIIICL2ION	0.0	0.0	0.0	0.0
FEIIICLION	0.0	0.0	0.0	0.0
FEIIIF2ION	2.4982E-27	0.0	0.0	0.0
FEIIIFION	5.8737E-29	0.0	0.0	0.0
FEIIIION	7.2958E-30	0.0	0.0	0.0
FEIIIOH2ION	8.4368E-13	0.0	0.0	0.0
FEIIIOH4ION	0.507383	0.0	0.0	0.0
FEIIIOHION	1.9974E-20	0.0	0.0	0.0
FION	15.65	0.0	0.0	0.0
H2SIO4ION	0.364889	0.0	0.0	0.0
H3SIO4ION	1.00658	0.0	0.0	0.0
HCO3ION	0.0534558	0.0	0.0	0.0
HF2ION	6.7557E-11	0.0	0.0	0.0
HION	1.0774E-10	0.0	0.0	0.0
HSIO3ION	0.102579	0.0	0.0	0.0
KION	6.69272	0.0	0.0	0.0
LACL2ION	9.9169E-23	0.0	0.0	0.0
LACL4ION	1.3946E-24	0.0	0.0	0.0
LACLION	2.6862E-21	0.0	0.0	0.0
LACO3ION	5.7414E-17	0.0	0.0	0.0
LAF2ION	2.8439E-18	0.0	0.0	0.0
LAF4ION	1.7419E-18	0.0	0.0	0.0
LAFION	1.5803E-18	0.0	0.0	0.0
LAHCO3ION	2.7593E-23	0.0	0.0	0.0
LAION	5.9148E-20	0.0	0.0	0.0
LANO3ION	7.8374E-22	0.0	0.0	0.0
LAOH2ION	2.3444E-13	0.0	0.0	0.0
LAOH4ION	4.9506E-09	0.0	0.0	0.0
LAOHION	8.7882E-17	0.0	0.0	0.0
NA2FION	0.0334119	0.0	0.0	0.0
NACO3ION	30.0014	0.0	0.0	0.0
NAION	783.639	0.0	0.0	0.0
NO2ION	54.7654	0.0	0.0	0.0
NO3ION	146.594	0.0	0.0	0.0
ALF2ION	6.2727E-20	0.0	0.0	0.0
SIO3ION	4.93722	0.0	0.0	0.0
TCVIIO4ION	0.109486	0.0	0.0	0.0
CAF2	0.0	1.70007	0.0	0.0
	==========	==========	==========	==========
Total g/hr	3.4578E+05	465.034	0.0	0.0
Volume, L/hr	310.356	0.055471	0.0	0.0
Enthalpy, cal/hr	-1.2136E+09	-1.1081E+06	0.0	0.0
Density, g/L	1114.1	8383.4		
Vapor fraction	0.0	0.0	0.0	0.0
Solid fraction	0.0	1.	0.0	0.0
Organic fraction	0.0	0.0	0.0	0.0
Osmotic Pres, atm	118.151			
Redox Pot, volts	0.0			
E-Con, 1/ohm-cm	0.209536			
E-Con, cm2/ohm-mol	79.5792			
Abs Visc, cP	0.961201			
Rel Visc	1.75653			
Ionic Strength	3.16762			

STREAM: Tc Eluate Concentrate
TO : Concentrate Storage
FROM : Recycle Split

Phases---------->	Aqueous	Solid	Vapor	Organic
Temperature, C	50.	50.	50.	50.
Pressure, atm	0.113058	0.113058	0.113058	0.113058
pH	12.5361			
Total mol/hr	1769.12	0.364102	0.0	0.0
----------	mol/hr--------	mol/hr--------	mol/hr--------	mol/hr--
H2O	1621.15	0.0	0.0	0.0
H2F2	2.4956E-25	0.0	0.0	0.0
CO2	8.6153E-10	0.0	0.0	0.0
HCL	6.3581E-18	0.0	0.0	0.0
HF	3.0085E-10	0.0	0.0	0.0
HNO2	5.5068E-10	0.0	0.0	0.0
HNO3	8.0863E-14	0.0	0.0	0.0
N2	1.3698E-06	0.0	0.0	0.0
O2	6.6701E-07	0.0	0.0	0.0
FEIIIF3	1.7206E-28	0.0	0.0	0.0
FEIIIOH3	2.8286E-06	0.0437514	0.0	0.0
ALF3	8.0423E-19	0.0	0.0	0.0
H2SIO3	2.0560E-05	0.0	0.0	0.0
BOH3	1.0759E-04	0.0	0.0	0.0
CACO3	6.5915E-05	0.0	0.0	0.0
CAH2SIO4	3.6179E-05	0.0	0.0	0.0
ALOH3	2.6256E-07	0.0	0.0	0.0
KCL	0.00141303	0.0	0.0	0.0
LACL3	4.7991E-25	0.0	0.0	0.0
LAF3	1.3885E-19	0.0	0.0	0.0
LAOH3	5.0204E-11	0.150344	0.0	0.0
NABOH4	0.313661	0.0	0.0	0.0
NAF	0.605207	0.0	0.0	0.0
NAHCO3	0.00184411	0.0	0.0	0.0
NAHSIO3	2.33548	0.0	0.0	0.0
NANO3	0.110962	0.0	0.0	0.0
SIO2	3.2898E-05	0.0	0.0	0.0
OHION	6.43846	0.0	0.0	0.0
ALF4ION	1.8120E-17	0.0	0.0	0.0
ALF5ION	1.1523E-16	0.0	0.0	0.0
ALF6ION	4.1645E-16	0.0	0.0	0.0
ALFION	3.4971E-24	0.0	0.0	0.0
ALION	3.7638E-29	0.0	0.0	0.0
ALOH2ION	9.8437E-15	0.0	0.0	0.0
ALOH4ION	1.49228	0.0	0.0	0.0
ALOHION	6.5871E-22	0.0	0.0	0.0
BOH4ION	0.744751	0.0	0.0	0.0
CAFION	2.9870E-08	0.0	0.0	0.0
CAH2BO3ION	2.8900E-06	0.0	0.0	0.0
CAHCO3ION	3.0162E-09	0.0	0.0	0.0
CAHSIO3ION	5.3857E-09	0.0	0.0	0.0
CAION	1.3480E-05	0.0	0.0	0.0
CANO3ION	1.3479E-07	0.0	0.0	0.0
CAOHION	9.8762E-06	0.0	0.0	0.0
CLION	18.5319	0.0	0.0	0.0
CO3ION	12.9448	0.0	0.0	0.0

FEIIIF2ION	2.4982E-28	0.0	0.0	0.0
FEIIIFION	5.8737E-30	0.0	0.0	0.0
FEIIIION	0.0	0.0	0.0	0.0
FEIIIOH2ION	8.4368E-14	0.0	0.0	0.0
FEIIIOH4ION	0.0507383	0.0	0.0	0.0
FEIIIOHION	1.9974E-21	0.0	0.0	0.0
FION	1.565	0.0	0.0	0.0
H2SIO4ION	0.0364889	0.0	0.0	0.0
H3SIO4ION	0.100658	0.0	0.0	0.0
HCO3ION	0.00534558	0.0	0.0	0.0
HF2ION	6.7557E-12	0.0	0.0	0.0
HION	1.0774E-11	0.0	0.0	0.0
HSIO3ION	0.0102579	0.0	0.0	0.0
KION	0.669272	0.0	0.0	0.0
LACL2ION	9.9169E-24	0.0	0.0	0.0
LACL4ION	1.3946E-25	0.0	0.0	0.0
LACLION	2.6862E-22	0.0	0.0	0.0
LACO3ION	5.7414E-18	0.0	0.0	0.0
LAF2ION	2.8439E-19	0.0	0.0	0.0
LAF4ION	1.7419E-19	0.0	0.0	0.0
LAFION	1.5803E-19	0.0	0.0	0.0
LAHCO3ION	2.7593E-24	0.0	0.0	0.0
LAION	5.9148E-21	0.0	0.0	0.0
LANO3ION	7.8374E-23	0.0	0.0	0.0
LAOH2ION	2.3444E-14	0.0	0.0	0.0
LAOH4ION	4.9506E-10	0.0	0.0	0.0
LAOHION	8.7882E-18	0.0	0.0	0.0
NA2FION	0.00334119	0.0	0.0	0.0
NACO3ION	3.00014	0.0	0.0	0.0
NAION	78.3639	0.0	0.0	0.0
NO2ION	5.47654	0.0	0.0	0.0
NO3ION	14.6594	0.0	0.0	0.0
ALF2ION	6.2727E-21	0.0	0.0	0.0
SIO3ION	0.493722	0.0	0.0	0.0
TCVIIO4ION	0.0109486	0.0	0.0	0.0
CAF2	0.0	0.170007	0.0	0.0
Total g/hr	34577.5	46.5034	0.0	0.0
Volume, L/hr	31.0356	0.0055471	0.0	0.0
Enthalpy, cal/hr	-1.2136E+08	-1.1081E+05	0.0	0.0
Density, g/L	1114.1	8383.4		
Vapor fraction	0.0	0.0	0.0	0.0
Solid fraction	0.0	1.	0.0	0.0
Organic fraction	0.0	0.0	0.0	0.0
Osmotic Pres, atm	118.151			
Redox Pot, volts	0.0			
E-Con, 1/ohm-cm	0.209536			
E-Con, cm2/ohm-mol	79.5792			
Abs Visc, cP	0.961201			
Rel Visc	1.75653			
Ionic Strength	3.16762			

STREAM: Concentrated Tc Eluate (8)
TO : Cs_Tc_Eluate Storage
FROM : Concentrate Storage

Phases---------->	Aqueous	Solid	Vapor	Organic
Temperature, C	25.	25.	25.	25.
Pressure, atm	1.	1.	1.	1.
pH	13.2614			
Total mol/hr	1768.13	0.407046	0.0	0.0
----------	mol/hr	mol/hr	mol/hr	mol/hr
H2O	1621.94	0.0	0.0	0.0
H2F2	2.5019E-27	0.0	0.0	0.0
CO2	4.9745E-11	0.0	0.0	0.0
HCL	2.6926E-19	0.0	0.0	0.0
HF	4.1569E-11	0.0	0.0	0.0
HNO2	1.6759E-10	0.0	0.0	0.0
HNO3	8.1941E-15	0.0	0.0	0.0
N2	1.3698E-06	0.0	0.0	0.0
O2	6.6701E-07	0.0	0.0	0.0
FEIIIF3	8.1047E-30	0.0	0.0	0.0
FEIIIOH3	5.6454E-07	0.0866198	0.0	0.0
ALF3	1.1561E-19	0.0	0.0	0.0
H2SIO3	3.5150E-06	0.0	0.0	0.0
BOH3	3.3734E-05	0.0	0.0	0.0
CACO3	2.1250E-05	0.0	0.0	0.0
CAH2SIO4	1.8234E-05	0.0	0.0	0.0
ALOH3	1.2133E-07	0.0	0.0	0.0
KCL	8.4088E-04	0.0	0.0	0.0
LACL3	3.3667E-26	0.0	0.0	0.0
LAF3	1.2362E-20	0.0	0.0	0.0
LAOH3	5.6557E-13	0.150344	0.0	0.0
NABOH4	0.327559	0.0	0.0	0.0
NAF	0.660981	0.0	0.0	0.0
NAHCO3	2.8482E-04	0.0	0.0	0.0
NAHSIO3	1.7298	0.0	0.0	0.0
NANO3	0.124648	0.0	0.0	0.0
SIO2	3.7865E-06	0.0	0.0	0.0
OHION	5.78261	0.0	0.0	0.0
ALF4ION	2.7860E-18	0.0	0.0	0.0
ALF5ION	1.7125E-17	0.0	0.0	0.0
ALF6ION	6.8109E-17	0.0	0.0	0.0
ALFION	7.0333E-25	0.0	0.0	0.0
ALION	9.2453E-30	0.0	0.0	0.0
ALOH2ION	3.5156E-15	0.0	0.0	0.0
ALOH4ION	1.49228	0.0	0.0	0.0
ALOHION	1.7954E-22	0.0	0.0	0.0
BOH4ION	0.730927	0.0	0.0	0.0
CAFION	3.4678E-09	0.0	0.0	0.0
CAH2BO3ION	1.6960E-06	0.0	0.0	0.0
CAHCO3ION	3.8074E-10	0.0	0.0	0.0
CAHSIO3ION	1.2029E-09	0.0	0.0	0.0
CAION	7.7811E-06	0.0	0.0	0.0
CANO3ION	8.2566E-08	0.0	0.0	0.0
CAOHION	3.7571E-06	0.0	0.0	0.0
CLION	18.5324	0.0	0.0	0.0
CO3ION	11.3492	0.0	0.0	0.0

FEIIIF2ION	4.2111E-30	0.0	0.0	0.0
FEIIIFION	0.0	0.0	0.0	0.0
FEIIIION	0.0	0.0	0.0	0.0
FEIIIOH2ION	1.1648E-14	0.0	0.0	0.0
FEIIIOH4ION	0.00787235	0.0	0.0	0.0
FEIIIOHION	1.4154E-22	0.0	0.0	0.0
FION	1.50944	0.0	0.0	0.0
H2SIO4ION	0.0314309	0.0	0.0	0.0
H3SIO4ION	0.0191009	0.0	0.0	0.0
HCO3ION	0.00131512	0.0	0.0	0.0
HF2ION	7.8258E-13	0.0	0.0	0.0
HION	1.9630E-12	0.0	0.0	0.0
HSIO3ION	0.00453115	0.0	0.0	0.0
KION	0.669844	0.0	0.0	0.0
LACL2ION	4.9705E-25	0.0	0.0	0.0
LACL4ION	1.8888E-26	0.0	0.0	0.0
LACLION	1.4433E-23	0.0	0.0	0.0
LACO3ION	8.1071E-19	0.0	0.0	0.0
LAF2ION	1.2650E-20	0.0	0.0	0.0
LAF4ION	5.4713E-20	0.0	0.0	0.0
LAFION	5.4587E-21	0.0	0.0	0.0
LAHCO3ION	4.7521E-26	0.0	0.0	0.0
LAION	5.2497E-22	0.0	0.0	0.0
LANO3ION	1.5787E-23	0.0	0.0	0.0
LAOH2ION	4.8965E-16	0.0	0.0	0.0
LAOH4ION	4.0681E-12	0.0	0.0	0.0
LAOHION	3.2262E-19	0.0	0.0	0.0
NA2FION	0.00298221	0.0	0.0	0.0
NACO3ION	4.60145	0.0	0.0	0.0
NAION	77.2871	0.0	0.0	0.0
NO2ION	5.47654	0.0	0.0	0.0
NO3ION	14.6457	0.0	0.0	0.0
ALF2ION	1.0902E-21	0.0	0.0	0.0
SIO3ION	1.19181	0.0	0.0	0.0
TCVIIO4ION	0.0109486	0.0	0.0	0.0
CAF2	0.0	0.170082	0.0	0.0
Total g/hr	34573.	51.0906	0.0	0.0
Volume, L/hr	30.5489	0.0068963	0.0	0.0
Enthalpy, cal/hr	-1.2208E+08	-1.1967E+05	0.0	0.0
Density, g/L	1131.7	7408.4		
Vapor fraction	0.0	0.0	0.0	0.0
Solid fraction	0.0	1.	0.0	0.0
Organic fraction	0.0	0.0	0.0	0.0
Osmotic Pres, atm	111.266			
Redox Pot, volts	0.0			
E-Con, 1/ohm-cm	0.147101			
E-Con, cm2/ohm-mol	65.7893			
Abs Visc, cP	1.54623			
Rel Visc	1.73593			
Ionic Strength	3.09835			

STREAM: Primary Vent (6)
TO :
FROM : Primary Condenser

Phases---------->	Aqueous	Solid	Vapor	Organic
Temperature, C	40.	40.	40.	40.
Pressure, atm	0.113058	0.113058	0.113058	0.113058
pH	0.0			
Total mol/hr	0.0	0.0	379.067	0.0
----------	mol/hr--------	mol/hr--------	mol/hr--------	mol/hr--
H2O	0.0	0.0	244.977	0.0
CO2	0.0	0.0	0.00196068	0.0
HF	0.0	0.0	3.0920E-16	0.0
HNO2	0.0	0.0	1.1137E-09	0.0
N2	0.0	0.0	105.992	0.0
O2	0.0	0.0	28.0965	0.0
Total g/hr	0.0	0.0	8281.66	0.0
Volume, L/hr	0.0	0.0	86092.2	0.0
Enthalpy, cal/hr	0.0	0.0	-1.4116E+07	0.0
Density, g/L			0.0961953	
Vapor fraction	0.0	0.0	1.	0.0
Solid fraction	0.0	0.0	0.0	0.0
Organic fraction	0.0	0.0	0.0	0.0
Osmotic Pres, atm	0.0			
Redox Pot, volts	0.0			
E-Con, 1/ohm-cm	0.0			
E-Con, cm2/ohm-mol	0.0			
Abs Visc, cP	0.0			
Rel Visc	0.0			
Ionic Strength	0.0			

STREAM: Primary Condensate (7)
TO :
FROM : Primary Condenser

Phases---------->	Aqueous	Solid	Vapor	Organic
Temperature, C	40.	40.	40.	40.
Pressure, atm	0.113058	0.113058	0.113058	0.113058
pH	6.71505			
Total mol/hr	80970.9	0.0	0.0	0.0
----------	mol/hr--------	mol/hr--------	mol/hr--------	mol/hr--
H2O	80970.9	0.0	0.0	0.0
H2F2	0.0	0.0	0.0	0.0
CO2	2.0061E-05	0.0	0.0	0.0
HF	1.1017E-12	0.0	0.0	0.0
HNO2	2.0590E-09	0.0	0.0	0.0
N2	0.0253457	0.0	0.0	0.0
O2	0.0126011	0.0	0.0	0.0
OHION	2.1879E-04	0.0	0.0	0.0
CO3ION	1.6849E-08	0.0	0.0	0.0
FION	3.0000E-09	0.0	0.0	0.0
HCO3ION	5.4004E-05	0.0	0.0	0.0
HF2ION	5.7018E-25	0.0	0.0	0.0
HION	2.8129E-04	0.0	0.0	0.0
NO2ION	8.4524E-06	0.0	0.0	0.0
Total g/hr	1.4587E+06	0.0	0.0	0.0
Volume, L/hr	1470.5	0.0	0.0	0.0
Enthalpy, cal/hr	-5.5097E+09	0.0	0.0	0.0
Density, g/L	991.99			
Vapor fraction	0.0	0.0	0.0	0.0
Solid fraction	0.0	0.0	0.0	0.0
Organic fraction	0.0	0.0	0.0	0.0
Osmotic Pres, atm	6.6583E-04			
Redox Pot, volts	0.0			
E-Con, 1/ohm-cm	1.1908E-07			
E-Con, cm2/ohm-mol	0.00130554			
Abs Visc, cP	0.653609			
Rel Visc	1.			
Ionic Strength	1.9284E-07			

STREAM: Concentrated Cs Eluate (10)
TO : Cs_Tc_Eluate Storage
FROM :

Phases---------->	Aqueous	Solid	Vapor	Organic
Temperature, C	25.	25.	25.	25.
Pressure, atm	1.	1.	1.	1.
pH	-0.954355			
Total mol/hr	254.703	0.0	0.0	0.0
----------	mol/hr	mol/hr	mol/hr	mol/hr
H2O	189.02	0.0	0.0	0.0
HCL	5.9085E-06	0.0	0.0	0.0
HNO3	6.61164	0.0	0.0	0.0
CUNO32	0.0213508	0.0	0.0	0.0
CUOH2	2.2594E-20	0.0	0.0	0.0
FECL3	4.5951E-04	0.0	0.0	0.0
FEIIIOH3	6.3313E-17	0.0	0.0	0.0
H2SIO3	0.0499729	0.0	0.0	0.0
BOH3	1.09172	0.0	0.0	0.0
CAH2SIO4	3.2088E-25	0.0	0.0	0.0
ALOH3	1.0394E-18	0.0	0.0	0.0
KCL	8.3263E-05	0.0	0.0	0.0
MNNO32	0.0195704	0.0	0.0	0.0
MNOH2	1.5478E-29	0.0	0.0	0.0
CSCL	0.00101195	0.0	0.0	0.0
NABOH4	5.0876E-11	0.0	0.0	0.0
NAHSIO3	1.7028E-10	0.0	0.0	0.0
NANO3	1.08881	0.0	0.0	0.0
NIOH2	2.3780E-23	0.0	0.0	0.0
CSNO3	0.087726	0.0	0.0	0.0
PBCL2	2.5330E-05	0.0	0.0	0.0
PBNO32	0.00367834	0.0	0.0	0.0
PBO	1.9471E-25	0.0	0.0	0.0
CUCL2	1.3417E-04	0.0	0.0	0.0
SIO2	0.0772829	0.0	0.0	0.0
UO2CL2	0.0016532	0.0	0.0	0.0
UO2OH2	4.0215E-16	0.0	0.0	0.0
OHION	2.6650E-15	0.0	0.0	0.0
ALION	0.340206	0.0	0.0	0.0
ALOH2ION	2.1110E-12	0.0	0.0	0.0
ALOH4ION	2.1431E-26	0.0	0.0	0.0
ALOHION	1.4907E-06	0.0	0.0	0.0
BOH4ION	4.2245E-11	0.0	0.0	0.0
CAH2BO3ION	1.2068E-11	0.0	0.0	0.0
CAHSIO3ION	3.5489E-16	0.0	0.0	0.0
CAION	0.0750342	0.0	0.0	0.0
CANO3ION	0.00194951	0.0	0.0	0.0
CAOHION	4.2621E-17	0.0	0.0	0.0
CLION	0.399633	0.0	0.0	0.0
CR2O7ION	0.0118321	0.0	0.0	0.0
CRO4ION	6.3327E-09	0.0	0.0	0.0
CSION	0.0137638	0.0	0.0	0.0
CUCL3ION	1.3360E-07	0.0	0.0	0.0
CUCLION	0.00216191	0.0	0.0	0.0
CUION	0.00502862	0.0	0.0	0.0
CUNO3ION	0.0521637	0.0	0.0	0.0

CUOHION	1.3769E-12	0.0	0.0	0.0
FEIII2OH2ION	5.5656E-11	0.0	0.0	0.0
FEIIICL2ION	0.0467814	0.0	0.0	0.0
FEIIICL4ION	2.5258E-06	0.0	0.0	0.0
FEIIICLION	0.261179	0.0	0.0	0.0
FEIIIION	0.0113766	0.0	0.0	0.0
FEIIINO3ION	0.0236585	0.0	0.0	0.0
FEIIIOH2ION	9.0875E-11	0.0	0.0	0.0
FEIIIOH4ION	1.5831E-27	0.0	0.0	0.0
FEIIIOHION	1.4804E-05	0.0	0.0	0.0
H2SIO4ION	1.2309E-27	0.0	0.0	0.0
H3SIO4ION	4.9053E-13	0.0	0.0	0.0
HCRO4ION	0.0257866	0.0	0.0	0.0
HION	12.8942	0.0	0.0	0.0
HSIO3ION	2.7855E-14	0.0	0.0	0.0
KION	0.245524	0.0	0.0	0.0
MNCLION	1.4831E-04	0.0	0.0	0.0
MNION	0.00169527	0.0	0.0	0.0
MNNO3ION	6.1424E-04	0.0	0.0	0.0
MNOHION	1.5329E-16	0.0	0.0	0.0
NAION	11.2531	0.0	0.0	0.0
NICLION	0.00350845	0.0	0.0	0.0
NIION	0.893345	0.0	0.0	0.0
NINO3ION	0.938285	0.0	0.0	0.0
NIOHION	3.5987E-13	0.0	0.0	0.0
NO3ION	28.8601	0.0	0.0	0.0
PBCL3ION	6.3316E-06	0.0	0.0	0.0
PBCL4ION	2.9689E-05	0.0	0.0	0.0
PBCLION	5.1308E-05	0.0	0.0	0.0
PBION	2.5421E-04	0.0	0.0	0.0
PBNO33ION	0.00826974	0.0	0.0	0.0
PBNO3ION	3.4290E-04	0.0	0.0	0.0
PBOHION	3.5074E-15	0.0	0.0	0.0
SIO3ION	6.7007E-26	0.0	0.0	0.0
UO22OH2ION	2.8668E-11	0.0	0.0	0.0
UO23OH5ION	2.8002E-25	0.0	0.0	0.0
UO2CLION	0.22541	0.0	0.0	0.0
UO2ION	0.0321997	0.0	0.0	0.0
UO2OHION	7.2955E-08	0.0	0.0	0.0
Total g/hr	6409.26	0.0	0.0	0.0
Volume, L/hr	4.689	0.0	0.0	0.0
Enthalpy, cal/hr	-1.5948E+07	0.0	0.0	0.0
Density, g/L	1366.9			
Vapor fraction	0.0	0.0	0.0	0.0
Solid fraction	0.0	0.0	0.0	0.0
Organic fraction	0.0	0.0	0.0	0.0
Osmotic Pres, atm	584.978			
Redox Pot, volts	0.0			
E-Con, 1/ohm-cm	0.3064			
E-Con, cm2/ohm-mol	39.6833			
Abs Visc, cP	2.458			
Rel Visc	2.75956			
Ionic Strength	9.30231			

STREAM: Concentrated Eluate Blend (9)
TO :
FROM : Cs_Tc_Eluate Storage

Phases---------->	Aqueous	Solid	Vapor	Organic
Temperature, C	30.0769	30.0769	30.0769	30.0769
Pressure, atm	1.	1.	1.	1.
pH	7.90708			
Total mol/hr	2005.14	4.53342	0.0	0.0
----------	mol/hr	mol/hr	mol/hr	mol/hr
H2O	1816.04	0.0	0.0	0.0
H2F2	1.3415E-16	0.0	0.0	0.0
CO2	0.09316	0.0	0.0	0.0
HCL	1.0434E-13	0.0	0.0	0.0
HF	7.2805E-06	0.0	0.0	0.0
HNO2	3.9983E-05	0.0	0.0	0.0
HNO3	8.5358E-09	0.0	0.0	0.0
N2	1.3698E-06	0.0	0.0	0.0
O2	6.6701E-07	0.0	0.0	0.0
SIF4	2.8294E-21	0.0	0.0	0.0
CUNO22	5.7540E-06	0.0	0.0	0.0
CUNO32	2.2677E-07	0.0	0.0	0.0
CUOH2	5.9402E-05	0.0	0.0	0.0
FECL3	7.1020E-21	0.0	0.0	0.0
FEIIIF3	4.5028E-14	0.0	0.0	0.0
FEIIIOH3	1.0002E-06	0.437964	0.0	0.0
ALF3	4.9183E-07	0.0	0.0	0.0
H2SIO3	0.710806	0.0	0.0	0.0
BOH3	1.89573	0.0	0.0	0.0
CACO3	1.7060E-06	0.0	0.0	0.0
CAH2SIO4	1.7646E-10	0.0	0.0	0.0
ALOH3	1.8521E-10	0.0	0.0	0.0
KCL	9.7360E-04	0.0	0.0	0.0
LACL3	2.3441E-10	0.0	0.0	0.0
LAF3	4.9547E-05	0.0	0.0	0.0
LAOH3	1.6471E-12	0.149923	0.0	0.0
MNNO32	3.0223E-06	0.0	0.0	0.0
MNOH2	7.2403E-13	0.0	0.0	0.0
CSCL	0.00519268	0.0	0.0	0.0
NABOH4	0.0846079	0.0	0.0	0.0
NAF	0.648664	0.0	0.0	0.0
NAHCO3	2.61983	0.0	0.0	0.0
NAHSIO3	1.53321	0.0	0.0	0.0
NANO3	0.479515	0.0	0.0	0.0
NIOH2	1.5319E-07	1.83148	0.0	0.0
CSNO3	0.0279573	0.0	0.0	0.0
PBCL2	2.9617E-08	0.0	0.0	0.0
PBF2	1.9110E-10	0.0	0.0	0.0
PBNO22	4.1984E-06	0.0	0.0	0.0
PBNO32	1.9676E-08	0.0	0.0	0.0
PBO	1.7905E-10	0.0	0.0	0.0
CUCL2	3.5032E-07	0.0	0.0	0.0
CUCO3	0.00275555	0.0	0.0	0.0
SIO2	0.83673	0.0	0.0	0.0
UO2CL2	2.1653E-20	0.0	0.0	0.0
UO2CO3	4.7312E-12	0.0	0.0	0.0

UO2F2	2.9159E-13	0.0	0.0	0.0
UO2OH2	5.9433E-15	0.0	0.0	0.0
OHION	4.0268E-05	0.0	0.0	0.0
ALF4ION	8.2854E-06	0.0	0.0	0.0
ALF5ION	4.1119E-05	0.0	0.0	0.0
ALF6ION	1.2599E-04	0.0	0.0	0.0
ALFION	4.1807E-12	0.0	0.0	0.0
ALION	1.0569E-17	0.0	0.0	0.0
ALOH2ION	6.8164E-13	0.0	0.0	0.0
ALOH4ION	1.0150E-08	0.0	0.0	0.0
ALOHION	3.3353E-15	0.0	0.0	0.0
BOH4ION	0.169907	0.0	0.0	0.0
CAFION	7.7483E-09	0.0	0.0	0.0
CAH2BO3ION	7.0267E-07	0.0	0.0	0.0
CAHCO3ION	4.9417E-06	0.0	0.0	0.0
CAHSIO3ION	1.4584E-09	0.0	0.0	0.0
CAION	1.2527E-05	0.0	0.0	0.0
CANO3ION	3.7893E-07	0.0	0.0	0.0
CAOHION	4.1026E-11	0.0	0.0	0.0
CLION	19.519	0.0	0.0	0.0
CO3ION	0.395912	0.0	0.0	0.0
CR2O7ION	3.5803E-07	0.0	0.0	0.0
CRO4ION	0.0492518	0.0	0.0	0.0
CSION	0.0693518	0.0	0.0	0.0
CUCL3ION	8.6319E-10	0.0	0.0	0.0
CUCLION	5.0780E-06	0.0	0.0	0.0
CUCO32ION	0.0779718	0.0	0.0	0.0
CUION	9.1682E-06	0.0	0.0	0.0
CUNO2ION	1.8835E-05	0.0	0.0	0.0
CUNO3ION	6.2455E-06	0.0	0.0	0.0
CUOH3ION	8.8451E-09	0.0	0.0	0.0
CUOH4ION	7.0556E-13	0.0	0.0	0.0
CUOHION	6.9122E-06	0.0	0.0	0.0
FEIII2OH2ION	2.2869E-26	0.0	0.0	0.0
FEIIICL2ION	7.0166E-19	0.0	0.0	0.0
FEIIICL4ION	8.8529E-23	0.0	0.0	0.0
FEIIICLION	1.4677E-18	0.0	0.0	0.0
FEIIIF2ION	3.1429E-14	0.0	0.0	0.0
FEIIIFION	1.2971E-15	0.0	0.0	0.0
FEIIIION	4.6503E-17	0.0	0.0	0.0
FEIIINO3ION	4.2192E-19	0.0	0.0	0.0
FEIIIOH2ION	2.8959E-09	0.0	0.0	0.0
FEIIIOH4ION	8.3815E-08	0.0	0.0	0.0
FEIIIOHION	3.4869E-12	0.0	0.0	0.0
FION	1.36694	0.0	0.0	0.0
H2SIO4ION	1.1483E-07	0.0	0.0	0.0
H3SIO4ION	0.0200197	0.0	0.0	0.0
HCO3ION	9.90022	0.0	0.0	0.0
HCRO4ION	1.9834E-04	0.0	0.0	0.0
HF2ION	1.3796E-07	0.0	0.0	0.0
HION	4.1995E-07	0.0	0.0	0.0
HPBO2ION	3.7106E-13	0.0	0.0	0.0
HSIO3ION	0.00317955	0.0	0.0	0.0
KION	0.915318	0.0	0.0	0.0
LACL2ION	3.3895E-09	0.0	0.0	0.0
LACL4ION	9.5571E-11	0.0	0.0	0.0
LACLION	1.1050E-07	0.0	0.0	0.0

LACO3ION	1.4820E-04	0.0	0.0	0.0
LAF2ION	6.3219E-05	0.0	0.0	0.0
LAF4ION	1.1883E-04	0.0	0.0	0.0
LAFION	3.8249E-05	0.0	0.0	0.0
LAHCO3ION	2.3950E-06	0.0	0.0	0.0
LAION	7.3897E-07	0.0	0.0	0.0
LANO3ION	1.2539E-07	0.0	0.0	0.0
LAOH2ION	1.4234E-10	0.0	0.0	0.0
LAOH4ION	6.7799E-17	0.0	0.0	0.0
LAOHION	7.5948E-09	0.0	0.0	0.0
MNCLION	4.8552E-06	0.0	0.0	0.0
MNION	2.1153E-05	0.0	0.0	0.0
MNNO3ION	3.1837E-06	0.0	0.0	0.0
MNOH3ION	5.2244E-17	0.0	0.0	0.0
MNOH4ION	1.4247E-21	0.0	0.0	0.0
MNOHION	1.2949E-08	0.0	0.0	0.0
NA2FION	0.00193658	0.0	0.0	0.0
NACO3ION	0.139518	0.0	0.0	0.0
NAION	89.7382	0.0	0.0	0.0
NICLION	1.8459E-05	0.0	0.0	0.0
NIFION	3.9087E-05	0.0	0.0	0.0
NIION	0.00287534	0.0	0.0	0.0
NINO3ION	7.1953E-04	0.0	0.0	0.0
NIOH3ION	3.9487E-10	0.0	0.0	0.0
NIOHION	4.7360E-06	0.0	0.0	0.0
NO2ION	5.47643	0.0	0.0	0.0
NO3ION	52.0414	0.0	0.0	0.0
ALF2ION	4.8300E-09	0.0	0.0	0.0
PBCL3ION	1.1574E-08	0.0	0.0	0.0
PBCL4ION	3.7170E-08	0.0	0.0	0.0
PBCLION	4.8872E-08	0.0	0.0	0.0
PBF3ION	1.8599E-10	0.0	0.0	0.0
PBF4ION	1.9297E-11	0.0	0.0	0.0
PBFION	2.0916E-09	0.0	0.0	0.0
PBION	3.7540E-08	0.0	0.0	0.0
PBNO23ION	1.0634E-05	0.0	0.0	0.0
PBNO2ION	2.7236E-06	0.0	0.0	0.0
PBNO33ION	6.1248E-09	0.0	0.0	0.0
PBNO3ION	5.5462E-08	0.0	0.0	0.0
PBOHION	8.4067E-09	0.0	0.0	0.0
SIF6ION	1.2712E-14	0.0	0.0	0.0
SIO3ION	3.6019E-06	0.0	0.0	0.0
TCVIIO4ION	0.0109486	0.0	0.0	0.0
UO22OH2ION	7.6362E-27	0.0	0.0	0.0
UO2CLION	2.3935E-18	0.0	0.0	0.0
UO2CO32ION	1.7933E-06	0.0	0.0	0.0
UO2CO33ION	0.259261	0.0	0.0	0.0
UO2F3ION	3.4947E-12	0.0	0.0	0.0
UO2F4ION	4.5395E-12	0.0	0.0	0.0
UO2FION	1.0986E-14	0.0	0.0	0.0
UO2ION	6.9394E-18	0.0	0.0	0.0
UO2OHION	1.6519E-15	0.0	0.0	0.0
CAF2	0.0	0.247099	0.0	0.0
MNCO3	0.0	0.0219959	0.0	0.0
NAALCO3OH2	0.0	1.83232	0.0	0.0
PBCO3	0.0	0.01264	0.0	0.0

Total g/hr	40499.2	534.074	0.0	0.0
Volume, L/hr	35.677	0.1706	0.0	0.0
Enthalpy, cal/hr	-1.3683E+08	-1.3174E+06	0.0	0.0
Density, g/L	1135.2	3130.6		
Vapor fraction	0.0	0.0	0.0	0.0
Solid fraction	0.0	1.	0.0	0.0
Organic fraction	0.0	0.0	0.0	0.0
Osmotic Pres, atm	128.348			
Redox Pot, volts	0.0			
E-Con, 1/ohm-cm	0.160954			
E-Con, cm2/ohm-mol	55.2961			
Abs Visc, cP	1.1624			
Rel Visc	1.45889			

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