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User's Guide to the SEPHIS Computer Code for Calculating the Thorex Solvent Extraction System

S. B. Watson
R. H. Rainey

MASTER

APPLIED TECHNOLOGY

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USER'S GUIDE TO THE SEPHIS COMPUTER CODE
FOR CALCULATING THE THOREX SOLVENT
EXTRACTION SYSTEM

S. B. Watson and R. H. Rainey*

(Sponsor: R. H. Rainey; Originator: S. B. Watson)

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S. B. Watson and R. H. Rainey*

ABSTRACT

The SEPHIS computer program was developed to simulate the countercurrent solvent extraction process. The code has now been adapted to model the Acid Thorex flow sheet. This report represents a practical user's guide to SEPHIS-Thorex containing a program description, user information, program listing, and sample input and output.

I. INTRODUCTION

SEPHIS, a computer program for Solvent Extraction Processes Having Interacting Solutes, was developed by W. S. Groenier¹ for the purpose of studying the application of a 15% TBP solvent extraction system for recovered irradiated LMFBR fuel. G. L. Richardson of HEDL has adapted the SEPHIS program to the conventional Purex process which uses 30% TBP and has made valuable changes in program structure.^{2,3} The authors have made additional modifications to the Richardson version of SEPHIS-Purex to make the code more efficient and adaptable for Oak Ridge National Laboratory (ORNL) uses.⁴ Research to improve SEPHIS-Purex is being continued by A. D. Mitchell who has written a code entitled SEPHIS-MOD4.^{5,6} This improved model of the Purex solvent extraction system is better able to simulate run conditions during transient periods than previous versions of SEPHIS and also better represents the operation of mixer-settlers.

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*Chemical Technology Division

A modification of the SEPHIS program has now been made for the simulation of the Acid Thorex flowsheet,⁷ and this report represents a documentation of the SEPHIS-Thorex computer code for the user. It should be noted that a version of SEPHIS-MOD4 for Thorex solvent extraction is in preparation.⁸

The SEPHIS program simulates the countercurrent multi-stage extraction of three interacting solutes. In the Purex version of the program, these solutes are uranium, plutonium IV and nitric acid. In the Thorex version thorium is substituted for the plutonium.

The SEPHIS computer program is useful for obtaining estimates of the concentration of components throughout a solvent extraction contactor system under either transient or equilibrium conditions or in estimating the time required to reach steady-state operation. The program is based on an empirical fit to data which had considerable scatter. Comparison of calculated data with data from a limited number of countercurrent batch experiments indicate good agreement in the middle range of concentrations. In the low concentration range, the calculated data do not fit experimental data. At low concentrations of metal ions, trace quantities of impurities strongly influence extraction characteristics. These effects are not included in the program. In spite of a considerable effort, the calculations for nitric acid are less accurate than for the metal ions. Experience has shown that analyses of free nitric acid have been erratic in solvent extraction systems of the type simulated by this program. Use of the computer program requires an input of the number of theoretical stages in the contacted system. In practical operating systems, the

number of theoretical stages varies with operating conditions and, therefore, is usually not accurately known. The program does not simulate the extraction of fission products.

Many of the technical aspects of the SEPHIS-Thorex computations are discussed elsewhere.⁷ These aspects include calculation of the distribution coefficients and partial molar volumes, explanation of uses and limitations of the code, and comparisons between SEPHIS-Thorex calculations and experimental data. In addition, the study of temperature effect on the extraction of thorium and nitric acid and the formation of third phase are discussed in another publication.⁹ Thus, this report includes only a general program description and user information necessary to execute the program. Also included are a program listing and sample input and output.

The Thorex version of the code would not have been possible without the valuable guidance of W. S. Groenier. This work was funded by the High-Temperature Gas-Cooled Reactor (HTGR) program.

II. PROGRAM DESCRIPTION

The description of the flow sheet and the contactor model for the Thorex version parallel those of Groenier.¹ In addition the calculational procedure used for the stage computations and used to determine the distribution coefficient are patterned after the technique of Groenier and discussed in Ref. 7.

In general the calculation simulates the extraction of the three interacting solutes by a cascade of mixer-settler units with 100% stage efficiency. Flow between stages is batchwise. This flow can either

be proportional to the feedstream flow rates or can be varied to simulate internal recycle or to increase stage holdup. The number of stages, the number of incoming and outgoing streams, the flow rate or volume of each stream, the flow patterns through the system, and the composition of each feedstream can be designated. Also, the composition of each phase in the contactor at the beginning of the calculation can be stipulated, that is, the initial profile of the system can be specified.

The simulation starts by computing the concentration of the solutes for each phase in each stage based on the distribution coefficients which are calculated as part of the program. These conditions are then used as the basis of a second calculation, and this iteration procedure is continued until the amount of material entering and leaving the system reaches a pre-determined material balance - normally 99.9%. This system gives an estimate of the composition of each phase in each stage of the system.

The program SEPHIS-Thorex consists of six routines that are programmed in a well-structured manner and are heavily augmented with program comment cards. The basic methodology and mathematical formulations have been described previously;^{1,7} thus, we include in this section only the diagram of program structure and a description of each routine.

Figure 1 shows the overall structure of the SEPHIS-Thorex program. Arrows indicate the calling sequence of routines. All routines are written in the IBM System/360 and System/370 FORTRAN IV language. A listing of SEPHIS-Thorex routines is given in Appendix A.

Fig. 1. Overall Structure of SEPHIS-Thorex.

The MAIN routine reads switches which determine program flow, directs the calling of subroutines according to these switches, determines steady state, and prints requested output. The routine functions as follows:

1. Read title information.
2. Read program switches (see Section III, Table 1).
3. Zero arrays and constants.
4. Call PROFIL to set initial concentrations for time zero and define feed streams.
5. Write feed stream data.
6. Convert feed streams concentrations to molarity.
7. Call FLOWS to set interstage flow rates, define outgoing streams and flow ratios and calculate necessary recycle flows.
8. Print outgoing streams.
9. Print initial profile in the stages of the contactor system.
10. Print phase ratios and stage flows.
11. Initialize total molarity coming in (SOLIN) and total molarity coming out (SOLOUT) of system.
12. Call STAGES to perform stage calculation.

13. Calculate percent of material balance which has been reached.
14. Convert concentration back to g/l.
15. Print concentrations for the given time interval.
16. Check for convergence. If not converged, return to 12.
17. Print total moles of each component in and out.
18. Call PLOTTR for Calcomp plots, if requested.
19. Punched card output, if requested.
20. Read next case information. Go to 1., 3. or stop depending on switches read.

The routine PROFIL defines the feed streams and the initial profile.

PROFIL proceeds as follows:

1. Read aqueous and organic feed concentrations and stream flow rates.
2. Read nonzero initial profile, if requested. Otherwise zero profile is assumed.

The manner in which 1 and 2 are executed depends on switches read by the MAIN routine.

FLows defines outgoing streams, unusual routing patterns, interstage flows, phase ratios, flow ratios, recycle volumes and ratios, and stage volumes. FLOWS proceeds thusly:

1. Define outgoing streams, if there are any.
2. Set aqueous and organic interstage flows. Determine unusual routing pattern for the flows, if there is one.
3. Define phase ratios.
4. Calculate necessary recycle flows.
5. Determine stage volumes.

The above listing is merely a general diagram of the flow of this routine.

The manner in which 1-5 are executed (or possibly omitted) depends on certain switches read by MAIN.

STAGES performs stage calculations for the current time interval.

It considers inputs from adjacent stages, input streams, and recycle within the stage. It executes in the following manner.

1. Compute aqueous and organic concentrations coming into the stage for the current time interval.
2. Zero iteration counter.
3. Calculate distribution coefficients for the current aqueous phase composition.
4. Using information calculated in 1 and 3, determine new aqueous phase concentration of each solute.
5. Compare new aqueous phase concentration with previous aqueous phase concentrations for each solute.
6. If new and previous values are "close" by a fixed criterion for each solute, proceed to 7. If not, increment the iteration counter and return to 4 with current aqueous phase composition for each solute redefined as the calculated value for this iteration.
7. Calculate the organic phase stage concentrations for the current time interval.

Steps 1-7 are performed in sequence for each stage in the contactor system.

UCOR calculates distribution coefficients for a given aqueous phase composition at the stage equilibrium temperature. UCOR embodies the equations for the mass action equilibrium constants which have been determined by the least squares fits described in Ref. 7. In addition, UCOR contains the temperature correction equations published in Ref. 9.

PLOTR may be used to plot concentration versus time and/or percent of feed versus time. A set of plot switches read by this routine allows the user to determine the stage number, the component (either aqueous or organic), the type of graph, and the number of points to be plotted. A list of these switches is given in Section III.

III. USER INFORMATION

SEPHIS-Thorex is written in the IBM System/360 and System/370 FORTRAN IV language. The program has been compiled using the H-level compiler and has been executed on both the IBM 360/91 and 360/75 at ORNL. The program requires about 210K (K = 1024 bytes; byte = 8 bits) of core storage for execution. Approximately 1/20 second of computing time on the IBM 360/91 is required for each time interval when calculating 10 stages.

The remainder of this section describes the content of the card input which must be prepared in order to execute the program and the output produced by the program. Sample input and the corresponding output are presented in Appendix B. The example is an Acid Thorex Flow sheet for extraction of uranium and thorium from solutions of Consolidated Edison fuel.¹⁰

Input

The input data are to be prepared in the order shown in Table 1. Referring to Table 1, "Subroutine" indicates the subroutine in which the card is read. "Card Number" denotes the order within the group (Program Cards, Feed Stream Cards, etc.) or quantity of cards for each group to be input. "Columns" refers to the actual columns on the card in which the data must be punched. "Remarks, Variables, etc." gives an explanation as to the variable name, definition, and form of the data to be punched on the card. In the FORMAT descriptor the letter "A" denotes alphabetic data; "I" refers to integer data (no decimal point) which must always be right-justified in the field; "F" indicates a real

Table 1. Input to SEPHIS Code

Subroutine	Card Number	Columns	Remarks, Variables, etc.
<u>Program Cards</u>			
MAIN	1		FØRMAT (I2)
	2 to NTTL+1	1-2, 1-80	NTTL - number of title cards FØRMAT (10A8) TITLE - problem title There are NTTL cards of this form.
	NTTL+2		FØRMAT (F8.2, 10I2)
		1-8	CTBP - volume fraction of dry TBP
		9-10	NTØST - total number of stages - must not exceed 25
		11-12	IPRØ - 0 for a zero initial concen- tration profile 1 for a non-zero initial profile
		13-14	IRATIØ - 0 if phase ratio = flow ratio 1 if phase ratio values are to be input
		15-16	ICALC - 0 for shutdown calculations (no U or Pu in feed streams) 1 for start-up or interrup- tion
		17-18	IØUT - 0 if there are no extra out going streams 1 if there are outgoing streams in addition to end streams

Table 1. Input to SEPHIS Code (cont'd)

Subroutine	Card Number	Columns	Remarks, Variables, etc.
MAIN (cont'd)		19-20	IVØL - 0 stage volumes are equal 1 stage volumes are unequal but according to total flow 2 stage volumes are inde- pendently unequal 3 stage volumes are equal and specified (Options 2 or 3 should be used for HAN* calculations to correct for stage residence time)(*Hydroxylamine Nitrate - Ref. 3)
		21-22	IPR - 0 print out all time inter- vals 1 print only last interval -1 print every 20th time interval
		23-24	IPNCH - 0 no punched card output desired 1 final profile output punched on cards
		25-26	ICALPL - 0 no Calcomp plots 1 plot concentration vs time 2 plot percent of feed vs time 3 plot both 1 and 2 If plots are desired, i.e., ICALPL > 0 IPR must be set equal to 0.
		27-28	NSTR - 0 no unusual routine pattern 1 routing pattern other than normal
		<u>Feed Stream Cards</u>	
PRØFIL	One card for each input stream		FØRMAT (2I2, 5F8.0, I2, F8.0)
		1-2	I - stage number that feed enters

Table 1. Input to SEPHIS Code (cont'd)

Subroutine	Card Number	Columns	Remarks, Variables, etc.
PRØFIL		3-4	JHAS - 1 for aqueous feed 0 for organic feed
		5-12	FDRT - feed flow rate (volume units)
		13-20	CØN1 - uranium content (g/l)
		21-28	CØN2 - plutonium content (g/l)
		29-36	CØN3 - acid molarity
		37-44	TEMP - temperature in degrees C
		45-46	INDEX - 1 more cards to follow 0 last card
		47-54	CØN4 - nitrate normality from inextractable salts, including the reductant (Enter Pu reductant normality as negative Pu concentration)
<u>Initial Profile Cards</u> (required only for non-zero initial profile)			
PRØFIL	One card for each stage		FØRMAT (8F8.0)
		1-8	X(1,J,1) - aqueous-phase uranium concentration in stage J (g/l)
		9-16	X(2,J,1) - aqueous-phase plutonium concentration in stage J (g/l)
		17-24	X(3,J,1) - aqueous-phase nitric acid concentration in stage J (<u>M</u>)
		25-32	Y(1,J,1) - organic-phase uranium concentration in stage J (g/l)

Table 1. Input to SEPHIS Code (cont'd)

Subroutine	Card Number	Columns	Remarks, Variables, etc.
PRØFIL (cont'd)		33-40	Y(2,J,1) - organic-phase plutonium concentration in stage J (g/l)
		41-48	Y(3,J,1) - organic-phase nitric acid concentration in stage J (<u>M</u>)
		49-56	TPRØF(J,1) - temperature in stage J
		57-64	X(4,J,1) - aqueous-phase nitrate concentration in stage J (<u>M</u>)
<u>Outgoing Stream Data</u> (other than aqueous raffinate and organic product)			
FLØWS	One card for each out-going stream		FØRMAT (2I2, F8.0, I2)
		1-2	I - stage number that stream leaves
		3-4	JHAS - 1 for aqueous stream 0 for organic stream
		5-12	ØTRT - exit flow rate (volume units) - total volume must exit
		13-14	INDEX - 1 more cards follow 0 last card
<u>Unusual Routing Data</u> (NSTR = 1)			
FLØWS	1		FØRMAT (2I5)
		1-5	ISTR - organic stream exits this stage and feeds stage JSTR
		6-10	JSTR - organic stream from stage ISTR feeds this stage

Table 1. Input to SEPHIS Code (cont'd)

Subroutine	Card Number	Columns	Remarks, Variables, etc.
<u>Phase Ratio Cards</u> (used only if phase ratio $\neq$ flow ratio)			
FLØWS	One card for each region of constant phase ratio		FØRMAT (I2, F8.0)
		1-2	I - number of stages having phase ratio shown
		3-12	RATIØ - aqueous/organic phase ratio
<u>Stage Volumes</u> (for IVØL = 2 and IVØL = 3)			
FLØWS			For IVØL = 2 stage volumes are unequal and not flow related
	1		FØRMAT (10A8)
		1-8	STVØL (1)
		⋮	⋮
		72-80	STVØL (10)
	2		FØRMAT (10A8)
		1-8	STVØL (11)
		⋮	⋮
		72-80	STVØL (20)
	3		FØRMAT (10A8)
		1-8	STVØL (21)
		⋮	⋮
		32-40	STVØL (25)
Only NTØST stage volumes need to be entered; that is, 1 to 3 cards are needed for input.			

Table 1. Input to SEPHIS Code (cont'd)

Subroutine	Card Number	Columns	Remarks, Variables, etc.
FLØWS	1	1-8	For IVØL = 3 stage volumes are equal and specified FØRMAT (F8.0) VØL - stage volume for all stages Graph Cards (ICALPL = 1, 2, 3)
For each plot include cards of the following form:			
PLØTR	1		FØRMAT (2I2, 1X, A1, 3I2)
		1-2	NSTR - number of outgoing stream to be plotted
		3-4	NCØM - number of components to be plotted (≤ 3)
		6	NAØ - A aqueous stream 0 organic stream
		7-8	NLL - 0 linear plot on both axes 1 linear abscissa axis, log ordinate axis
		9-10	NALT - 0 plot every point 1 plot every other point
		11-12	NLAST - 0 last plot 1 more plots to come
	2		FØRMAT (10I2)
		1-2	ICØM(1) - 1 st component to be plotted (1-uranium, 2-thorium, or 3-acid)
		3-4	ICØM(2) - 2 nd component to be plotted (1, 2, or 3)
		5-6	ICØM(3) - 3 rd component to be plotted (1, 2, or 3)

Table 1. Input to SEPHIS Code (cont'd)

Subroutine	Card Number	Columns	Remarks, Variables, etc.
For ICALPL-3 include only one set of cards for each group of two plots that is generated.			
<u>Next Case</u>			
MAIN	1		FORMAT (2I2)
		1-2	ICHNGE - 0 next case is new 1 new Feed Stream Cards and Outgoing Stream Data required for each feed and exit stream - no Program Cards, Initial Profile Cards, Phase Ratio Cards, or Stage Volume Cards are required 2 stop
		3-4	IDIF - 0 no changes in Program Card parameters 1 changes in at least one of these Program Card parameters - ICALC, IØUT, IPR, IPNCH, ICALPL (these parameters are explained in the section Program Cards)
If IDIF = 1, input a card of the following form; if IDIF = 0, omit this card.			
	2		FORMAT (5I2)
		1-2	ICALC
		3-4	IØUT
		5-6	IPR
		7-8	IPNCH
		9-10	ICALPL
			See Program Cards for explanation of these parameters.

number with or without signed exponent (decimal point should be punched). The variable names are those used in the FORTRAN program. An example of sample input is included in Appendix B.

Output

An example of program printout is given in Appendix B. A general explanation of this example and hence all output are herein described.

The first page of printed output provides a synopsis of input and various initial conditions. Included are the feed stream data, initial profile, phase ratios, and stage flows. The remainder of the printout consists of transient behavior results from each time interval. Printout for each time interval includes aqueous- and organic-phase concentrations, aqueous and organic flows, temperature, and number of iterations required for convergence in the stage calculations; all of which are printed for each stage. It should be noted that a "#" printed to the right of an organic thorium concentration indicates third phase within accuracy of about 10%. Experimental evidence indicate that third-phase formation did not occur during this study,¹⁰ but the SEPHIS program indicated that the third phase occurred starting at time interval 15. This discrepancy can be due either to the fact that the third phase is extremely difficult to detect experimentally or the mathematical representation of the third-phase surface in SEPHIS is only accurate to within 10%.

After every time interval which is a multiple of 100 and upon convergence of the transient calculations, the percent steady state and the time intervals at which 90, 95, 99, and 99.5% steady state have been reached and printed.

If desired, output may also be obtained in the form of Calcomp plots. Graphs for concentration versus time interval and/or percent of feed versus time may be produced by (1) requesting plots on the "Program Cards" and (2) entering the correct input as described in "Graph Cards" (see Input).

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APPENDIX A
A LISTING OF SEPHIS-THOREX ROUTINES


```

CCC
C   PROGRAM SEPHIS
C
C   TRANSIENT STAGE CALCULATIONS FOR THOREX SOLVENT EXTRACTION
C   PROCESS.  CALCULATIONS VALID FOR 3 TRANSFERRING COMPONENTS.
C   INCLUDING SALTING EFFECT FROM NON-TRANSFERRING NITRATE SALTS.
C   COMPONENT 1 = URANIUM      COMPONENT 3 = NITRIC ACID
C   COMPONENT 2 = THORIUM      COMPONENT 4 = ALUMINUM NITRATE
C   STAGE VOLUMES EQUAL UNLESS NOTED OTHERWISE
CCC
C
C   PROGRAM WRITTEN BY S. B. WATSON AT OAK RIDGE NATIONAL LABORATORY
C   JUNE 1978 VERSION
C
C   REAL*8 TITLE(10,10)
C   DIMENSION AQOUT(100), OOUT(100), STVOL(100), DF(4), SOLIN(3), SOLOU
C   IT(3), AQOUT(100), ORGOUT(100)
C   DIMENSION AA(100), TT(100), OO(100), RATIO(100)
C   COMMON /FLWS/ IRATIO,IOUT,IVOL,RECY(100),ICHNGE,ALVRT(100),OLVRT(1
C   100)
C   COMMON /STGS/ NSOLU,CODUH(100),AR(100),OR(100),AT(100),OT(100)
C   COMMON /FEED/ NTOST,AFDRT(100),OPDRT(100)
C   COMMON /PROP/ IPRO,X(4,100,2),Y(4,100,2),XFD(4,100),YFD(4,100),TPR
C   1OF(100,2),AFDTEH(100),OPDTEH(100)
C   COMMON /REC/ A(100),O(100),RAIO(100),RCYCA(100),RCYCO(100)
C   COMMON /DIST/ CTBP,ARY(4),DTRY(4),TO
C   COMMON /ROUTE/ NSTR,ISTR,JSTR
C
C   NSOLU=4
C
C   NEXT CASE IS NEW
C
C   10 CONTINUE
C     READ 540, NTTL
C     DO 20 ITTL=1,NTTL
C       READ 550, (TITLE(ITTL,I),I=1,10)
C   20 CONTINUE
C     READ 560, CTBP,NTOST,IPRO,IRATIO,ICALC,IOUT,IVOL,IPR,IPNCH,ICALPL,
C     1NSTR
C
C   TITLE IS THE PROBLEM TITLE. 40 SPACES ARE ALLOWED.
C   NTOST = TOTAL NUMBER OF STAGES, MUST NOT EXCEED 25
C   NSOLU = NUMBER OF SOLUTES, MAXIMUM 4
C   CTBP = VOLUME FRACTION OF DRY TBP
C   IPRO = 0 FOR A ZERO INITIAL CONCENTRATION PROFILE
C   IRATIO = 1 FOR A NON-ZERO INITIAL PROFILE
C   0 IF PHASE RATIO = FLOW RATIO
C   1 IF PHASE RATIO CARDS FOLLOW
C   ICALC = 0 FOR SHUTDOWN CALCULATIONS (NO U OR TH IN FEED STREAMS)
C   1 FOR START-UP OR INTERRUPTION
C   IOUT = 0 IF THERE ARE NO EXTRA OUTGOING STREAMS
C   1 IF THERE ARE OUT GOING STREAMS IN ADDITION TO END STREAMS.
C   IVOL = 0 IF STAGE VOLUMES ARE ALL EQUAL
C   1 IF STAGE VOLUMES ARE UNEQUAL BUT ACCORDING TO TOTAL FLOW
C   2 IF STAGE VOLUMES ARE INDEPENDENTLY UNEQUAL
C   3 IF STAGE VOLUMES ARE EQUAL AND SPECIFIED. (OPTIONS 2 OR 3
C   SHOULD BE USED FOR HAN CALCULATIONS TO CORRECT FOR STAGE
C   RESIDENCE TIME.)
C   IPR = 0 TO PRINT OUT ALL TIME INTERVALS
C   1 TO PRINT ONLY LAST INTERVAL
C   -1 TO PRINT EVERY 20TH TIME INTERVAL
C   ICHNGE = 0 IF NEXT CASE IS NEW
C   1 IF NEXT CASE INVOLVES ONLY A CHANGE IN FEED FLOWS, COMP, AN
C   2 STOP
C   IPNCH = 0 IF NO PUNCHED CARD OUTPUT DESIRED
C   1 FOR FINAL PROFILE OUTPUT ON PUNCHED CARDS
C   ICALPL = 0 NO CALCOMP PLOTS
C   1 CONCENTRATION VS TIME INTERVAL
C   2 PERCENT OF FEED VS TIME INTERVAL
C   3 PLOT BOTH 1 AND 2
C   NSTR = 0 NO UNUSUAL ROUTING PATTERN
C   1 ROUTING PATTERN OTHER THAN NORMAL
C
C   ZEROING OF ARRAYS
C
C     DO 30 J=1,NTOST
C       CODUH(J)=0.0
C       STVOL(J)=0.0
C     DO 30 K=1,2
C       TPROP(J,K)=25.0
C     DO 30 I=1,NSOLU
C       DF(I)=0.0
C       X(I,J,K)=0.0
C       Y(I,J,K)=0.0
C   30 CONTINUE
C   ICHNGE=0
C
C   ISTR AND JSTR ASSIGNED VALUES TO AVOID COMPILER PROBLEMS
C
C     ISTR=0
C     JSTR=0
C
C   NEXT CASE INVOLVES ONLY A CHANGE IN FEED FLOWS, COMP,TEMP
C

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40 CONTINUE
DO 50 J=1,NTOST
A(J)=0.0
O(J)=0.0
AFDRT(J)=0.0
OPDRT(J)=0.0
ALVRT(J)=0.0
OLVRT(J)=0.0
AFDTEH(J)=25.0
OPDTEH(J)=25.0
50 CONTINUE
DO 60 I=1,NSOLU
DO 60 J=1,NTOST
XPD(I,J)=0.0
YFD(I,J)=0.0
60 CONTINUE
C
C PROFIL SETS INITIAL CONCENTRATIONS FOR TIME ZERO, ALSO DEFINES FEED S
C
C CALL PROFIL
C
C WRITE FEED STREAM DATA
C
C PRINT 570
DO 70 ITTL=1,NTTL
PRINT 580, (TITLE(ITTL,I),I=1,10)
70 CONTINUE
WRITE (6,590)
DO 80 I=1,NTOST
IF (AFDRT(I).LE.0.) GO TO 80
PRINT 600, I,XPD(1,I),XPD(2,I),XPD(3,I),XPD(4,I),AFDRT(I),AFDTEH(I)
80 CONTINUE
DO 90 I=1,NTOST
C
C CONVERT TO MOLARITY
C
C XPD(1,I)=XPD(1,I)/238.
C XPD(2,I)=XPD(2,I)/232.
80 CONTINUE
DO 90 I=1,NTOST
C
C SET ACID IN ALL STAGES TO SCRUB ACID CONCENTRATION
C
C IF (IPRO.EQ.0.AND.ICHNGE.EQ.0) X(3,I,1)=(XPD(3,I)*AFDRT(1)+XPD(3,4)
1)*AFDRT(4))/(AFDRT(1)+AFDRT(4))
C
C IF (OPDRT(I).LE.0.) GO TO 90
PRINT 610, CTBP,I,YFD(1,I),YFD(2,I),YFD(3,I),YFD(4,I),OPDRT(I),OPD
1TEH(I)
C
C CONVERT TO MOLARITY
C
C YFD(1,I)=YFD(1,I)/238.
C YFD(2,I)=YFD(2,I)/232.
90 CONTINUE
CALL FLOWS (STVOL)
C
C PRINT OUTGOING STREAMS (ALVRT AND OLVRT)
C
C IF NO EXTRA OUTGOING STREAMS, AVOID PRINT OF ALVRT AND OLVRT
C
C IF (IOUT.EQ.0) GO TO 120
C
C PRINT 620
DO 100 I=1,NTOST
IF (ALVRT(I).LE.0.) GO TO 100
PRINT 630, I,ALVRT(I)
100 CONTINUE
DO 110 I=1,NTOST
IF (OLVRT(I).LE.0.) GO TO 110
PRINT 640, I,OLVRT(I)
110 CONTINUE
C
C PRINT UNUSUAL ROUTING PATTERN
C
C IF (NSTR.EQ.1) PRINT 650, ISTR,JSTR
C
C PRINT INITIAL PROFILE BEFORE UNIT CONVERSION
C
120 CONTINUE
PRINT 660
DO 130 J=1,NTOST
PRINT 670, J,X(1,J,1),X(2,J,1),X(3,J,1),Y(1,J,1),Y(2,J,1),Y(3,J,1)
1,TPROP(J,1)
130 CONTINUE
C
C CHECK FOR NON-ZERO INITIAL PROFILE
C
C IF (IPRO.EQ.0.AND.ICHNGE.EQ.0) GO TO 150
C
C DO 140 J=1,NTOST

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C CONVERT TO MOLARITY
C
X(1,J,1)=X(1,J,1)/238.
Y(1,J,1)=Y(1,J,1)/238.
X(2,J,1)=X(2,J,1)/232.
Y(2,J,1)=Y(2,J,1)/232.
140 CONTINUE
150 CONTINUE
C
C PRINT APPROPRIATE TITLE FOR IRATIO
C
IF (IRATIO.EQ.0) GO TO 160
PRINT 680
GO TO 170
160 CONTINUE
PRINT 690
170 CONTINUE
C
C PRINT PHASE RATIOS
C
DO 200 I=1,NTOST
IF (L.EQ.1) GO TO 180
IF (PRATIO.EQ.RAIO(I)) GO TO 190
IK=I-1
PRINT 700, NST,IK,PRATIO
180 CONTINUE
PRATIO=RAIO(I)
NST=I
190 CONTINUE
IF (L.LT.NTOST) GO TO 200
PRINT 700, NST,I,PRATIO
200 CONTINUE
PRINT 710
C
C A IS AQUEOUS INTERSTAGE FLOW
C O IS ORGANIC INTERSTAGE FLOW
C AA IS TOTAL AQUEOUS FLOW LEAVING STAGE
C OO IS TOTAL ORGANIC FLOW LEAVING STAGE
C RCYCA IS AQUEOUS RECYCLE TO SATISFY PHASE RATIO
C RCYCO IS ORGANIC RECYCLE TO SATISFY PHASE RATIO
C AR IS AQUEOUS RECYCLE TO FILL STAGE
C OR IS ORGANIC RECYCLE TO FILL STAGE
C AT IS TOTAL AQUEOUS FLOW WITHIN A STAGE
C OT IS TOTAL ORGANIC FLOW WITHIN A STAGE
C TT IS TOTAL FLOW ON TO A STAGE
C
DO 210 I=1,NTOST
AA(I)=ALVRT(I)+A(I)
OO(I)=OLVRT(I)+O(I)
RATIO(I)=AA(I)/OO(I)
AR(I)=RCY(I)*RAIO(I)/(1.0+RAIO(I))
OR(I)=RCY(I)/(1.0+RAIO(I))
AT(I)=AA(I)+AR(I)+RCYCA(I)
OT(I)=OO(I)+OR(I)+RCYCO(I)
TT(I)=AT(I)+OT(I)
210 CONTINUE
C
C PRINT STAGE FLOWS
C
DO 220 J=1,NTOST
PRINT 720, J,RATIO(J),AA(J),AR(J),RCYCA(J),AT(J)
220 CONTINUE
PRINT 730
DO 230 J=1,NTOST
PRINT 740, J,TT(J),STVOL(J),OO(J),OR(J),RCYCO(J),OT(J)
230 CONTINUE
WRITE (6,750)
C
N - IS 100 OR LAST TIME INTERVAL
C ICEN - COUNTS BY 100'S NUMBER OF ITERATIONS
C ADF - MAX (DF(1),DF(2),DF(3)) FOR A GIVEN TIME INTERVAL
C BDF - ADF FOR PREVIOUS TIME INTERVAL
C CDF - SET EQUAL TO ADF IF ADF=BDF (CONVERGENCE HAS OCCURRED)
C DDF - DETERMINES PDF,PPDF,PPPDF,PPPPDF (PERCENT STEADY STATE)
C
N=100
ICEN=0
BDF=0.
CDF=0.
DDF=0.10
C
C INITIALIZATION OF TOTAL MOLES IN (SOLIN) AND TOTAL MOLES OUT (SOLOUT)
C
DO 240 I=1,3
SOLIN(I)=0.0
SOLOUT(I)=0.0
240 CONTINUE
DO 250 I=1,3
DO 250 J=1,NTOST
SOLIN(I)=SOLIN(I)+APDRT(J)*XPD(I,J)+OPDRT(J)*YPD(I,J)
IF (NPD(I,J).LT.0) SOLIN(I) = SOLIN(I) - APDRT(J)*XPD(I,J)
250 CONTINUE
C
SPH=0.399*CTBP+0.321*(1.0-CTBP)

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C                                     1405
C K - TIME INTERVAL COUNTER (MOD 100) 1410
C                                     1415
C 260 CONTINUE 1420
C K=1 1425
C                                     1430
C STAGES PERFORMS STAGE CALCULATIONS FOR EACH TIME INTERVAL 1435
C                                     1440
C 270 CONTINUE 1445
C CALL STAGES (SPR) 1450
C DO 280 J=1,NTOST 1455
C TPROP(J,1)=TPROP(J,2) 1460
C DO 280 I=1,4 1465
C X(I,J,1)=X(I,J,2) 1470
C Y(I,J,1)=Y(I,J,2) 1475
C 280 CONTINUE 1480
C                                     1485
C IF NUMBER OF TIME INTERVALS IS LESS THAN THE NUMBER OF STAGES, 1490
C OMIT CALCULATION OF SOLIN,SOLOUT, AND PERCENT STEADY STATE 1495
C                                     1500
C IF (ICEN.EQ.0.AND.K.LT.NTOST) GO TO 390 1505
C                                     1510
C IF SHUTDOWN (ICALC=0), CHECK FOR NEAR ZERO CONCENTRATION 1515
C                                     1520
C IF (ICALC.EQ.1) GO TO 300 1525
C                                     1530
C FOR SHUTDOWN, ICALC=0, TEST FOR COMPONENTS 1 AND 2 = 0, NOT COMPONENT 1535
C                                     1540
C DO 290 J=1,NTOST 1545
C IF (X(1,J,1).GT.0.000001) GO TO 390 1550
C IF (Y(1,J,1).GT.0.000001) GO TO 390 1555
C IF (X(2,J,1).GT.0.000001) GO TO 390 1560
C IF (Y(2,J,1).GT.0.000001) GO TO 390 1565
C 290 CONTINUE 1570
C GO TO 380 1575
C                                     1580
C CALCULATION OF PERCENT STEADY STATE 1585
C                                     1590
C                                     1595
C CALCULATE TOTAL HOLES IN (SOLIN) AND TOTAL HOLES OUT (SOLOUT) 1600
C                                     1605
C 300 CONTINUE 1610
C DO 310 I=1,3 1615
C SOLOUT(I)=A(NTOST)*X(I,NTOST,1)+O(1)*Y(I,1,1) 1620
C DO 310 J=1,NTOST 1625
C SOLOUT(I)=SOLOUT(I)+ALVRT(J)*X(I,J,1)+OLVRT(J)*Y(I,J,1) 1630
C 310 CONTINUE 1635
C                                     1640
C DO 330 I=1,3 1645
C IF (SOLIN(I).GT.0.) GO TO 320 1650
C DF(I)=0. 1655
C GO TO 330 1660
C 320 CONTINUE 1665
C DF(I)=ABS((SOLIN(I)-SOLOUT(I))/SOLIN(I)) 1670
C 330 CONTINUE 1675
C ADF=AMAX1(DF(1),DF(2),DF(3)) 1680
C                                     1685
C IF ADF=BDF (PERCENT STEADY STATE FOR CURRENT TIME INTERVAL 1690
C SAME AS PREVIOUS TIME INTERVAL), TERMINATE CALCULATIONS 1695
C                                     1700
C IF(ADF.NE.BDF) GO TO 175 1705
C IF (ABS((ADF-BDF)/ADF).GT.5.E-4.OR.ADF.GT.DDF) GO TO 340 1710
C CDF=ADF 1715
C GO TO 380 1720
C                                     1725
C 340 CONTINUE 1730
C BDF=ADF 1735
C IF (ICEN.GE.3.AND.DDF.LT.0.004) DDF=2.*DDF 1740
C IF (ADF.GT.DDF) GO TO 390 1745
C                                     1750
C 90% STEADY STATE 1755
C                                     1760
C IF (DDF.LT.0.100) GO TO 350 1765
C JK=K+100*ICEN 1770
C PPDF=100.*(1.0-DDF) 1775
C DDF=0.05 1780
C GO TO 390 1785
C                                     1790
C 95% STEADY STATE 1795
C                                     1800
C 350 CONTINUE 1805
C IF (DDF.LT.0.05) GO TO 360 1810
C JJK=K+100*ICEN 1815
C PPDF=100.*(1.0-DDF) 1820
C DDF=0.010 1825
C GO TO 390 1830
C                                     1835
C IF 99% STEADY STATE HAS BEEN REACHED AND ICEN>0, PRINT TIME INTERVAL 1840
C AND PERCENT STEADY STATE 1845
C                                     1850
C 360 CONTINUE 1855
C IF (ICEN.GT.0) GO TO 380 1860
C                                     1865
C 99% STEADY STATE AND ICEN=0 1870
C                                     1875

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C      IF (DDF.LT.0.010) GO TO 370
      JJK=K+100*ICEN
      PPPDF=100.*(1.0-DDF)
      DDF=0.005
      GO TO 390
C
C      IF 99.5% STEADY STATE HAS BEEN REACHED AND ICEN>0, PRINT
C      TIME INTERVAL AND PERCENT STEADY STATE
C
C      370 CONTINUE
      IF (ICEN.GT.0) GO TO 380
C
C      99.5% STEADY STATE AND ICEN=0
C
C      IF (DDF.LT.0.005) GO TO 380
      JJK=K+100*ICEN
      PPPDF=100.*(1.0-DDF)
      DDF=0.001
      GO TO 390
C
C      380 CONTINUE
      H=K
C
C      390 CONTINUE
C
C      DETERMINE IF TIME INTERVAL IS TO BE PRINTED
C
C      IF (XPR.EQ.0) GO TO 400
      IF (XPR.EQ.-1.AND.(K.EQ.20.OR.K.EQ.40.OR.K.EQ.60.OR.K.EQ.80.OR.K.E
      10.H)) GO TO 400
      IF (XPR.EQ.1.AND.K.EQ.H) GO TO 400
      GO TO 470
C
C      400 CONTINUE
      DO 420 J=1,NTOST
      AOUT(J)=A(J)+ALVRT(J)
      OOUT(J)=O(J)+OLVRT(J)
      IF (IOUT.EQ.0) GO TO 410
      AOUT(J)=A(J)+ALVRT(J)
      OOUT(J)=O(J)+OLVRT(J)
C
C      410 CONTINUE
C
C      CONVERT TO G/L
C
C      X(1,J,2)=X(1,J,2)*238.
      Y(1,J,2)=Y(1,J,2)*238.
      X(2,J,2)=X(2,J,2)*232.
      Y(2,J,2)=Y(2,J,2)*232.
C
C      420 CONTINUE
C
C      PRINT X AND Y ON DISK (UNIT 10) FOR CALCOMP PLOTS
C
C      L=K+100*ICEN
      DO 430 J=1,NTOST
      WRITE (11) L, (X(I,J,2), I=1,4), (Y(I,J,2), I=1,4), AOUT(J), OOUT(J)
C
C      430 CONTINUE
C
C      PRINTOUT FOR A GIVEN TIME INTERVAL
C
C      PRINT 760
      DO 450 J=1,NTOST
      IF (J.GT.1) GO TO 440
      L=K+100*ICEN
      PRINT 770, L, J, (X(I,J,2), I=1,3), AOUT(J)
      IF (ALVRT(J).GT.0.) PRINT 780, AOUT(J)
      GO TO 450
C
C      440 CONTINUE
      PRINT 790, J, (X(I,J,2), I=1,3), AOUT(J)
      IF (ALVRT(J).GT.0.) PRINT 780, AOUT(J)
C
C      450 CONTINUE
      PRINT 800
      DO 460 J=1,NTOST
      IF (OLVRT(J).GT.0.) PRINT 780, OOUT(J)
      PRINT 810, J, (Y(I,J,2), I=1,3), OOUT(J), CODUM(J), TPROF(J,2)
C
C      CHECK FOR THIRD PHASE
C
C      IF (Y(2,J,2).GT.SQRT(.4311727E-1-.3317647E-4*(TPROF(J,2)-55.03193)
      1**2+.36719*(Y(3,J,2)-.3455787)**2)*232.) PRINT 820
C
C      460 CONTINUE
C
C      INCREMENT TIME INTERVAL COUNTER
C
C      470 CONTINUE
      K=K+1
C
C      IF K LESS THAN OR EQUAL TO H, PERFORM STAGE CALCULATIONS FOR ANOTHER
C      TIME INTERVAL
C
C      IF (K.LE.H) GO TO 270
C
C
C

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1880
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2295
2300
2305
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2320
2325
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2335
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2345
2350

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C IF SHUTDOWN (ICALC=0), BYPASS PRINTOUT OF PERCENT STEADY STATE 2355
C IF (ICALC.EQ.0) GO TO 480 2360
C 2365
C 2370
C 2375
C PRINT PERCENT STEADY STATE AFTER EVERY 100 TIME INTERVALS 2380
C AND OTHER CASES WHEN K=M 2385
C 2390
C   APDF=100.*(1.0-ADP) 2395
C   PRINT 830 2400
C   PRINT 840, APDF 2405
C   IF (DDF.LT.0.1) PRINT 850, PDF,JK 2410
C   IF (DDF.LT.0.05) PRINT 850, PPDF,JJK 2415
C   IF (DDF.LT.0.01) PRINT 850, PPPDF,JJJK 2420
C   IF (DDF.LT.0.005) PRINT 850, PPPPDF,JJJJK 2425
C   IF (IOUT.GT.0) PRINT 860 2430
C 2435
C CHECK FOR CONVERGENCE 2440
C 2445
C   IF (ADF.NE.CDF) GO TO 480 2450
C 2455
C   PRINT 870 2460
C   *80 CONTINUE 2465
C   IF (N.LT.100) GO TO 490 2470
C   ICEN=ICEN+1 2475
C   IF (ICEN.EQ.15) GO TO 490 2480
C   GO TO 260 2485
C 2490
C CONVERT TOTAL HOLES IN AND OUT TO G/L AND PRINT 2495
C 2500
C *90 CONTINUE 2505
C   SOLIN(1)=SOLIN(1)*238. 2510
C   SOLOUT(1)=SOLOUT(1)*238. 2515
C   SOLIN(2)=SOLIN(2)*232. 2520
C   SOLOUT(2)=SOLOUT(2)*232. 2525
C   PRINT 880, SOLIN(1),SOLOUT(1) 2530
C   PRINT 890, SOLIN(2),SOLOUT(2) 2535
C   PRINT 900, SOLIN(3),SOLOUT(3) 2540
C 2545
C PRINT MINUTES PER TIME INTERVAL 2550
C 2555
C   TIMINT=STVOL(1)/(AT(1)+OT(1)) 2560
C   IF (IVOL.GE.2) PRINT 910, TIMINT 2565
C 2570
C CALCOMP PLCTER OUTPUT 2575
C 2580
C   IF (ICALPL.EQ.0) GO TO 500 2585
C   CALL PLCTR (N+100*ICEN,ICALPL,NTOST,SOLIN) 2590
C 500 CONTINUE 2595
C 2600
C PUNCHED CARD OUTPUT 2605
C 2610
C   IF (IPNCH.LE.0) GO TO 520 2615
C   DO 510 J=1,NTOST 2620
C   PUNCH 920, (X(I,J,2),I=1,3), (Y(I,J,2),I=1,3), TPROP(J,2), X(4,J,2) 2625
C 510 CONTINUE 2630
C 2635
C 2640
C READ NEXT CASE 2645
C 2650
C 520 CONTINUE 2655
C   READ 930, ICHNGE,IDIF 2660
C   IF (IDIF.EQ.1) READ 930, ICALC,IOUT,IPR,IPNCH,ICALPL 2665
C   IF (ICHNGE.EQ.0) GO TO 10 2670
C   IF (ICHNGE.EQ.2) STOP 2675
C 2680
C IF ICHNGE = 1, NEW FEED STREAM AND OUT CARDS ARE REQUIRED FOR EACH 2685
C FEED AND EXIT STREAM, EVEN IF NO CHANGE IS MADE. NO PROFILE CARDS 2690
C ARE REQUIRED. 2695
C 2700
C ICHNGE=1 2705
C 2710
C INITIAL PROFILE IS SET AS THAT AT END OF LAST CALCULATION. 2715
C 2720
C   IPRO=0 2725
C   DO 530 I=1,4 2730
C   DO 530 J=1,NTOST 2735
C   X(I,J,1)=X(I,J,2) 2740
C   Y(I,J,1)=Y(I,J,2) 2745
C 530 CONTINUE 2750
C   GO TO 40 2755
C 2760
C 2765
C 2770
C 540 FORMAT (I2) 2775
C 550 FORMAT (10A8) 2780
C 560 FORMAT (F8.0,10I2) 2785
C 570 FORMAT ('1 CALCULATIONS FOR A SOLVENT EXTRACTION PROCESS', ' HAVING 2790
C   13 INTERACTING SOLUTES' /) 2795
C 580 FORMAT (' ',10A8) 2800
C 590 FORMAT ('0 FEED STREAM DATA',16X,'STAGE',3X,'URANIUM',6X,'THORIUM', 2805
C   17X,'HNO3',5X,'ALUMINUM NO3',2X,'FLOW RATE',6X,'TEMP',/,34X,'NO.',5 2810
C   2X,'(G/L)',8X,'(G/L)',8X,'(N)',10X,'(N)',6X,'(VOL.UNITS)',5X,'DEG C 2815
C   3' /) 2820
C 600 FORMAT (24X,'AQUEOUS ',I4,4(2X,1PE11.4),3X,E9.3,3X,0PF7.1) 2825

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610 FORMAT (19X,2PF6.1,' - TBP ',I4.4(3X,1PE10.4),3X,E9.3,3X,OPF7.1) 2830
620 FORMAT ('O') 2835
630 FORMAT ('AQUEOUS STREAM REMOVED AT STAGE',I3,'. FLOW =',1PE9.3) 2840
640 FORMAT ('ORGANIC STREAM REMOVED AT STAGE',I3,'. FLOW =',1PE9.3) 2845
650 FORMAT ('ORGANIC STREAM EXITING AT STAGE',I4,' FEEDS STAGE',I4) 2850
660 FORMAT ('INITIAL PROFILE',17X,'STAGE',13X,'AQUEOUS PHASE',26X,'OR
1GAMIC PHASE',10X,'34X','WO.',4X,'URANIUM',6X,'THORIUM',7X,'HNO3',8
2X,'URANIUM',6X,'THORIUM',7X,'HNO3',7X,'TEMP',/,31X,'(OUTFLOW)',2X,
3'(G/L)',8X,'(G/L)',8X,'(M)',10X,'(G/L)',8X,'(G/L)',8X,'(M)',8X,'DE
4G C',/) 2870
670 FORMAT (32X,I4.6(3X,1PE10.4),3X,OPF6.1) 2880
680 FORMAT ('OPHASE RATIOS DO NOT EQUAL FLOW RATIOS',3X,'STAGE NO.',2X
1,'A/O PHASE RATIO',/) 2885
690 FORMAT ('OPHASE RATIOS EQUAL FLOW RATIOS',11X,'STAGE NO.',2X,'A/O
1PHASE RATIO',/) 2900
700 FORMAT (40X,I4,' -',I4,4X,1PE10.3) 2905
710 FORMAT (/, 'STAGE FLOWS:',/,51X,'AQUEOUS PHASE',/,47X,'RECYCLE 2
1RECYCLE 1 TOTAL',/, 'STAGE FLOW',22X,'FLOW OUT TO FILL
2FOR PHASE', 'AQUEOUS',/, 'NO. RATIO',21X,'OF STAGE STAG
3E', ' RATIO FLOW') 2925
720 FORMAT (2X,I2,4X,1PE9.3,17X,4(2X,E9.3)) 2930
730 FORMAT (/,9X,'OVERALL',36X,'ORGANIC PHASE',/,10X,'TOTAL',32X,'RECY
1CLE 2 RECYCLE 1 TOTAL',/, 'STAGE STAGE',21X,'FLOW OUT TO
2 FILL FOR PHASE ORGANIC',/, 'NO. FLOW STAGE VOL.',7X,
3'OF STAGE', ' STAGE RATIO FLOW') 2950
740 FORMAT (2X,I2,2X,2(2X,1PE9.3),6X,4(2X,E9.3)) 2955
750 FORMAT (27H1TRANSIENT BEHAVIOR RESULTS,10X,49HSOLUTE CONCENTRATION
1S IN EFFLUENT FROM EACH STAGE) 2965
760 FORMAT (///,31X,'AQUEOUS PHASE',/,3X,'TIME',4X,'STAGE',3X,'URANIUM
1',4X,'THORIUM',5X,'HNO3',5X,'FLOW OUT',/, 'INTERVAL',3X,'NO.',5X,'
2(G/L)',6X,'(G/L)',7X,'(M)',5X,'OF STAGE') 2980
770 FORMAT (1X,I4,7X,I2,2X,4(1X,1PE10.3)) 2985
780 FORMAT (12X,3(10X,'*'),5X,1PE10.3) 2990
790 FORMAT (12X,I2,2X,5(1X,1PE10.3),12X,E10.3) 2995
800 FORMAT (/,31X,'ORGANIC PHASE',/,11X,'STAGE',3X,'URANIUM',4X,'THORI
1UM',5X,'HNO3',5X,'FLOW OUT',6X,'ITERA-',2X,'TEMP',/,12X,'WO.',5X,'
2(G/L)',6X,'(G/L)',7X,'(M)',5X,'OF STAGE',6X,'TIONS',3X,'DEG C') 3010
810 FORMAT (12X,I2,2X,4(2X,1PE9.3),6X,OPF3.0,4X,E4.1) 3015
820 FORMAT ('*',37X,'*') 3020
830 FORMAT ('O# INDICATES THIRD PHASE WITHIN 10% TOLERANCE') 3025
840 FORMAT ('O',P7.2,' PERCENT STEADY STATE BY OVERALL MATERIAL', ' BAL
1ANCE') 3035
850 FORMAT (' ',P6.1,2X,'PERCENT OF STEADY STATE AFTER TIME', 'INTERVA
1L',I6) 3045
860 FORMAT (1H0,' * SIDE STREAM REMOVED FROM INTERSTAGE FLOW BETWEEN
1THE INDICATED STAGES.') 3055
870 FORMAT (1H0,'CALCULATION TERMINATED BY CONVERGENCE AT INDICATED _
1STEADY STATE.') 3065
880 FORMAT (/, 'TOTAL G/L URANIUM IN:',2X,1PE11.4,' , OUT:',E11.4) 3075
890 FORMAT (/, 'TOTAL G/L THORIUM IN:',2X,1PE11.4,' , OUT:',E11.4) 3080
900 FORMAT (/, 'TOTAL MOLES HNO3 IN:',5X,1PE11.4,' , OUT:',E11.4) 3085
910 FORMAT (/, 'MINUTES/TIME INTERVAL:',P7.3) 3090
920 FORMAT (1P8E10.4) 3095
930 FORMAT (5I2) 3100-
END

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SUBROUTINE PROFIL PRO 5
COMMON /PROF/ IPRG,X(4,100,2),Y(4,100,2),XPD(4,100),YPD(4,100),TPBPRO 10
1OP(100,2),AFDTEH(100),OPDTEH(100) PRO 15
COMMON /FEED/ HTOST,AFDRT(100),OPDRT(100) PRO 20
C PRO 25
C DEFINE FEED STREAMS PRO 30
C I = STAGE NUMBER THAT FEED ENTERS JHAS = 1 FOR AQUEOUS FEED PRO 35
C FDR1 = FEED FLOW RATE (VOLUME UNITS) 0 FOR ORGANIC FEED PRO 40
C CON1 = URANIUM CONTENT IN MOLARITY INDEX = 1 IF MORE FEED CARDS FOR PRO 45
C CON2 = THORIUM CONTENT IN MOLARITY 0 FOR LAST CARD PRO 50
C CON3 = ACID MOLARITY TEMP = TEMPERATURE IN DEGREES PRO 55
C CON4 = NITRATE MOLARITY FROM INEXTRACTABLE SALTS, INCLUDING THE REDUC PRO 60
C PRO 65
10 CONTINUE PRO 70
READ (5,90) I,JHAS,FDR1,CON1,CON2,CON3,TEMP,INDEX,CON4 PRO 75
IF (JHAS.EQ.1) GO TO 30 PRO 80
C PRO 85
C ORGANIC FEED PRO 90
C PRO 95
OPDRT(I)=FDR1 PRO 100
IF (TEMP.EQ.0.) GO TO 20 PRO 105
OPDTEH(I)=TEMP PRO 110
20 CONTINUE PRO 115
YFD(1,I)=CON1 PRO 120
YFD(2,I)=CON2 PRO 125
YFD(3,I)=CON3 PRO 130
YFD(4,I)=CON4 PRO 135
GO TO 50 PRO 140
C PRO 145
C AQUEOUS FEED PRO 150

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C          30 CONTINUE                                PRO 155
          APDRT(I)=PDRT                                PRO 160
          IF (TEMP.EQ.0.) GO TO 40                     PRO 165
          APDTER(I)=TEMP                               PRO 170
          40 CONTINUE                                PRO 175
          XPD(1,I)=CON1                                PRO 180
          XPD(2,I)=CON2                                PRO 185
          XPD(3,I)=CON3                                PRO 190
          XPD(4,I)=CON4                                PRO 195
          50 CONTINUE                                PRO 200
          IF (INDEX.EQ.1) GO TO 10                     PRO 205
          60 CONTINUE                                PRO 210
          CHECK FOR NON-ZERO INITIAL PROFILE           PRO 215
          IF (IPRO.GT.0) GO TO 70                     PRO 220
          FOR IPRO = 0, THE ZERO PROFILE IS ALREADY IN X AND Y ARRAYS PRO 225
          DO 60 J=1,NTOST                               PRO 230
          TPROF(J,1)=APDTER(1)                         PRO 235
          60 CONTINUE                                PRO 240
          RETURN                                       PRO 245
          FOR A NON-ZERO INITIAL PROFILE, VALUES ARE NOW READ PRO 250
          70 CONTINUE                                PRO 255
          DO 80 J=1,NTOST                               PRO 260
          READ (5,100) (X(I,J,1),I=1,3), (Y(I,J,1),I=1,3), TPROF(J,1), X(4,J,1) PRO 265
          IF (TPROF(J,1).EQ.0.) TPROF(J,1)=25.0        PRO 270
          80 CONTINUE                                PRO 275
          RETURN                                       PRO 280
          90 FORMAT (2I2,5F8.0,I2,F8.0)               PRO 285
          100 FORMAT (8F10.0)                         PRO 290
          END                                          PRO 295

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          SUBROUTINE FLOWS (STVOL)                    FLO 5
          COMMON /PLWS/ IRATIO,IOUT,IVOL,RECY(100), ICHNGE,ALVRT(100),OLVRT(100) FLO 10
          100)                                         FLO 15
          COMMON /FEED/ NTOST,APDRT(100),OPDRT(100)   FLO 20
          COMMON /REC/ A(100),O(100),RAIO(100),RCYCA(100),RCYCO(100) FLO 25
          COMMON /ROUTE/ MSTR,ISTR,JSTR              FLO 30
          DIMENSION STVOL(100)                       FLO 35
          C                                           FLO 40
          C DEFINE OUTGOING STREAMS OTHER THAN AQUEOUS RAFFINATE AND ORGANIC PROD FLO 45
          C I = STAGE NUMBER THAT STREAM LEAVES JHAS = 1 FOR AQUEOUS STREAM FLO 50
          C INDEX = 1 IF MORE CARDS FOLLOW              0 FOR ORGANIC STREAM FLO 55
          C 0 FOR LAST CARD                            OTRT = EXIT FLOW RATE (VOLUME FLO 60
          C                                           FLO 65
          C CHECK FOR OUTGOING STREAMS (IOUT=0-NO,IOUT=1-YES) FLO 70
          C IF (IOUT.EQ.0) GO TO 60                   FLO 75
          C READ OUTGOING STREAM DATA                 FLO 80
          C IBA=1                                       FLO 85
          C IEO=NTOST                                   FLO 90
          C 10 CONTINUE                                FLO 95
          C READ 290, I,JHAS,OTRT,INDEX               FLO 100
          C IF (JHAS.EQ.1) GO TO 30                   FLO 105
          C ORGANIC STREAM                             FLO 110
          C OLVRT(I)=OTRT                               FLO 115
          C IF (OLVRT(I).NE.0.) GO TO 50               FLO 120
          C DO 20 J=I,IEO                               FLO 125
          C OLVRT(I)=OLVRT(I)+OPDRT(J)                 FLO 130
          C 20 CONTINUE                                FLO 135
          C IEO=I-1                                     FLO 140
          C GO TO 50                                    FLO 145
          C AQUEOUS STREAM                             FLO 150
          C 30 CONTINUE                                FLO 155
          C ALVRT(I)=OTRT                               FLO 160
          C IF (ALVRT(I).NE.0.) GO TO 50               FLO 165
          C DO 40 J=IBA,I                               FLO 170
          C                                           FLO 175
          C                                           FLO 180
          C                                           FLO 185
          C                                           FLO 190
          C                                           FLO 195
          C                                           FLO 200
          C                                           FLO 205
          C                                           FLO 210
          C                                           FLO 215

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      ALVRT(I)=ALVRT(I)+AFDRT(J)          FLO 220
40  CONTINUE                             FLO 225
      IBA=I+1                             FLO 230
C                                         FLO 235
C MORE CARDS?                             FLO 240
C                                         FLO 245
50  CONTINUE                             FLO 250
      IF (INDEX.EQ.1) GO TO 10            FLO 255
C                                         FLO 260
C WE DO NOT PROVIDE FOR RETURNING STREAMS FLO 265
C                                         FLO 270
C                                         FLO 275
      SET AQUEOUS AND ORGANIC INTERSTAGE FLOW (A AND O) FLO 280
C                                         FLO 285
60  CONTINUE                             FLO 290
C                                         FLO 295
      READ UNUSUAL ROUTING PATTERN        FLO 300
      ORGANIC STREAM FROM STAGE ISTR FEEDS INTO STAGE JSTR FLO 305
C                                         FLO 310
      IF (NSTR.EQ.1) READ 300, ISTR,JSTR FLO 315
      DO 80 I=1,NTOST                     FLO 320
      IF (I.GT.1) GO TO 70                 FLO 325
      A(I)=AFDRT(I)-ALVRT(I)               FLO 330
      O(NTOST)=OPDRT(NTOST)-OLVRT(NTOST) FLO 335
      GO TO 80                             FLO 340
70  CONTINUE                             FLO 345
      A(I)=A(I-1)+AFDRT(I)-ALVRT(I)        FLO 350
      NST=NTOST+1-I                       FLO 355
      O(NST)=O(NST+1)+OPDRT(NST)-OLVRT(NST) FLO 360
      IF (NSTR.EQ.1.AND.NST.EQ.ISTR-1) O(NST)=OPDRT(NST)-OLVRT(NST) FLO 365
      IF (NSTR.EQ.1.AND.NST.EQ.JSTR) O(NST)=O(ISTR)+OPDRT(NST)-OLVRT(NST) FLO 370
      I)+O(NST+1)                          FLO 375
80  CONTINUE                             FLO 380
C                                         FLO 385
C THE INTERSTAGE FLOWS ARE NOW SET        FLO 390
C                                         FLO 395
      DEFINE PHASE RATIOS                  FLO 400
C                                         FLO 405
      DO 90 I=1,NTOST                     FLO 410
      RCYA(I)=0.0                         FLO 415
      RCTO(I)=0.0                         FLO 420
90  CONTINUE                             FLO 425
      FLOWAX=0.0                          FLO 430
      K=1                                 FLO 435
      IF (IRATIO.EQ.1) GO TO 110           FLO 440
C                                         FLO 445
      DEFINE PHASE RATIO WHEN IRATIO=0, PHASE RATIO=FLOW RATIO FLO 450
C                                         FLO 455
      DO 100 I=1,NTOST                    FLO 460
      RAO(I)=(ALVRT(I)+A(I))/(OLVRT(I)+O(I)) FLO 465
100 CONTINUE                             FLO 470
      GO TO 130                           FLO 475
C                                         FLO 480
      DO NOT REDEFINE PHASE RATIO IF ICHNGE=1 FLO 485
C                                         FLO 490
110 CONTINUE                             FLO 495
      IF (ICHNGE.EQ.1) GO TO 150           FLO 500
C                                         FLO 505
      DEFINE PHASE RATIOS WHEN IRATIO=1, PHASE RATIOS DO NOT EQUAL FLO 510
      FLOW RATIOS                          FLO 515
C                                         FLO 520
      I=NUMBER OF STAGES HAVING PHASE RATIO SHOWN FLO 525
C                                         FLO 530
      READ 310, I,RATIO                   FLO 535
      I=I+1                               FLO 540
      DO 120 J=K,I                         FLO 545
      RAO(J)=RATIO                        FLO 550
120 CONTINUE                             FLO 555
      IF (I.EQ.NTOST) GO TO 150           FLO 560
      K=I+1                               FLO 565
      GO TO 110                           FLO 570
C                                         FLO 575
      CALCULATE NECESSARY RECYCLE FLOWS    FLO 580
      TYPE 1 IS RECYCLE OF ONE PHASE ONLY, TO SATISFY PHASE RATIO FLO 585
      USED WHEN IRATIO = 1                 FLO 590
      TYPE 2 IS RECYCLE OF BOTH PHASES WITH PHASE RATIO RAO(I) FLO 595
      TO ALLOW TOTAL STAGE FLOW TO EQUAL FLOWAX FLO 600
      USED WHEN IVOL = 0,2                 FLO 605
C                                         FLO 610
      CALCULATE FLOTOT, RECY, AND FLOWAX FOR IRATIO=0; IVOL=0,2,3 FLO 615
      FOR IVOL=1, RECY SET TO 0.0          FLO 620
      FLOTOT - TOTAL FLOW LEAVING STAGE    FLO 625
      FLOWAX - GREATEST TOTAL FLOW FROM A STAGE FLO 630
C                                         FLO 635
130 CONTINUE                             FLO 640
      IF (IVOL.EQ.1) GO TO 210             FLO 645
      DO 140 I=1,NTOST                     FLO 650
      FLOTOT=ALVRT(I)+A(I)+OLVRT(I)+O(I) FLO 655
      RECY(I)=FLOTOT                       FLO 660
      FLOWAX=MAX1(FLOTOT,FLOWAX)           FLO 665
140 CONTINUE                             FLO 670
      IF (IVOL.EQ.0) GO TO 190             FLO 675
      IF (IVOL.EQ.1) GO TO 210             FLO 680
      IF (IVOL.EQ.2.OR.IVOL.EQ.3) GO TO 230 FLO 685
C                                         FLO 690

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C	CALCULATE PLOTOT,RCYCA,RCYCO,RECY,FLOWAX,RECY FOR IRATIO=1	FLO 1
C	AND IVOL=0,1,2,3	FLO 2
C	APL - TOTAL AQUEOUS FLOW LEAVING A STAGE	FLO 3
C	OPL - TOTAL ORGANIC FLOW LEAVING A STAGE	FLO 4
C	RFL - RATIO OF AQUEOUS TO ORGANIC FLOW LEAVING A STAGE (APL/OPL)	FLO 5
C	RCYCA - AQUEOUS RECYCLE TO SATISFY PHASE RATIO	FLO 6
C	RCYCO - ORGANIC RECYCLE TO SATISFY PHASE RATIO	FLO 7
C	150 CONTINUE	FLO 8
C	DO 180 I=1,NTOST	FLO 9
C	APL=ALVRT(I)+A(I)	FLO 10
C	OPL=OLVRT(I)+O(I)	FLO 11
C	PLOTOT=APL+OPL	FLO 12
C	RFL=APL/OPL	FLO 13
C	COMPARISON OF FLOW RATIO (RFL) TO PHASE RATIO (RAIO)	FLO 14
C	IF (RFL.GT.RAIO(I)) GO TO 160	FLO 15
C	IF (RFL.EQ.RAIO(I)) GO TO 170	FLO 16
C	PLOTOT=PLOTOT*(RAIO(I)+1.0)/(RFL+1.0)	FLO 17
C	RCYCA(I)=PLOTOT-APL-OPL	FLO 18
C	GO TO 170	FLO 19
C	160 CONTINUE	FLO 20
C	PLOTOT=PLOTOT*RFL*(RAIO(I)+1.0)/(RAIO(I)*(RFL+1.0))	FLO 21
C	RCYCO(I)=PLOTOT-APL-OPL	FLO 22
C	170 CONTINUE	FLO 23
C	RECY(I)=PLOTOT	FLO 24
C	FLOWAX=ANAX1(PLOTOT,FLOWAX)	FLO 25
C	180 CONTINUE	FLO 26
C	FLOWAX CONTAINS THE LARGEST TOTAL FLOW FROM A STAGE - STAGES HAVING	FLO 27
C	TOTAL FLOW LESS THAN FLOWAX MUST EXHIBIT RECYCLE	FLO 28
C	OF TYPE 2	FLO 29
C	IF (IVOL.EQ.0) GO TO 190	FLO 30
C	IF (IVOL.EQ.1) GO TO 210	FLO 31
C	IF (IVOL.EQ.2.OR.IVOL.EQ.3) GO TO 230	FLO 32
C	IVOL=0; IRATIO=0,1	FLO 33
C	190 CONTINUE	FLO 34
C	DO 200 I=1,NTOST	FLO 35
C	RECY(I)=FLOWAX-RECY(I)	FLO 36
C	200 CONTINUE	FLO 37
C	RETURN	FLO 38
C	IVOL=1; IRATIO=0,1	FLO 39
C	210 CONTINUE	FLO 40
C	DO 220 I=1,NTOST	FLO 41
C	RECY(I)=0.0	FLO 42
C	220 CONTINUE	FLO 43
C	RETURN	FLO 44
C	DETERMINE STAGE VOLUME	FLO 45
C	STAGE VOLUMES ARE ZERO FOR IVOL=0,1	FLO 46
C	IF ICHNGE=0, READ STAGE VOLUMES	FLO 47
C	IF ICHNGE=1, BYPASS READING OF STAGE VOLUMES	FLO 48
C	230 CONTINUE	FLO 49
C	IF (ICHNGE.EQ.1) GO TO 260	FLO 50
C	IF (IVOL.EQ.2) GO TO 250	FLO 51
C	IVOL=3; STAGE VOLUMES ARE EQUAL AND SPECIFIED	FLO 52
C	IRATIO=0,1	FLO 53
C	READ 320, VOL	FLO 54
C	DO 240 J=1,NTOST	FLO 55
C	STVOL(J)=VOL	FLO 56
C	240 CONTINUE	FLO 57
C	GO TO 260	FLO 58
C	IVOL=2; STAGE VOLUMES ARE INDEPENDENTLY UNEQUAL	FLO 59
C	250 CONTINUE	FLO 60
C	READ 330, (STVOL(J),J=1,NTOST)	FLO 61
C	CALCULATE LENGTH OF TIME INTERVAL(TININ) AND RECY FOR IVOL=2,3	FLO 62
C	260 CONTINUE	FLO 63
C	TININ=0.0	FLO 64
C	DO 270 I=1,NTOST	FLO 65
C	RECY(I)=RECY(I)/STVOL(I)	FLO 66
C	TININ=ANAX1(RECY(I),TININ)	FLO 67
C	270 CONTINUE	FLO 68
C	FLOWAX=TININ	FLO 69
C	DO 280 I=1,NTOST	FLO 70
C	RECY(I)=(FLOWAX-RECY(I))*STVOL(I)	FLO 71
C	280 CONTINUE	FLO 72
C	RETURN	FLO 73

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C
290 FORMAT (2I2,F8.0,I2)
300 FORMAT (2I5)
310 FORMAT (I2,F8.0)
320 FORMAT (F8.0)
330 FORMAT (10F8.0)
END
FLO1170
FLO1175
FLO1180
FLO1185
FLO1190
FLO1195
FLO1200-

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SUBROUTINE STAGES (SPH)
DIMENSION AIN(4), OIN(4)
COMMON /STGS/ NSOLU,CODUM(100),AR(100),OR(100),AT(100),OT(100)
COMMON /FEED/ NTOST,AFDRT(100),OPDRT(100)
COMMON /PROP/ IPRO,I(4,100,2),Y(4,100,2),XPD(4,100),YFD(4,100),TPRSTA
10F(100,2),AFDTEH(100),OPDTEH(100)
COMMON /REC/ A(100),O(100),RAIO(100),RCYCA(100),RCYCO(100)
COMMON /DIST/ CTBP,ARY(4),DTRY(4),TO
COMMON /ROUTE/ NSTR,ISTR,JSTR
STA 5
STA 10
STA 15
STA 20
STA 25
STA 30
STA 35
STA 40
STA 45
STA 50
C PERFORM STAGE CALCULATIONS FOR CURRENT TIME INTERVAL - CONSIDER
C INPUTS FROM ADJACENT STAGES, FEED STREAMS, AND MOST IMPORTANTLY
C RECYCLE WITHIN THE STAGE - RECYCLE A RESULT OF STAGE FLOW BEING
C LESS THAN FLOWMAX (TYPE 2) AND PHASE RATIO NOT EQUAL TO FLOW
C RATIO (TYPE 1)
STA 55
STA 60
STA 65
STA 70
STA 75
C
C AR - AQUEOUS RECYCLE TO FILL STAGE
C OR - ORGANIC RECYCLE TO FILL STAGE
C RCYCA - AQUEOUS RECYCLE TO SATISFY PHASE RATIO
C RCYCO - ORGANIC RECYCLE TO SATISFY PHASE RATIO
C AT - TOTAL AQUEOUS FLOW WITHIN A STAGE =
C TOTAL AQUEOUS FLOW LEAVING A STAGE + AQUEOUS RECYCLE
C TO FILL STAGE + AQUEOUS RECYCLE TO SATISFY PHASE RATIO
C OT - TOTAL ORGANIC FLOW WITHIN A STAGE =
C TOTAL ORGANIC FLOW LEAVING A STAGE + ORGANIC RECYCLE
C TO FILL STAGE + ORGANIC RECYCLE TO SATISFY PHASE RATIO
C XPD - AQUEOUS FEED CONTENT OF STAGE
C YFD - ORGANIC FEED CONTENT OF STAGE
C AFDRT - AQUEOUS STAGE FLOW RATE
C OPDRT - ORGANIC STAGE FLOW RATE
C X - SOLUTE CONCENTRATION IN AQUEOUS PHASE FOR A GIVEN STAGE
C Y - SOLUTE CONCENTRATION IN ORGANIC PHASE FOR A GIVEN STAGE
C AFDTEH - TEMPERATURE OF AQUEOUS FEED
C OPDTEH - TEMPERATURE OF ORGANIC FEED
C TPROP - TEMPERATURE OF SOLUTE IN A GIVEN STAGE
C ARY - TRIAL AQUEOUS PHASE COMPOSITION
C DTRY - DISTRIBUTION RATIOS
STA 80
STA 85
STA 90
STA 95
STA 100
STA 105
STA 110
STA 115
STA 120
STA 125
STA 130
STA 135
STA 140
STA 145
STA 150
STA 155
STA 160
STA 165
STA 170
STA 175
STA 180
STA 185
STA 190
C
DO 140 J=1,NTOST
JJ=J-1
JJJ=J+1
DO 50 I=1,NSOLU
IF (J.GT.1) GO TO 10
AIN(I)=AFDRT(J)*XPD(I,J)+(AR(J)+RCYCA(J))*X(I,J,1)
GO TO 20
10 CONTINUE
AIN(I)=AFDRT(J)*XPD(I,J)+(AR(J)+RCYCA(J))*X(I,J,1)+A(JJJ)*X(I,JJJ,1)
20 CONTINUE
IF (J.EQ.NTOST) GO TO 30
OIN(I)=OPDRT(J)*YFD(I,J)+(OR(J)+RCYCO(J))*Y(I,J,1)+O(JJJ)*Y(I,JJJ,1)
11) IF (NSTR.EQ.1.AND.J.EQ.ISTR-1) OIN(I)=OPDRT(J)*YFD(I,J)+(OR(J)+RCYCA(J))*Y(I,J,1)
1CO(J))*Y(I,J,1)
IF (NSTR.EQ.1.AND.J.EQ.JSTR) OIN(I)=OPDRT(J)*YFD(I,J)+(OR(J)+RCYCO(J))*Y(I,J,1)+O(JJJ)*Y(I,JJJ,1)
GO TO 40
30 CONTINUE
OIN(I)=OPDRT(J)*YFD(I,J)+(OR(J)+RCYCO(J))*Y(I,J,1)
40 CONTINUE
AIN(I)=AIN(I)/AT(J)
OIN(I)=OIN(I)/OT(J)
ARY(I)=X(I,J,1)
IF (ARY(2).LT.0) ARY(2)=(AIN(2)*RAIO(J)+OIN(2))/RAIO(J)
ARY(4)=AIN(4)
50 CONTINUE
IF (J.GT.1) GO TO 60
AHTIN=AFDRT(J)*AFDTEH(J)+(AR(J)+RCYCA(J))*TPROP(J,1)
GO TO 70
60 CONTINUE
AHTIN=AFDRT(J)*AFDTEH(J)+(AR(J)+RCYCA(J))*TPROP(J,1)+A(JJJ)*TPROP(J,JJJ,1)
1J,1)
70 CONTINUE
IF (J.EQ.NTOST) GO TO 80
OHTIN=SPH*(OPDRT(J)*OPDTEH(J)+(OR(J)+RCYCO(J))*TPROP(J,1)+O(JJJ)*TPROP(J,JJJ,1))
1PROF(JJJ,1)
IF (NSTR.EQ.1.AND.J.EQ.ISTR-1) OHTIN=SPH*(OPDRT(J)*OPDTEH(J)+(OR(J)+RCYCA(J))*TPROP(J,1))
1)+RCYCO(J))*TPROP(J,1)
IF (NSTR.EQ.1.AND.J.EQ.JSTR) OHTIN=SPH*(OPDRT(J)*OPDTEH(J)+(OR(J)+RCYCO(J))*TPROP(J,1))
STA 195
STA 200
STA 205
STA 210
STA 215
STA 220
STA 225
STA 230
STA 235
STA 240
STA 245
STA 250
STA 255
STA 260
STA 265
STA 270
STA 275
STA 280
STA 285
STA 290
STA 295
STA 300
STA 305
STA 310
STA 315
STA 320
STA 325
STA 330
STA 335
STA 340
STA 345
STA 350
STA 355
STA 360
STA 365
STA 370
STA 375
STA 380
STA 385
STA 390

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      1RCYCO(J)*TPROF(J,1)+O(ISTR)*TPROF(ISTR,1)+O(JJJ)*TPROF(JJJ,1) ) STA 395
      GO TO 90 STA 400
80 CONTINUE STA 405
      OHTIN=SPH*(OPDRT(J)*OPDTER(J)+(OR(J)+RCYCO(J))*TPROF(J,1)) STA 410
90 CONTINUE STA 415
      TPROF(J,2)=(AHTIN+OHTIN)/(AT(J)+SPH*OT(J)) STA 420
      TENPC=TPROF(J,2) STA 425
      CCD = 0.001 STA 430
      CCD=0.005 STA 435
C STA 440
C HCK IS THE ITERATION COUNTER STA 445
C HDEX IS THE FIT COUNTER STA 450
C STA 455
      HCK=0 STA 460
100 CONTINUE STA 465
      HDEX=0 STA 470
C STA 475
C UCOR CALCULATES DISTRIBUTION RATIOS (DTRY) FOR EACH TRIAL AQUEOUS PHASTA 480
C COMPOSITION (ARY) AT THE STAGE EQUILIBRIUM TEMPERATURE (TENPC) STA 485
C STA 490
      CALL UCOR (ARY,DTRY,TENPC,CTBP) STA 495
      DO 110 I=1,NSOLU STA 500
      TSIN=AIN(I)*RAIO(J)+OIN(I) STA 505
      IF (TSIN.LT.0.) DTRY(I)=0. STA 510
      DTRY(I)=0. STA 515
      X(I,J,2)=TSIN/(RAIO(J)+DTRY(I)) STA 520
      IF (ABS(X(I,J,2))-LT.1.E-6) GO TO 110 STA 525
      DI=(X(I,J,2)-ARY(I))/X(I,J,2) STA 530
      DIP=ABS(DI) STA 535
      ARY(I)=X(I,J,2) STA 540
      IF (DIP.LE.CCD) GO TO 110 STA 545
C STA 550
C HDEX COUNTS NUMBER OF SOLUTES THAT NOT CONVERGED STA 555
C STA 560
      HDEX=HDEX+1 STA 565
110 CONTINUE STA 570
      HCK=HCK+1 STA 575
C STA 580
C ALLOW ONLY 20 ITERATIONS STA 585
C STA 590
      IF (HCK.EQ.20) GO TO 120 STA 595
C STA 600
C IF ALL SOLUTES HAVE NOT CONVERGED, REPEAT CALL TO UCOR STA 605
C WITH NEW VALUES OF ARY STA 610
C STA 615
      IF (HDEX.GT.0) GO TO 100 STA 620
120 CONTINUE STA 625
      DO 130 I=1,NSOLU STA 630
      Y(I,J,2)=X(I,J,2)*DTRY(I) STA 635
130 CONTINUE STA 640
      CODUH(J)=HCK STA 645
140 CONTINUE STA 650
      RETURN STA 655
C STA 660
C STA 665
      END STA 670-

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      SUBROUTINE UCOR (ARY,DTRY,TENPC,CTBP) UCO 5
      REAL** COEF(12,3),KU(3),KH(3),KTH(3),ARY(4),DTRY(4),A(4),TBP(3) UCO 10
      REAL** B03 UCO 15
C UCOR RETURNS A VALUE OF THE DISTRIBUTION COEFFICIENT - UCO 20
C DTRY UCO 25
C U - TOTAL IONIC STRENGTH UCO 30
C TENPC - TEMPERATURE IN DEGREES CENTIGRADE UCO 35
C ARY - AQUEOUS PHASE COMPOSITION UCO 40
C T - MOLALITY OF TBP IN DRY, SOLUTE-FREE SOLVENT UCO 45
C KU,KTH,KH - MASS ACTION EQUILIBRIUM CONSTANTS. UCO 50
C THESE EQUILIBRIUM CONSTANTS MAY BE EXPRESSED AS UCO 55
C  $A+Bx+Cy+Dz$  UCO 60
C WHERE X,Y, AND Z ARE 1ST,2ND AND 3RD POWERS OF UCO 65
C IONIC STRENGTH UCO 70
C FOR KU(I) - A,B,C,D ARE COEF(1,I), COEF(2,I), COEF(3,I), UCO 75
C AND COEF(4,I) - U COEFFICIENTS OPTIMIZED UCO 80
C FOR I=1 U ACCURACY UCO 85
C I=2 TH ACCURACY UCO 90
C I=3 H ACCURACY UCO 95
C FOR KTH(I) - A,B,C,D ARE COEF(5,I), COEF(6,I), COEF(7,I), UCO 100
C AND COEF(8,I) - TH COEFFICIENTS OPTIMIZED UCO 105
C FOR I=1 U ACCURACY UCO 110
C I=2 TH ACCURACY UCO 115
C I=3 H ACCURACY UCO 120
C FOR KH(I) - A,B,C,D ARE COEF(9,I), COEF(10,I), COEF(11,I), UCO 125
C AND COEF(12,I) - H COEFFICIENTS OPTIMIZED UCO 130
C FOR I=1 U ACCURACY UCO 135
C I=2 TH ACCURACY UCO 140
C I=3 H ACCURACY UCO 145

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```

C
C
DATA COEF/5.16764,12.7385,-6.10939,0.825665,
1 0.895314,-0.258242,0.0628435,0.00145494,
2 0.480975,-0.222463,0.0320684,-0.000857849,
3 4.98513,13.7875,-7.02178,-.883583,
4 1.52821,-.527579,-.0324897,-.00416738,
5 .538601,-.207956,-.0304384,-.00118149,
6 2.55963,-7.66961,2.03295,1.58978,
7 1.31060,-0.475194,0.0370571,0.00577316,
8 0.398105,-0.158715,0.0312364,-0.00164366/
U=3.0*ARY(1)+10.0*ARY(2)+ARY(3)
NO3=2.0*ARY(1)+4.0*ARY(2)+ARY(3)
T=(CTBP*0.973*1000.0)/266.3
C
C CALCULATE MASS ACTION EQUILIBRIUM CONSTANTS
C
DO 50 I=1,3
KU(I)=COEF(1,I)+COEF(2,I)*U+COEF(3,I)*U**2+COEF(4,I)*U**3
KTH(I)=COEF(5,I)+COEF(6,I)*U+COEF(7,I)*U**2+COEF(8,I)*U**3
KH(I)=COEF(9,I)+COEF(10,I)*U+COEF(11,I)*U**2+COEF(12,I)*U**3
C
C SOLVE CUBIC EQUATION FOR TBP
C
A(1)=-T
A(2)=1.0+KH(I)*ARY(3)*NO3
A(3)=2.0*KU(I)*ARY(1)*NO3**2
A(4)=3.0*KTH(I)*ARY(2)*NO3**4
Y=ANIN1(-A(1),-A(1)/A(2))
IF (Y.LT.0.) Y=-A(1)
DO 20 J=1,20
JJ=J
D=A(4)
C=A(4)
DO 10 II=1,2
K=4-II
D=A(K)+Y*D
C=D+Y*C
10 CONTINUE
D=A(1)+Y*D
DELT=Y-D/C
IF (ABS(DELT).LT.1.E-5.AND.ABS(D).LT.1.E-5) GO TO 30
Y=Y-DELT
20 CONTINUE
30 CONTINUE
TBP(I)=Y
IF (Y.LT.0.) GO TO 40
GO TO 50
40 CONTINUE
PRINT 70, TBP(I),I,KU(I),KTH(I),KH(I),ARY,(COEF(J,I),J=1,12)
Y=0.
50 CONTINUE
DTRY(1)=KU(1)*NO3**2*TBP(1)**2
DTRY(2)=KTH(2)*NO3**4*TBP(2)**3
DTRY(3)=KH(3)*NO3*TBP(3)
DTRY(4)=0.
C
C TEMPERATURE ADJUSTMENT
C
IF (TEMPC.EQ.25.) GO TO 60
IF (TEMPC.LT.15.-OR.TEMPC.GT.70.) GO TO 60
XTEMP=1./{273.+TEMPC}-1./298.
DTRY(1)=DTRY(1)*EXP(2500.*XTEMP)
DTRY(2)=DTRY(2)*EXP(891.664+879.688*ARY(2)-1474.38*ARY(2)**2)*XTEMP
1NP)
DTRY(3)=DTRY(3)*EXP(-818.802*XTEMP)
60 CONTINUE
C
C
RETURN
C
70 FORMAT (////' VALUE OF TBP IS ',1PE11.3,' FOR COMPONENT ',I2,/,
1PSEUDO-EQUILIBRIUM CONSTANTS ',3E11.3,/, ' AQUEOUS PHASE COMPOSITION
2N ',4E11.3,/, ' PARAMETERS ',4E11.3,/,(' ',11X,4E11.3))
END

```

```

SUBROUTINE PLOTR (KOUNT,ICALPL,NTOST,SOLIN)
C
C THIS ROUTINE GENERATES CALCOMP PLOTS OF TWO KINDS:
C ICALPL = 1 CONCENTRATION VS TIME INTERVAL
C ICALPL = 2 PERCENT OF FEED VS TIME INTERVAL
C ICALPL = 3 PLOT BOTH
C
C KOUNT - TOTAL NUMBER OF TIME INTERVALS
C NTOST - TOTAL NUMBER OF STAGES
C SOLIN - TOTAL AMOUNT IN FEED

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```

UCO 150
UCO 155
UCO 160
UCO 165
UCO 170
UCO 175
UCO 180
UCO 185
UCO 190
UCO 195
UCO 200
UCO 205
UCO 210
UCO 215
UCO 220
UCO 225
UCO 230
UCO 235
UCO 240
UCO 245
UCO 250
UCO 255
UCO 260
UCO 265
UCO 270
UCO 275
UCO 280
UCO 285
UCO 290
UCO 295
UCO 300
UCO 305
UCO 310
UCO 315
UCO 320
UCO 325
UCO 330
UCO 335
UCO 340
UCO 345
UCO 350
UCO 355
UCO 360
UCO 365
UCO 370
UCO 375
UCO 380
UCO 385
UCO 390
UCO 395
UCO 400
UCO 405
UCO 410
UCO 415
UCO 420
UCO 425
UCO 430
UCO 435
UCO 440
UCO 445
UCO 450
UCO 455
UCO 460
UCO 465
UCO 470
UCO 475
UCO 480
UCO 485
UCO 490
UCO 495
UCO 500
UCO 505
UCO 510
UCO 515
UCO 520-

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PLO 5
PLO 10
PLO 15
PLO 20
PLO 25
PLO 30
PLO 35
PLO 40
PLO 45
PLO 50

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C A - AQUEOUS CONCENTRATIONS PLO 55
C O - ORGANIC CONCENTRATIONS PLO 60
C AOUT - AQUEOUS FLOW OUT OF STAGE PLO 65
C OOUT - ORGANIC FLOW OUT OF STAGE PLO 70
C PLO 75
C DIMENSION A(8,100), O(8,100), AOUT(100), OOUT(100), X(1500), Y(150) PLO 80
C 10,3), SOLIN(100), ICON(3), BUFFER(4000) PLO 85
C REAL*8 YLAB(8) /'CONCENTR', 'ATION ( ' , 'U, TH IN ' , 'G/L; HNO', '3 IN HPL' PLO 90
C 1 ) , 'S', 'PERCENT ' , 'OF FEEDS' / PLO 95
C REAL*8 XLAB(2) /'TIME INT', 'ERVALS' / PLO 100
C REAL*4 CON(3) /'U', 'TH', 'H', 'LL(2) /'LIN', 'LOG ' / PLO 105
C LOGICAL*1 AQU /'A' /, ORG /'O' /, WAO PLO 110
C LOGICAL*1 DESCR(30) PLO 115
C LOGICAL*1 DESC1(30) /'U', 'R', 'A', 'N', 'I', 'U', 'H', 'S', 'T', 'H', 'O', 'P' PLO 120
C 1', 'I', 'U', 'H', 'S', 'N', 'I', 'T', 'R', 'I', 'C', 'A', 'C', 'I', 'D', 'S' / PLO 125
C PLO 130
C IF ICALPL = 3, PLOT BOTH CONCENTRATION VS TIME AND PLO 135
C PERCENT OF FEED VS TIME PLO 140
C PLO 145
C IC=0 PLO 150
C IF (ICALPL.EQ.3) IC=3 PLO 155
C IF (ICALPL.EQ.3) ICALPL=1 PLO 160
C PLO 165
C CALL QQNEWS (0) PLO 170
C WRITE (9,190) PLO 175
C WRITE (9,200) PLO 180
C IPL=0 PLO 185
C PLO 190
C READ SET OF PLOT SWITCHES PLO 195
C NSTR - STREAM NUMBER TO BE PLOTTED PLO 200
C NCON - NUMBER OF COMPONENTS TO BE PLOTTED PLO 205
C WAO - A PLOT AQUEOUS STREAM PLO 210
C 0 PLOT ORGANIC STREAM PLO 215
C NLL - 0 LINEAR X-AXIS, LINEAR Y-AXIS PLO 220
C 1 LINEAR X-AXIS, LOG Y-AXIS PLO 225
C NALT - 0 PLOT EVERY POINT PLO 230
C 1 PLOT EVERY OTHER POINT PLO 235
C NLAST - 0 LAST PLOT PLO 240
C 1 OTHER PLOTS FOLLOW PLO 245
C PLO 250
C PLO 255
C READ INDICES OF COMPONENTS TO BE PLOTTED PLO 260
C 1 - URANIUM PLO 265
C 2 - THORIUM PLO 270
C 3 - NITRIC ACID PLO 275
C PLO 280
C 10 CONTINUE PLO 285
C READ (5,210) NSTR,NCON,WAO,NLL,NALT,NLAST PLO 290
C READ (5,220) (ICON(I), I=1,NCON) PLO 295
C 20 CONTINUE PLO 300
C IPL=IPL+1 PLO 305
C PLO 310
C SET UP POINTS TO BE PLOTTED PLO 315
C PLO 320
C YHAX=0. PLO 325
C YHIN=1.E10 PLO 330
C REWIND 11 PLO 335
C I=0 PLO 340
C DO 50 IK=1,KOUNT PLO 345
C PLO 350
C READ CONCENTRATIONS (A AND O) AND FLOWS (AOUT AND OOUT) PLO 355
C PLO 360
C DO 30 J=1,NTOST PLO 365
C READ (1) ITH, (A(K,J), K=1,4), (O(K,J), K=1,4), AOUT(J), OOUT(J) PLO 370
C 30 CONTINUE PLO 375
C IF (NALT.EQ.1.AND.IK/2*2.EQ.IK) GO TO 50 PLO 380
C I=I+1 PLO 385
C DO 40 K=1,NCON PLO 390
C IF (ICALPL.EQ.1.AND.WAO.EQ.AQU) Y(I,K)=A(ICON(K),NSTR) PLO 395
C IF (ICALPL.EQ.1.AND.WAO.EQ.ORG) Y(I,K)=O(ICON(K),NSTR) PLO 400
C IF (ICALPL.EQ.2.AND.WAO.EQ.AQU) Y(I,K)=A(ICON(K),NSTR)*AOUT(NSTR) / PLO 405
C 1SOLIN(ICON(K))*100. PLO 410
C IF (ICALPL.EQ.2.AND.WAO.EQ.ORG) Y(I,K)=O(ICON(K),NSTR)*OOUT(NSTR) / PLO 415
C 1SOLIN(ICON(K))*100. PLO 420
C YHAX=AMAX1(Y(I,K),YHAX) PLO 425
C IF (NLL.EQ.1.AND.Y(I,K).LE.0.) GO TO 40 PLO 430
C YHIN=AMIN1(Y(I,K),YHIN) PLO 435
C 40 CONTINUE PLO 440
C X(I)=I PLO 445
C 50 CONTINUE PLO 450
C PLO 455
C PLO 460
C YHAX=YHAX*YHAX*.05 PLO 465
C YHIN=0. PLO 470
C YHAX=KOUNT PLO 475
C CALL INTL ('HECH',BUFFER,4000,'S.B. WATSONS') PLO 480
C CALL QQCCPA (3,YHIN) PLO 485
C CALL QQCCPA (4,YHAX) PLO 490
C CALL QQCCPA (13,YHIN) PLO 495
C CALL QQCCPA (14,YHAX) PLO 500
C IF (KOUNT.LE.100) CALL SCALE (1,10,.0., 'LINE') PLO 505
C IF (KOUNT.GT.100) CALL SCALE (1,KOUNT/10.,0., 'LINE') PLO 510
C IF (NLL.EQ.0) CALL SCALE (-1,10.,0., 'LINE') PLO 515
C IF (NLL.EQ.1) CALL SCALE (-1,10.,0., 'LOG2') PLO 520
C CALL AXIS (1,15,15) PLO 525

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      IF (NLL.EQ.0) CALL AXIS (-1,-15,-.15) PLO 530
      IF (NLL.EQ.1) CALL AXIS (-1,-1,-.15) PLO 535
      CALL BOX (3) PLO 540
      IF (NLL.EQ.0) CALL BOX (0,1.5,-1.5) PLO 545
      IF (NLL.EQ.1) CALL BOX (0,-1.5,1.5) PLO 550
      IF (NLL.EQ.0) CALL GRID (.35,1.5,-1.5) PLO 555
      IF (NLL.EQ.0) CALL GRID (-.45,1.5,-1.5) PLO 560
      IF (NLL.EQ.1) CALL GRID (.35,-1.5,1.5) PLO 565
      IF (NLL.EQ.1) CALL GRID (-.45,-1.5,1.5) PLO 570
C     LABEL AXES PLO 575
C     PLO 580
C     PLO 585
      IF (ICALPL.EQ.1) CALL TITLE (0.4,'EXIT STREAM COMPOSITION VS TIME' PLO 590
      1',XLAB(1),YLAB(1)) PLO 595
      IF (ICALPL.EQ.2) CALL TITLE (0.4,'EXIT STREAM COMPOSITION VS TIME' PLO 600
      1',XLAB(1),YLAB(7)) PLO 605
C     PLOT GRAPHS PLO 610
C     PLO 615
C     DO 80 K=1,NCON PLO 620
      IS=ICON(K) PLO 625
      IB=1 PLO 630
      NPTS=KOUNT PLO 635
      IF (NLL.EQ.0) GO TO 70 PLO 640
      DO 60 J=1,KOUNT PLO 645
      IB=J PLO 650
      IF (Y(J,K)-GT.0.) GO TO 70 PLO 655
      NPTS=NPTS+1 PLO 660
      60 CONTINUE PLO 665
      70 CONTINUE PLO 670
      IF (IB.EQ.KOUNT) GO TO 80 PLO 675
      CALL LINEPLT (X(IB),Y(IB,K),NPTS,IS,-1) PLO 680
      80 CONTINUE PLO 685
C     SET UP LEGEND PLO 690
C     PLO 695
C     PLO 700
      IP=1 PLO 705
      DO 150 K=1,NCON PLO 710
      IF (ICON(K).EQ.1) GO TO 90 PLO 715
      IF (ICON(K).EQ.2) GO TO 110 PLO 720
      IF (ICON(K).EQ.3) GO TO 130 PLO 725
      GO TO 150 PLO 730
      90 CONTINUE PLO 735
      DO 100 I=1,8 PLO 740
      DESCR(IP)=DESC1(I) PLO 745
      IP=IP+1 PLO 750
      100 CONTINUE PLO 755
      GO TO 150 PLO 760
      110 CONTINUE PLO 765
      DO 120 I=9,16 PLO 770
      DESCR(IP)=DESC1(I) PLO 775
      IP=IP+1 PLO 780
      120 CONTINUE PLO 785
      GO TO 150 PLO 790
      130 CONTINUE PLO 795
      DO 140 I=17,28 PLO 800
      DESCR(IP)=DESC1(I) PLO 805
      IP=IP+1 PLO 810
      140 CONTINUE PLO 815
      150 CONTINUE PLO 820
      IF (NLL.EQ.0) CALL LEGEND ('COMPONENTS$',ICON,NCON,DESCR,2,1.5,-1. PLO 825
      15) PLO 830
      IF (NLL.EQ.1) CALL LEGEND ('COMPONENTS$',ICON,NCON,DESCR,2,-1.5,1. PLO 835
      15) PLO 840
C     WRITE (9,230) IPL,NSTR,NAO,LL(NLL+1),(CON(ICON(K)),K=1,NCON) PLO 845
C     PLO 850
      IF (IC.EQ.3.AND.ICALPL.EQ.1) GO TO 160 PLO 855
      IF (NLAST.EQ.0) GO TO 180 PLO 860
      IF (IC.EQ.3.AND.ICALPL.EQ.2) GO TO 170 PLO 865
      IF (NLAST.NE.0) GO TO 10 PLO 870
      160 CONTINUE PLO 875
      ICALPL=2 PLO 880
      GO TO 20 PLO 885
      170 CONTINUE PLO 890
      ICALPL=1 PLO 895
      GO TO 10 PLO 900
      180 CONTINUE PLO 905
      CALL ADVANS PLO 910
C     PLO 915
C     PLO 920
C     PLO 925
      RETURN PLO 930
C     PLO 935
C     PLO 940
      190 FORMAT (' ',///,' ',21X,'PLOT SUMMARY'/) PLO 945
      200 FORMAT (' ',,'PLOT',4X,'STAGE',4X,'AQUEOUS OR',4X,'LINEAR OR',4X,'CPLO PLO 950
      10PONENTS'/ ' ',1X,'NO.',5X,'NO.',6X,'ORGANIC?',7X,'LOG?',8X,'PLOTTPLO 955
      2ED'/) PLO 960
      210 FORMAT (2I2,1X,A1,3I2) PLO 965
      220 FORMAT (10I2) PLO 970
      230 FORMAT (' ',I2,7X,I2,10X,A1,12X,A4,6X,3A4) PLO 975
      END PLO 980-

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APPENDIX B

SAMPLE INPUT AND CORRESPONDING COMPUTER OUTPUT

SAMPLE INPUT TO SEPHIS-THOREX

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
2																																																																															
ACID THOREX FLOWSHEET FOR EXTRACTION OF URANIUM AND THORIUM																																																																															
FROM SOLUTIONS OF CONSOLIDATED EDISON FUEL (SEE REF. 7, FIG. 2)																																																																															
. 3 1 1 0 0 1 0 1 0 0 0																																																																															
1 1 . 8 0 . 0 . 0 . 4 0 . 1 0 .																																																																															
4 1 . 2 0 . 0 . 5 . 4 0 . 1 0 .																																																																															
7 1 1 . 2 0 . 0 2 6 5 . - . 1 5 3 5 . 1 0 .																																																																															
1 0 1 . 3 0 . 0 . 1 3 . 2 5 . 1 0 .																																																																															
1 1 0 7 . 0 . 0 . 0 . 2 5 . 0 0 .																																																																															
2																																																																															

CALCULATIONS FOR A SOLVENT EXTRACTION PROCESS HAVING 3 INTERACTING SOLUTES

ACID THOREX FLOWSHEET FOR EXTRACTION OF URANIUM AND THORIUM FROM SOLUTIONS OF CONSOLIDATED EDISON FUEL (SEE REF. 7, FIG. 2)

FEED STREAM DATA		STAGE NO.	URANIUM (G/L)	THORIUM (G/L)	HNO3 (N)	ALUMINUM NO3 (N)	FLOW RATE (VOL. UNITS)	TEMP DEG C
AQUEOUS	1	0.0	0.0	0.0	0.0	0.0	8.000E-01	40.0
AQUEOUS	4	0.0	0.0	5.0000E 00	0.0	0.0	2.000E-01	40.0
AQUEOUS	7	2.0000E 01	2.6500E 02	-1.5000E-01	0.0	0.0	1.000E 00	35.0
AQUEOUS	10	0.0	0.0	1.3000E 01	0.0	0.0	3.000E-01	25.0
30.0 - TBP	11	0.0	0.0	0.0	0.0	0.0	7.000E 00	25.0

INITIAL PROFILE		STAGE NO. (OUTFLOW)	URANIUM (G/L)	AQUEOUS PHASE THORIUM (G/L)	HNO3 (N)	URANIUM (G/L)	ORGANIC PHASE THORIUM (G/L)	HNO3 (N)	TEMP DEG C
	1	0.0	0.0	1.0000E 00	0.0	0.0	0.0	0.0	40.0
	2	0.0	0.0	1.0000E 00	0.0	0.0	0.0	0.0	40.0
	3	0.0	0.0	1.0000E 00	0.0	0.0	0.0	0.0	40.0
	4	0.0	0.0	1.0000E 00	0.0	0.0	0.0	0.0	40.0
	5	0.0	0.0	1.0000E 00	0.0	0.0	0.0	0.0	40.0
	6	0.0	0.0	1.0000E 00	0.0	0.0	0.0	0.0	40.0
	7	0.0	0.0	1.0000E 00	0.0	0.0	0.0	0.0	40.0
	8	0.0	0.0	1.0000E 00	0.0	0.0	0.0	0.0	40.0
	9	0.0	0.0	1.0000E 00	0.0	0.0	0.0	0.0	40.0
	10	0.0	0.0	1.0000E 00	0.0	0.0	0.0	0.0	40.0
	11	0.0	0.0	1.0000E 00	0.0	0.0	0.0	0.0	40.0

PHASE RATIOS EQUAL FLOW RATIOS

STAGE NO. A/O PHASE RATIO

1 - 3	1.143E-01
4 - 6	1.429E-01
7 - 9	2.857E-01
10 - 11	3.286E-01

STAGE FLOWS:

STAGE NO.

FLOW RATIO

FLOW OUT OF STAGE

RECYCLE 2 TO FILL STAGE

RECYCLE 1 FOR PHASE RATIO

TOTAL AQUEOUS FLOW

1

1.143E-01

8.000E-01

0.0

0.0

8.000E-01

2

1.143E-01

8.000E-01

0.0

0.0

8.000E-01

3

1.143E-01

8.000E-01

0.0

0.0

8.000E-01

4

1.429E-01

1.000E 00

0.0

0.0

1.000E 00

5

1.429E-01

1.000E 00

0.0

0.0

1.000E 00

6

1.429E-01

1.000E 00

0.0

0.0

1.000E 00

7

2.857E-01

2.000E 00

0.0

0.0

2.000E 00

8

2.857E-01

2.000E 00

0.0

0.0

2.000E 00

9

2.857E-01

2.000E 00

0.0

0.0

2.000E 00

10

3.286E-01

2.300E 00

0.0

0.0

2.300E 00

11

3.286E-01

2.300E 00

0.0

0.0

2.300E 00

OVERALL TOTAL STAGE

STAGE VOL.

FLOW OUT OF STAGE

RECYCLE 2 TO FILL STAGE

RECYCLE 1 FOR PHASE RATIO

TOTAL ORGANIC FLOW

1

7.800E 00

0.0

7.000E 00

0.0

0.0

7.000E 00

2

7.800E 00

0.0

7.000E 00

0.0

0.0

7.000E 00

3

7.800E 00

0.0

7.000E 00

0.0

0.0

7.000E 00

4

8.000E 00

0.0

7.000E 00

0.0

0.0

7.000E 00

5

8.000E 00

0.0

7.000E 00

0.0

0.0

7.000E 00

6

8.000E 00

0.0

7.000E 00

0.0

0.0

7.000E 00

7

9.000E 00

0.0

7.000E 00

0.0

0.0

7.000E 00

8

9.000E 00

0.0

7.000E 00

0.0

0.0

7.000E 00

9

9.000E 00

0.0

7.000E 00

0.0

0.0

7.000E 00

10

9.300E 00

0.0

7.000E 00

0.0

0.0

7.000E 00

11

9.300E 00

0.0

7.000E 00

0.0

0.0

7.000E 00

TRANSIENT BEHAVIOR RESULTS

SOLUTE CONCENTRATIONS IN EFFLUENT FROM EACH STAGE

TIME INTERVAL	STAGE NO.	AQUEOUS PHASE			FLOW OUT OF STAGE	ITERA- TIONS	TEMP DEG C
		URANIUM (G/L)	THORIUM (G/L)	HNO3 (M)			
1	1	0.0	0.0	0.0	8.000E-01		
	2	0.0	0.0	4.108E-01	8.000E-01		
	3	0.0	0.0	4.108E-01	8.000E-01		
	4	0.0	0.0	6.913E-01	1.000E 00		
	5	0.0	0.0	4.487E-01	1.000E 00		
	6	0.0	0.0	4.487E-01	1.000E 00		
	7	5.208E-01	5.976E 01	2.722E-01	2.000E 00		
	8	0.0	0.0	5.794E-01	2.000E 00		
	9	0.0	0.0	5.794E-01	2.000E 00		
	10	0.0	0.0	1.391E 00	2.300E 00		
	11	0.0	0.0	6.201E-01	2.300E 00		
	STAGE NO.	ORGANIC PHASE			FLOW OUT OF STAGE	ITERA- TIONS	TEMP DEG C
		URANIUM (G/L)	THORIUM (G/L)	HNO3 (M)			
		1	0.0	0.0	7.000E 00		
		2	0.0	0.0	6.734E-02		
		3	0.0	0.0	6.734E-02		
		4	0.0	0.0	1.584E-01		
		5	0.0	0.0	7.875E-02		
		6	0.0	0.0	7.875E-02		
		7	2.708E 00	4.365E-02	7.000E 00		
		8	0.0	0.0	1.202E-01		
		9	0.0	0.0	1.202E-01		
		10	0.0	0.0	3.858E-01		
		11	0.0	0.0	1.248E-01		

TIME INTERVAL	STAGE NO.	AQUEOUS PHASE			FLOW OUT OF STAGE	ITERA- TIONS	TEMP DEG C
		URANIUM (G/L)	THORIUM (G/L)	HNO3 (M)			
2	1	0.0	0.0	2.843E-01	8.000E-01		
	2	0.0	0.0	2.838E-01	8.000E-01		
	3	0.0	0.0	6.211E-01	8.000E-01		
	4	0.0	0.0	7.160E-01	1.000E 00		
	5	0.0	0.0	5.261E-01	1.000E 00		
	6	4.335E-01	4.368E 01	3.340E-01	1.000E 00		
	7	5.118E-01	5.766E 01	3.640E-01	2.000E 00		
	8	2.332E-02	2.914E 01	4.088E-01	2.000E 00		
	9	0.0	0.0	1.003E 00	2.000E 00		
	10	0.0	0.0	1.420E 00	2.300E 00		
	11	0.0	0.0	8.173E-01	2.300E 00		
	STAGE NO.	ORGANIC PHASE			FLOW OUT OF STAGE	ITERA- TIONS	TEMP DEG C
		URANIUM (G/L)	THORIUM (G/L)	HNO3 (M)			
		1	0.0	0.0	3.484E-02		
		2	0.0	0.0	3.490E-02		
		3	0.0	0.0	1.343E-01		
		4	0.0	0.0	1.663E-01		
		5	0.0	0.0	1.023E-01		
		6	2.646E 00	1.454E 01	6.003E-02		
		7	2.711E 00	2.138E 01	5.886E-02		
		8	1.421E-01	8.748E 00	8.117E-02		
		9	0.0	0.0	2.649E-01		
		10	0.0	0.0	3.811E-01		
		11	0.0	0.0	1.885E-01		

TIME INTERVAL	STAGE NO.	AQUEOUS PHASE			FLOW OUT OF STAGE	ITERA- TIONS	TEMP DEG C
		URANIUM (G/L)	THORIUM (G/L)	HNO3 (M)			
3	1	0.0	0.0	1.781E-01	8.000E-01		
	2	0.0	0.0	5.361E-01	8.000E-01		
	3	0.0	0.0	6.064E-01	8.000E-01		
	4	0.0	0.0	8.117E-01	1.000E 00		
	5	4.089E-01	3.044E 01	4.758E-01	1.000E 00		
	6	4.225E-01	4.237E 01	4.130E-01	1.000E 00		
	7	7.329E-01	8.386E 01	2.567E-01	2.000E 00		
	8	1.894E-02	2.202E 01	7.359E-01	2.000E 00		
	9	7.963E-04	9.954E 00	9.512E-01	2.000E 00		
	10	0.0	0.0	1.738E 00	2.300E 00		
	11	0.0	0.0	8.364E-01	2.300E 00		
	STAGE NO.	ORGANIC PHASE			FLOW OUT OF STAGE	ITERA- TIONS	TEMP DEG C
		URANIUM (G/L)	THORIUM (G/L)	HNO3 (M)			
		1	0.0	0.0	1.456E-02		
		2	0.0	0.0	1.056E-01		
		3	0.0	0.0	1.294E-01		
		4	0.0	0.0	2.002E-01		
		5	2.588E 00	1.019E 01	9.435E-02		
		6	2.651E 00	1.533E 01	7.503E-02		
		7	2.852E 00	2.889E 01	3.411E-02		
		8	1.408E-01	1.018E 01	1.586E-01		
		9	6.435E-03	5.483E 00	2.261E-01		
		10	0.0	0.0	4.611E-01		
		11	0.0	0.0	1.916E-01		

TIME INTERVAL	STAGE NO.	URANIUM (G/L)	AQUEOUS PHASE		FLOW OUT OF STAGE
			THORIUM (G/L)	HNO3 (M)	
1	0.0	0.0	0.0	3.880E-01	8.000E-01
2	0.0	0.0	0.0	4.955E-01	8.000E-01
3	0.0	0.0	0.0	7.448E-01	8.000E-01
4	3.531E-01	1.672E 01	8.301E-01	1.000E 00	1.000E 00
5	3.909E-01	2.963E 01	5.558E-01	1.000E 00	1.000E 00
6	5.997E-01	6.528E 01	3.467E-01	1.000E 00	1.000E 00
7	7.305E-01	8.190E 01	4.714E-01	2.000E 00	2.000E 00
8	2.903E-02	3.899E 01	6.329E-01	2.000E 00	2.000E 00
9	5.258E-04	5.783E 00	1.253E 00	2.000E 00	2.000E 00
10	1.432E-05	1.666E 00	1.761E 00	2.300E 00	2.300E 00
11	0.0	0.0	1.000E 00	2.300E 00	2.300E 00

STAGE NO.	URANIUM (G/L)	ORGANIC PHASE		FLOW OUT OF STAGE	ITERA- TIONS	TEMP DEG C
		THORIUM (G/L)	HNO3 (M)			
1	0.0	0.0	6.123E-02	7.000E 00	8.	40.0
2	0.0	0.0	9.312E-02	7.000E 00	5.	40.0
3	0.0	0.0	1.764E-01	7.000E 00	5.	40.0
4	2.538E 00	7.806E 00	1.879E-01	7.000E 00	6.	39.6
5	2.595E 00	1.110E 01	1.116E-01	7.000E 00	4.	39.4
6	2.825E 00	2.391E 01	5.255E-02	7.000E 00	4.	38.7
7	2.850E 00	3.069E 01	6.153E-02	7.000E 00	4.	38.2
8	2.075E-01	1.830E 01	1.186E-01	7.000E 00	5.	37.7
9	5.262E-03	4.639E 00	3.134E-01	7.000E 00	5.	36.7
10	2.288E-04	2.297E 00	4.418E-01	7.000E 00	4.	32.7
11	0.0	0.0	2.423E-01	7.000E 00	3.	29.7

TIME INTERVAL	STAGE NO.	URANIUM (G/L)	AQUEOUS PHASE		FLOW OUT OF STAGE
			THORIUM (G/L)	HNO3 (M)	
1	0.0	0.0	0.0	3.554E-01	8.000E-01
2	0.0	0.0	0.0	6.553E-01	8.000E-01
3	3.922E-01	1.581E 01	7.186E-01	8.000E-01	8.000E-01
4	3.337E-01	1.662E 01	9.184E-01	1.000E 00	1.000E 00
5	4.644E-01	4.704E 01	5.414E-01	1.000E 00	1.000E 00
6	6.150E-01	6.521E 01	4.831E-01	1.000E 00	1.000E 00
7	6.974E-01	1.005E 02	3.607E-01	2.000E 00	2.000E 00
8	2.642E-02	3.217E 01	9.355E-01	2.000E 00	2.000E 00
9	7.966E-04	1.257E 01	1.217E 00	2.000E 00	2.000E 00
10	8.084E-06	8.320E-01	2.003E 00	2.300E 00	2.300E 00
11	5.254E-07	6.203E-01	1.017E 00	2.300E 00	2.300E 00

STAGE NO.	URANIUM (G/L)	ORGANIC PHASE		FLOW OUT OF STAGE	ITERA- TIONS	TEMP DEG C
		THORIUM (G/L)	HNO3 (M)			
1	0.0	0.0	5.250E-02	7.000E 00	5.	40.0
2	0.0	0.0	1.458E-01	7.000E 00	6.	40.0
3	2.493E 00	5.999E 00	1.624E-01	7.000E 00	6.	39.7
4	2.547E 00	8.723E 00	2.084E-01	7.000E 00	5.	39.6
5	2.809E 00	1.958E 01	9.381E-02	7.000E 00	5.	39.0
6	2.818E 00	2.561E 01	7.190E-02	7.000E 00	5.	38.6
7	2.951E 00	3.676E 01	4.365E-02	7.000E 00	4.	37.3
8	2.064E-01	1.885E 01	1.808E-01	7.000E 00	5.	37.4
9	8.289E-03	9.847E 00	2.750E-01	7.000E 00	4.	34.9
10	1.476E-04	1.379E 00	4.993E-01	7.000E 00	4.	32.4
11	4.531E-06	3.436E-01	2.446E-01	7.000E 00	3.	28.7

TIME INTERVAL	STAGE NO.	URANIUM (G/L)	AQUEOUS PHASE		FLOW OUT OF STAGE
			THORIUM (G/L)	HNO3 (M)	
1	0.0	0.0	0.0	4.872E-01	8.000E-01
2	4.572E-01	1.501E 01	6.054E-01	8.000E-01	8.000E-01
3	3.577E-01	1.538E 01	8.243E-01	8.000E-01	8.000E-01
4	3.812E-01	3.060E 01	9.466E-01	1.000E 00	1.000E 00
5	4.719E-01	4.748E 01	6.482E-01	1.000E 00	1.000E 00
6	7.422E-01	8.453E 01	4.464E-01	1.000E 00	1.000E 00
7	6.804E-01	9.811E 01	5.631E-01	2.000E 00	2.000E 00
8	3.146E-02	4.765E 01	8.240E-01	2.000E 00	2.000E 00
9	6.336E-04	8.297E 00	1.476E 00	2.000E 00	2.000E 00
10	1.260E-05	2.014E 00	2.025E 00	2.300E 00	2.300E 00
11	2.523E-07	2.640E-01	1.143E 00	2.300E 00	2.300E 00

STAGE NO.	URANIUM (G/L)	ORGANIC PHASE		FLOW OUT OF STAGE	ITERA- TIONS	TEMP DEG C
		THORIUM (G/L)	HNO3 (M)			
1	0.0	0.0	9.016E-02	7.000E 00	7.	40.0
2	2.440E 00	4.283E 00	1.338E-01	7.000E 00	6.	39.8
3	2.506E 00	6.965E 00	1.890E-01	7.000E 00	6.	39.7
4	2.799E 00	1.701E 01	1.836E-01	7.000E 00	5.	39.2
5	2.798E 00	2.120E 01	1.105E-01	7.000E 00	5.	38.9
6	2.911E 00	3.140E 01	5.721E-02	7.000E 00	4.	37.8
7	2.957E 00	3.799E 01	6.749E-02	7.000E 00	4.	37.1
8	1.985E-01	2.495E 01	1.426E-01	7.000E 00	5.	36.0
9	7.516E-03	8.201E 00	3.449E-01	7.000E 00	5.	34.7
10	2.280E-04	3.272E 00	4.840E-01	7.000E 00	4.	31.1
11	2.573E-06	1.866E-01	2.825E-01	7.000E 00	4.	28.6

TIME INTERVAL	STAGE NO.	AQUEOUS PHASE			FLOW OUT OF STAGE	ITERA- TIONS	TEMP DEG C
		URANIUM (G/L)	THORIUM (G/L)	HNO3 (M)			
7	1	6.146E-01	1.544E 01	4.225E-01	8.000E-01		
	2	4.009E-01	1.456E 01	7.153E-01	8.000E-01		
	3	3.869E-01	3.041E 01	8.107E-01	8.000E-01		
	4	3.855E-01	3.147E 01	1.046E 00	1.000E 00		
	5	6.275E-01	6.280E 01	6.644E-01	1.000E 00		
	6	7.367E-01	8.401E 01	5.952E-01	1.000E 00		
	7	5.906E-01	1.112E 02	4.589E-01	2.000E 00		
	8	2.854E-02	4.054E 01	1.094E 00	2.000E 00		
	9	7.908E-04	1.400E 01	1.439E 00	2.000E 00		
	10	8.798E-06	1.172E 00	2.225E 00	2.300E 00		
	11	3.760E-07	6.216E-01	1.159E 00	2.300E 00		
	STAGE NO.	ORGANIC PHASE			FLOW OUT OF STAGE	ITERA- TIONS	TEMP DEG C
		URANIUM (G/L)	THORIUM (G/L)	HNO3 (M)			
	1	2.370E 00	2.519E 00	8.556E-02	7.000E 00	12.	39.8
	2	2.460E 00	5.301E 00	1.630E-01	7.000E 00	6.	39.8
	3	2.807E 00	1.525E 01	1.601E-01	7.000E 00	6.	39.3
	4	2.784E 00	1.846E 01	1.981E-01	7.000E 00	5.	39.1
	5	2.876E 00	2.680E 01	9.753E-02	7.000E 00	5.	38.2
	6	2.919E 00	3.277E 01	7.507E-02	7.000E 00	4.	37.6
	7	2.993E 00	4.312E 01	5.386E-02	7.000E 00	5.	36.2
	8	1.938E-01	2.465E 01	1.931E-01	7.000E 00	5.	35.8
	9	8.991E-03	1.289E 01	3.082E-01	7.000E 00	5.	33.3
	10	1.807E-04	2.172E 00	5.301E-01	7.000E 00	4.	30.9
	11	4.015E-06	4.575E-01	2.844E-01	7.000E 00	3.	28.0

TIME INTERVAL	STAGE NO.	AQUEOUS PHASE			FLOW OUT OF STAGE	ITERA- TIONS	TEMP DEG C
		URANIUM (G/L)	THORIUM (G/L)	HNO3 (M)			
8	1	5.203E-01	1.588E 01	4.999E-01	8.000E-01		
	2	4.061E-01	3.094E 01	6.659E-01	8.000E-01		
	3	3.811E-01	3.073E 01	9.051E-01	8.000E-01		
	4	4.978E-01	4.378E 01	1.085E 00	1.000E 00		
	5	6.550E-01	6.371E 01	7.880E-01	1.000E 00		
	6	6.805E-01	9.794E 01	5.672E-01	1.000E 00		
	7	5.804E-01	1.082E 02	6.380E-01	2.000E 00		
	8	3.079E-02	5.450E 01	9.775E-01	2.000E 00		
	9	6.443E-04	9.916E 00	1.666E 00	2.000E 00		
	10	1.138E-05	2.092E 00	2.241E 00	2.300E 00		
	11	2.339E-07	3.207E-01	1.266E 00	2.300E 00		
	STAGE NO.	ORGANIC PHASE			FLOW OUT OF STAGE	ITERA- TIONS	TEMP DEG C
		URANIUM (G/L)	THORIUM (G/L)	HNO3 (M)			
	1	2.401E 00	3.486E 00	1.058E-01	7.000E 00	8.	39.8
	2	2.831E 00	1.348E 01	1.323E-01	7.000E 00	5.	39.5
	3	2.786E 00	1.662E 01	1.764E-01	7.000E 00	4.	39.3
	4	2.849E 00	2.403E 01	1.781E-01	7.000E 00	5.	38.6
	5	2.881E 00	2.816E 01	1.120E-01	7.000E 00	4.	38.1
	6	2.985E 00	3.810E 01	6.774E-02	7.000E 00	5.	36.8
	7	2.990E 00	4.360E 01	7.440E-02	7.000E 00	4.	36.0
	8	1.690E-01	2.908E 01	1.600E-01	7.000E 00	5.	34.6
	9	8.151E-03	1.092E 01	3.667E-01	7.000E 00	4.	33.1
	10	2.262E-04	3.770E 00	5.167E-01	7.000E 00	3.	30.1
	11	2.814E-06	2.796E-01	3.151E-01	7.000E 00	4.	27.9

TIME INTERVAL	STAGE NO.	AQUEOUS PHASE			FLOW OUT OF STAGE	ITERA- TIONS	TEMP DEG C
		URANIUM (G/L)	THORIUM (G/L)	HNO3 (M)			
9	1	4.544E-01	3.155E 01	4.265E-01	8.000E-01		
	2	3.930E-01	3.122E 01	7.500E-01	8.000E-01		
	3	4.765E-01	4.406E 01	8.961E-01	8.000E-01		
	4	5.287E-01	4.524E 01	1.190E 00	1.000E 00		
	5	7.304E-01	7.872E 01	8.300E-01	1.000E 00		
	6	6.645E-01	9.634E 01	7.155E-01	1.000E 00		
	7	5.100E-01	1.176E 02	5.474E-01	2.000E 00		
	8	2.816E-02	4.722E 01	1.215E 00	2.000E 00		
	9	7.563E-04	1.500E 01	1.625E 00	2.000E 00		
	10	8.291E-06	1.338E 00	2.414E 00	2.300E 00		
	11	2.942E-07	5.630E-01	1.278E 00	2.300E 00		
	STAGE NO.	ORGANIC PHASE			FLOW OUT OF STAGE	ITERA- TIONS	TEMP DEG C
		URANIUM (G/L)	THORIUM (G/L)	HNO3 (M)			
	1	2.779E 00	9.875E 00	8.355E-02	7.000E 00	5.	39.6
	2	2.800E 00	1.486E 01	1.478E-01	7.000E 00	5.	39.4
	3	2.841E 00	2.253E 01	1.517E-01	7.000E 00	5.	38.8
	4	2.849E 00	2.521E 01	1.883E-01	7.000E 00	3.	38.5
	5	2.952E 00	3.311E 01	1.042E-01	7.000E 00	4.	37.3
	6	2.989E 00	3.894E 01	8.476E-02	7.000E 00	5.	36.6
	7	2.978E 00	4.732E 01	6.325E-02	7.000E 00	4.	35.2
	8	1.659E-01	2.834E 01	2.018E-01	7.000E 00	5.	34.5
	9	8.806E-03	1.505E 01	3.318E-01	7.000E 00	4.	32.1
	10	1.842E-04	2.673E 00	5.553E-01	7.000E 00	4.	29.9
	11	3.642E-06	5.025E-01	3.162E-01	7.000E 00	3.	27.5

TIME INTERVAL	STAGE NO.	AQUEOUS PHASE			FLOW OUT OF STAGE
		URANIUM (G/L)	THORIUM (G/L)	HNO3 (M)	
1	1	4.313E-01	3.234E 01	4.766E-01	8.000E-01
2	2	4.691E-01	4.541E 01	6.991E-01	8.000E-01
3	3	4.950E-01	4.500E 01	9.804E-01	8.000E-01
4	4	6.701E-01	5.871E 01	1.251E 00	1.000E 00
5	5	7.215E-01	7.875E 01	9.562E-01	1.000E 00
6	6	5.826E-01	1.062E 02	7.017E-01	1.000E 00
7	7	5.073E-01	1.144E 02	7.055E-01	2.000E 00
8	8	2.876E-02	5.928E 01	1.102E 00	2.000E 00
9	9	6.287E-04	1.116E 01	1.822E 00	2.000E 00
10	10	1.021E-05	2.115E 00	2.420E 00	2.300E 00
11	11	1.957E-07	3.270E-01	1.373E 00	2.300E 00

STAGE NO.	URANIUM (G/L)	ORGANIC PHASE			FLOW OUT OF STAGE	ITERA- TIONS	TEMP DEG C
		THORIUM (G/L)	HNO3 (M)				
1	2.751E 00	1.117E 01	9.334E-02		7.000E 00	4.	39.6
2	2.840E 00	2.094E 01	1.206E-01		7.000E 00	5.	39.0
3	2.837E 00	2.364E 01	1.620E-01		7.000E 00	4.	38.7
4	2.911E 00	2.976E 01	1.707E-01		7.000E 00	5.	37.8
5	2.961E 00	3.415E 01	1.181E-01		7.000E 00	4.	37.2
6	2.999E 00	4.340E 01	8.158E-02		7.000E 00	5.	35.8
7	2.973E 00	4.728E 01	8.104E-02		7.000E 00	4.	35.1
8	1.463E-01	3.173E 01	1.735E-01		7.000E 00	5.	33.5
9	8.051E-03	1.298E 01	3.819E-01		7.000E 00	5.	32.0
10	2.164E-04	4.093E 00	5.424E-01		7.000E 00	3.	29.3
11	2.660E-06	3.320E-01	3.420E-01		7.000E 00	3.	27.4

TIME INTERVAL	STAGE NO.	AQUEOUS PHASE			FLOW OUT OF STAGE
		URANIUM (G/L)	THORIUM (G/L)	HNO3 (M)	
1	1	4.496E-01	4.380E 01	4.100E-01	8.000E-01
2	2	4.806E-01	4.631E 01	7.631E-01	8.000E-01
3	3	6.415E-01	5.917E 01	9.725E-01	8.000E-01
4	4	6.866E-01	6.020E 01	1.357E 00	1.000E 00
5	5	6.565E-01	8.959E 01	9.987E-01	1.000E 00
6	6	5.722E-01	1.039E 02	8.421E-01	1.000E 00
7	7	4.582E-01	1.216E 02	6.313E-01	2.000E 00
8	8	2.687E-02	5.212E 01	1.310E 00	2.000E 00
9	9	7.063E-04	1.564E 01	1.775E 00	2.000E 00
10	10	7.691E-06	1.449E 00	2.570E 00	2.300E 00
11	11	2.375E-07	5.138E-01	1.379E 00	2.300E 00

STAGE NO.	URANIUM (G/L)	ORGANIC PHASE			FLOW OUT OF STAGE	ITERA- TIONS	TEMP DEG C
		THORIUM (G/L)	HNO3 (M)				
1	2.788E 00	1.594E 01	7.372E-02		7.000E 00	4.	39.2
2	2.831E 00	2.204E 01	1.293E-01		7.000E 00	4.	38.9
3	2.891E 00	2.819E 01	1.395E-01		7.000E 00	5.	38.1
4	2.920E 00	3.070E 01	1.791E-01		7.000E 00	3.	37.7
5	3.001E 00	3.893E 01	1.176E-01		7.000E 00	4.	36.4
6	2.994E 00	4.369E 01	9.734E-02		7.000E 00	5.	35.7
7	2.956E 00	5.001E 01	7.195E-02		7.000E 00	4.	34.4
8	1.453E-01	3.076E 01	2.090E-01		7.000E 00	5.	33.4
9	8.232E-03	1.656E 01	3.501E-01		7.000E 00	4.	31.2
10	1.797E-04	3.046E 00	5.754E-01		7.000E 00	4.	29.2
11	3.277E-06	5.263E-01	3.418E-01		7.000E 00	2.	27.1

TIME INTERVAL	STAGE NO.	AQUEOUS PHASE			FLOW OUT OF STAGE
		URANIUM (G/L)	THORIUM (G/L)	HNO3 (M)	
1	1	4.494E-01	4.471E 01	4.419E-01	8.000E-01
2	2	6.098E-01	6.014E 01	7.064E-01	8.000E-01
3	3	6.647E-01	6.053E 01	1.050E 00	8.000E-01
4	4	6.879E-01	7.312E 01	1.411E 00	1.000E 00
5	5	6.402E-01	8.912E 01	1.121E 00	1.000E 00
6	6	5.087E-01	1.112E 02	8.346E-01	1.000E 00
7	7	4.596E-01	1.182E 02	7.714E-01	2.000E 00
8	8	2.647E-02	6.218E 01	1.209E 00	2.000E 00
9	9	6.040E-04	1.207E 01	1.948E 00	2.000E 00
10	10	9.130E-06	2.116E 00	2.566E 00	2.300E 00
11	11	1.660E-07	3.252E-01	1.463E 00	2.300E 00

STAGE NO.	URANIUM (G/L)	ORGANIC PHASE			FLOW OUT OF STAGE	ITERA- TIONS	TEMP DEG C
		THORIUM (G/L)	HNO3 (M)				
1	2.780E 00	1.693E 01	7.876E-02		7.000E 00	4.	39.2
2	2.873E 00	2.632E 01	1.056E-01		7.000E 00	5.	38.4
3	2.899E 00	2.907E 01	1.463E-01		7.000E 00	3.	38.0
4	2.976E 00	3.525E 01	1.701E-01		7.000E 00	5.	37.0
5	3.001E 00	3.956E 01	1.311E-01		7.000E 00	5.	36.3
6	2.977E 00	4.698E 01	9.540E-02		7.000E 00	5.	35.0
7	2.953E 00	4.969E 01	8.751E-02		7.000E 00	4.	34.3
8	1.316E-01	3.354E 01	1.851E-01		7.000E 00	5.	32.7
9	7.683E-03	1.449E 01	3.933E-01		7.000E 00	5.	31.1
10	2.021E-04	4.300E 00	5.628E-01		7.000E 00	3.	28.7
11	2.472E-06	3.693E-01	3.638E-01		7.000E 00	3.	27.1

TIME INTERVAL	STAGE NO.	AQUEOUS PHASE			
		URANIUM (G/L)	THORIUM (G/L)	HNO3 (M)	FLOW OUT OF STAGE
13	1	5.045E-01	5.410E 01	3.774E-01	8.000E-01
	2	6.312E-01	6.146E 01	7.556E-01	8.000E-01
	3	7.240E-01	7.518E 01	1.051E 00	8.000E-01
	4	6.706E-01	7.356E 01	1.504E 00	1.000E 00
	5	5.630E-01	9.755E 01	1.153E 00	1.000E 00
	6	5.040E-01	1.086E 02	9.651E-01	1.000E 00
	7	4.239E-01	1.241E 02	7.103E-01	2.000E 00
	8	2.527E-02	5.537E 01	1.393E 00	2.000E 00
	9	6.533E-04	1.592E 01	1.900E 00	2.000E 00
	10	7.148E-06	1.526E 00	2.697E 00	2.300E 00
	11	1.958E-07	4.748E-01	1.464E 00	2.300E 00

STAGE NO.	URANIUM (G/L)	ORGANIC PHASE		FLOW OUT OF STAGE	ITERA- TIONS	TEMP DEG C
		THORIUM (G/L)	HNO3 (M)			
1	2.815E 00	2.014E 01	6.248E-02	7.000E 00	4.	38.8
2	2.878E 00	2.716E 01	1.105E-01	7.000E 00	3.	38.3
3	2.963E 00	3.353E 01	1.308E-01	7.000E 00	4.	37.4
4	2.981E 00	3.597E 01	1.792E-01	7.000E 00	3.	36.9
5	2.995E 00	4.349E 01	1.322E-01	7.000E 00	5.	35.6
6	2.972E 00	4.691E 01	1.098E-01	7.000E 00	5.	34.9
7	2.980E 00	5.181E 01	7.996E-02	7.000E 00	4.	33.7
8	1.318E-01	3.244E 01	2.159E-01	7.000E 00	5.	32.5
9	7.579E-03	1.752E 01	3.654E-01	7.000E 00	5.	30.5
10	1.727E-04	3.318E 00	5.911E-01	7.000E 00	3.	28.6
11	2.935E-06	5.394E-01	3.623E-01	7.000E 00	2.	26.8

TIME INTERVAL	STAGE NO.	AQUEOUS PHASE			
		URANIUM (G/L)	THORIUM (G/L)	HNO3 (M)	FLOW OUT OF STAGE
14	1	5.130E-01	5.509E 01	3.971E-01	8.000E-01
	2	7.310E-01	7.561E 01	7.106E-01	8.000E-01
	3	7.160E-01	7.596E 01	1.120E 00	8.000E-01
	4	6.005E-01	8.354E 01	1.530E 00	1.000E 00
	5	5.517E-01	9.608E 01	1.263E 00	1.000E 00
	6	4.571E-01	1.144E 02	9.579E-01	1.000E 00
	7	4.275E-01	1.207E 02	8.351E-01	2.000E 00
	8	2.438E-02	6.362E 01	1.304E 00	2.000E 00
	9	5.744E-04	1.265E 01	2.051E 00	2.000E 00
	10	8.172E-06	2.090E 00	2.686E 00	2.300E 00
	11	1.440E-07	3.207E-01	1.537E 00	2.300E 00

STAGE NO.	URANIUM (G/L)	ORGANIC PHASE		FLOW OUT OF STAGE	ITERA- TIONS	TEMP DEG C
		THORIUM (G/L)	HNO3 (M)			
1	2.819E 00	2.086E 01	6.510E-02	7.000E 00	4.	38.7
2	2.937E 00	3.107E 01	9.268E-02	7.000E 00	5.	37.7
3	2.971E 00	3.431E 01	1.375E-01	7.000E 00	3.	37.3
4	2.992E 00	4.015E 01	1.765E-01	7.000E 00	4.	36.3
5	2.989E 00	4.369E 01	1.441E-01	7.000E 00	5.	35.5
6	2.955E 00	4.940E 01	1.079E-01	7.000E 00	4.	34.3
7	2.939E 00	5.133E 01	9.370E-02	7.000E 00	4.	33.6
8	1.217E-01	3.481E 01	1.958E-01	7.000E 00	4.	32.0
9	7.227E-03	1.552E 01	4.031E-01	7.000E 00	5.	30.4
10	1.869E-04	4.400E 00	5.795E-01	7.000E 00	3.	28.3
11	2.301E-06	3.960E-01	3.811E-01	7.000E 00	3.	26.8

TIME INTERVAL	STAGE NO.	AQUEOUS PHASE			
		URANIUM (G/L)	THORIUM (G/L)	HNO3 (M)	FLOW OUT OF STAGE
15	1	5.937E-01	6.438E 01	3.478E-01	8.000E-01
	2	7.356E-01	7.685E 01	7.535E-01	8.000E-01
	3	6.555E-01	8.764E 01	1.112E 00	8.000E-01
	4	5.852E-01	8.313E 01	1.610E 00	1.000E 00
	5	4.925E-01	1.029E 02	1.278E 00	1.000E 00
	6	4.570E-01	1.117E 02	1.075E 00	1.000E 00
	7	3.998E-01	1.258E 02	7.837E-01	2.000E 00
	8	2.373E-02	5.733E 01	1.467E 00	2.000E 00
	9	6.028E-04	1.588E 01	2.005E 00	2.000E 00
	10	6.635E-06	1.570E 00	2.800E 00	2.300E 00
	11	1.644E-07	4.405E-01	1.534E 00	2.300E 00

STAGE NO.	URANIUM (G/L)	ORGANIC PHASE		FLOW OUT OF STAGE	ITERA- TIONS	TEMP DEG C
		THORIUM (G/L)	HNO3 (M)			
1	2.869E 00	2.371E 01	5.293E-02	7.000E 00	4.	38.3
2	2.946E 00	3.182E 01	9.672E-02	7.000E 00	3.	37.6
3	3.000E 00	3.877E 01	1.306E-01	7.000E 00	4.	36.6
4	2.988E 00	4.050E 01	1.850E-01	7.000E 00	3.	36.1
5	2.971E 00	4.664E 01	1.439E-01	7.000E 00	4.	34.8
6	2.952E 00	4.910E 01	1.206E-01	7.000E 00	5.	34.2
7	2.930E 00	5.307E 01	8.727E-02	7.000E 00	4.	33.2
8	1.226E-01	3.362E 01	2.226E-01	7.000E 00	4.	31.9
9	6.981E-03	1.804E 01	3.791E-01	7.000E 00	5.	29.9
10	1.642E-04	3.496E 00	6.040E-01	7.000E 00	3.	28.2
11	2.631E-06	5.419E-01	3.787E-01	7.000E 00	3.	26.6

AQUEOUS PHASE

TIME INTERVAL	STAGE NO.	URANIUM (G/L)	THORIUM (G/L)	HNO3 (M)	FLOW OUT OF STAGE
16	1	6.070E-01	6.546E 01	3.655E-01	8.000E-01
	2	7.136E-01	8.905E 01	7.245E-01	8.000E-01
	3	6.419E-01	8.764E 01	1.172E 00	8.000E-01
	4	5.248E-01	9.082E 01	1.618E 00	1.000E 00
	5	4.882E-01	1.010E 02	1.374E 00	1.000E 00
	6	4.219E-01	1.169E 02	1.063E 00	1.000E 00
	7	4.051E-01	1.223E 02	8.938E-01	2.000E 00
	8	2.268E-02	6.411E 01	1.391E 00	2.000E 00
	9	5.439E-04	1.294E 01	2.138E 00	2.000E 00
	10	7.335E-06	2.037E 00	2.786E 00	2.300E 00
	11	1.268E-07	3.138E-01	1.599E 00	2.300E 00

STAGE NO.	URANIUM (G/L)	ORGANIC THORIUM (G/L)	HNO3 (M)	FLOW OUT OF STAGE	ITERA- TIONS	TEMP DEG C
1	2.877E 00	2.434E 01	5.495E-02	7.000E 00	3.	38.2
2	2.987E 00	3.596E 01	8.759E-02	7.000E 00	4.	37.0
3	2.998E 00	3.927E 01	1.372E-01	7.000E 00	3.	36.5
4	2.971E 00	4.368E 01	1.827E-01	7.000E 00	4.	35.6
5	2.966E 00	4.654E 01	1.543E-01	7.000E 00	4.	34.7
6	2.940E 00	5.107E 01#	1.180E-01	7.000E 00	4.	33.7
7	2.929E 00	5.248E 01#	9.932E-02	7.000E 00	4.	33.1
8	1.147E-01	3.567E 01	2.057E-01	7.000E 00	4.	31.4
9	6.788E-03	1.618E 01	4.124E-01	7.000E 00	5.	29.9
10	1.724E-04	4.409E 00	5.935E-01	7.000E 00	3.	27.9
11	2.138E-06	4.127E-01	3.948E-01	7.000E 00	3.	26.6

TIME INTERVAL	STAGE NO.	URANIUM (G/L)	THORIUM (G/L)	HNO3 (M)	FLOW OUT OF STAGE
17	1	6.918E-01	7.518E 01	3.460E-01	8.000E-01
	2	7.039E-01	8.949E 01	7.626E-01	8.000E-01
	3	5.736E-01	9.625E 01	1.158E 00	8.000E-01
	4	5.164E-01	8.987E 01	1.687E 00	1.000E 00
	5	4.458E-01	1.068E 02	1.376E 00	1.000E 00
	6	4.242E-01	1.140E 02	1.165E 00	1.000E 00
	7	3.826E-01	1.269E 02	8.487E-01	2.000E 00
	8	2.235E-02	5.833E 01	1.534E 00	2.000E 00
	9	5.591E-04	1.561E 01	2.096E 00	2.000E 00
	10	6.158E-06	1.583E 00	2.885E 00	2.300E 00
	11	1.404E-07	4.093E-01	1.592E 00	2.300E 00

STAGE NO.	URANIUM (G/L)	ORGANIC THORIUM (G/L)	HNO3 (M)	FLOW OUT OF STAGE	ITERA- TIONS	TEMP DEG C
1	2.908E 00	2.736E 01	4.804E-02	7.000E 00	4.	37.8
2	2.987E 00	3.652E 01	9.178E-02	7.000E 00	3.	36.9
3	2.987E 00	4.286E 01	1.332E-01	7.000E 00	4.	35.9
4	2.966E 00	4.372E 01	1.902E-01	7.000E 00	3.	35.5
5	2.951E 00	4.878E 01#	1.525E-01	7.000E 00	4.	34.2
6	2.938E 00	5.063E 01#	1.291E-01	7.000E 00	4.	33.6
7	2.923E 00	5.396E 01#	9.363E-02	7.000E 00	4.	32.7
8	1.161E-01	3.446E 01	2.293E-01	7.000E 00	4.	31.3
9	6.493E-03	1.827E 01	3.919E-01	7.000E 00	5.	29.5
10	1.555E-04	3.591E 00	6.148E-01	7.000E 00	3.	27.9
11	2.364E-06	5.349E-01	3.921E-01	7.000E 00	3.	26.4

TIME INTERVAL	STAGE NO.	URANIUM (G/L)	THORIUM (G/L)	HNO3 (M)	FLOW OUT OF STAGE
18	1	6.982E-01	7.593E 01	3.645E-01	8.000E-01
	2	6.412E-01	9.842E 01	7.448E-01	8.000E-01
	3	5.657E-01	9.564E 01	1.210E 00	8.000E-01
	4	4.734E-01	9.600E 01	1.683E 00	1.000E 00
	5	4.451E-01	1.048E 02	1.460E 00	1.000E 00
	6	3.969E-01	1.187E 02	1.149E 00	1.000E 00
	7	3.887E-01	1.235E 02	9.456E-01	2.000E 00
	8	2.135E-02	6.401E 01	1.468E 00	2.000E 00
	9	5.140E-04	1.300E 01	2.212E 00	2.000E 00
	10	6.634E-06	1.966E 00	2.869E 00	2.300E 00
	11	1.129E-07	3.043E-01	1.650E 00	2.300E 00

STAGE NO.	URANIUM (G/L)	ORGANIC THORIUM (G/L)	HNO3 (M)	FLOW OUT OF STAGE	ITERA- TIONS	TEMP DEG C
1	2.907E 00	2.788E 01	5.012E-02	7.000E 00	3.	37.7
2	2.993E 00	4.020E 01	8.765E-02	7.000E 00	5.	36.4
3	2.982E 00	4.302E 01	1.390E-01	7.000E 00	3.	35.8
4	2.949E 00	4.607E 01#	1.873E-01	7.000E 00	4.	35.0
5	2.949E 00	4.850E 01#	1.616E-01	7.000E 00	4.	34.1
6	2.930E 00	5.226E 01#	1.260E-01	7.000E 00	4.	33.2
7	2.923E 00	5.332E 01#	1.042E-01	7.000E 00	4.	32.7
8	1.097E-01	3.624E 01	2.149E-01	7.000E 00	4.	31.0
9	6.395E-03	1.654E 01	4.212E-01	7.000E 00	5.	29.4
10	1.599E-04	4.350E 00	6.055E-01	7.000E 00	3.	27.6
11	1.986E-06	4.203E-01	4.059E-01	7.000E 00	3.	26.4

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TIME INTERVAL	STAGE NO.	URANIUM (G/L)	AQUEOUS PHASE		FLOW OUT OF STAGE		
			THORIUM (G/L)	HNO3 (M)			
113	1	6.311E-01	9.853E 01	4.250E-01	8.000E-01		
	2	4.570E-01	1.126E 02	8.847E-01	8.000E-01		
	3	4.049E-01	1.089E 02	1.392E 00	8.000E-01		
	4	3.725E-01	1.021E 02	1.979E 00	1.000E 00		
	5	3.517E-01	1.099E 02	1.817E 00	1.000E 00		
	6	3.491E-01	1.148E 02	1.590E 00	1.000E 00		
	7	3.569E-01	1.195E 02	1.264E 00	2.000E 00		
	8	1.755E-02	4.961E 01	1.981E 00	2.000E 00		
	9	3.506E-04	9.133E 00	2.622E 00	2.000E 00		
	10	3.231E-06	1.017E 00	3.308E 00	2.300E 00		
	11	4.905E-08	1.642E-01	1.908E 00	2.300E 00		
	STAGE NO.	URANIUM (G/L)	ORGANIC PHASE		FLOW OUT OF STAGE	ITERA- TIONS	TEMP DEG C
			THORIUM (G/L)	HNO3 (M)			
	1	2.857E 00	3.784E 01	5.121E-02	7.000E 00	1.	34.6
	2	2.929E 00	4.910E 01	9.980E-02	7.000E 00	1.	32.9
	3	2.909E 00	5.070E 01	1.523E-01	7.000E 00	1.	32.3
	4	2.903E 00	5.028E 01	2.104E-01	7.000E 00	1.	32.1
	5	2.910E 00	5.242E 01	1.911E-01	7.000E 00	1.	31.4
	6	2.907E 00	5.353E 01	1.680E-01	7.000E 00	1.	31.1
	7	2.907E 00	5.422E 01	1.356E-01	7.000E 00	1.	30.9
	8	1.020E-01	3.410E 01	2.911E-01	7.000E 00	1.	29.2
	9	5.014E-03	1.412E 01	4.961E-01	7.000E 00	1.	27.8
	10	1.002E-04	2.557E 00	6.793E-01	7.000E 00	1.	26.6
	11	1.046E-06	2.803E-01	4.599E-01	7.000E 00	1.	25.8

TIME INTERVAL	STAGE NO.	URANIUM (G/L)	AQUEOUS PHASE		FLOW OUT OF STAGE		
			THORIUM (G/L)	HNO3 (M)			
114	1	6.311E-01	9.853E 01	4.251E-01	8.000E-01		
	2	4.570E-01	1.125E 02	8.847E-01	8.000E-01		
	3	4.050E-01	1.089E 02	1.393E 00	8.000E-01		
	4	3.725E-01	1.021E 02	1.979E 00	1.000E 00		
	5	3.517E-01	1.099E 02	1.817E 00	1.000E 00		
	6	3.491E-01	1.148E 02	1.590E 00	1.000E 00		
	7	3.570E-01	1.195E 02	1.264E 00	2.000E 00		
	8	1.755E-02	4.959E 01	1.981E 00	2.000E 00		
	9	3.506E-04	9.129E 00	2.622E 00	2.000E 00		
	10	3.230E-06	1.016E 00	3.308E 00	2.300E 00		
	11	4.904E-08	1.642E-01	1.908E 00	2.300E 00		
	STAGE NO.	URANIUM (G/L)	ORGANIC PHASE		FLOW OUT OF STAGE	ITERA- TIONS	TEMP DEG C
			THORIUM (G/L)	HNO3 (M)			
	1	2.857E 00	3.784E 01	5.122E-02	7.000E 00	1.	34.6
	2	2.929E 00	4.910E 01	9.979E-02	7.000E 00	1.	32.9
	3	2.909E 00	5.070E 01	1.524E-01	7.000E 00	1.	32.3
	4	2.903E 00	5.028E 01	2.104E-01	7.000E 00	1.	32.1
	5	2.910E 00	5.242E 01	1.911E-01	7.000E 00	1.	31.4
	6	2.907E 00	5.352E 01	1.680E-01	7.000E 00	1.	31.1
	7	2.907E 00	5.422E 01	1.356E-01	7.000E 00	1.	30.9
	8	1.020E-01	3.410E 01	2.911E-01	7.000E 00	1.	29.2
	9	5.014E-03	1.412E 01	4.962E-01	7.000E 00	1.	27.8
	10	1.002E-04	2.556E 00	6.793E-01	7.000E 00	1.	26.6
	11	1.045E-06	2.802E-01	4.599E-01	7.000E 00	1.	25.8

# INDICATES THIRD PHASE WITHIN 10% TOLERANCE

99.90 PERCENT STEADY STATE BY OVERALL MATERIAL BALANCE
 90.0 PERCENT OF STEADY STATE AFTER TIME INTERVAL 23
 95.0 PERCENT OF STEADY STATE AFTER TIME INTERVAL 30
 99.0 PERCENT OF STEADY STATE AFTER TIME INTERVAL 50
 99.5 PERCENT OF STEADY STATE AFTER TIME INTERVAL 76

TOTAL G/L URANIUM IN: 2.0000E 01, OUT: 1.9999E 01
 TOTAL G/L THORIUM IN: 2.6500E 02, OUT: 2.6526E 02
 TOTAL MOLES HNO3 IN: 4.7500E 00, OUT: 4.7473E 00

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