A Generalized Computer Model for the KALC Process

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Reprocessing Development - Task 300

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ABSTRACT

A multicomponent multistage computer model for the KALC (Krypton Absorption in Liquid Carbon Dioxide) process is presented. Important features, input and output information, and reference material relating to the development and use of the model are discussed. A complete sample program listing is provided.

INTRODUCTION

The present computer model of the KALC process is a culmination of several previous works.^{1,2} Mullins and Glass presented a generic equilibrium stage model for the KALC process and discussed earlier less comprehensive models.³ Glass and Barker reduced the Mullins-Glass model to a specific case corresponding to an existing pilot plant used for KALC process demonstration-type experiments.⁴ Additionally, Glass and Barker provided a companion computer program to produce McCabe-Thiele plots for converged solutions.⁴ (The plotting program has been retained for the present work.)

Although extensive and exhaustive analyses of equilibrium data were integral to the formation of the Mullins-Glass model (and the

more recent Glass-Barker model), a review of data relative to specific model use compelled a revision of procedures (including the associated empirical relations) used to calculate equilibrium concentrations. The revised routines (original routines were presented by Glass, Barker, and Mullins⁵) are a major and substantive part of the present computer model. Other changes incorporated in the present model are essentially cosmetic except for slight reductions in time and core storage requirements.

From the standpoint of the user, the programmatic discussions presented by Barker and Glass for the so-called "pilot-plant" model⁴ remain essentially unchanged, and reference to earlier documents in this series is essential for a complete understanding of both the KALC process and the competent interpretation of computer results.

COMPUTER MODEL CONSIDERATIONS

The present program is basically the same as the earlier models in this series,^{3,4} and two notable features are employed: (1) a matrix algebra technique as described by Tierney and coworkers^{6,7} for stagewise material and energy balances, and (2) a modified Redlich-Kwong⁸ model for gas-liquid equilibria of the CO_2 (solvent)/Xe- O_2 -CO- N_2 -Kr(solute) system. A typical equipment configuration considered by the present model is illustrated in Fig. 1.

All input necessary for equilibrium calculations are included in the model, and only numbers relating to a specific equipment configuration together with numbers regarding the desired operation (such as pressures, temperatures, feed rates, etc.) are required. However, as

Fig. 1. Typical equipment arrangement for the KALC system.

familiarity with the model will indicate, only an authoritative knowledge of the programmatic performance will allow the ultimate utility of the model to be extracted.

The converged solution of a given computer "run" represents a steady-state process operation. Parametric studies or sensitivity analyses may be performed with sequential trials. The effect of the locations of the fractionator and stripper feed plate, as well as other parameters, are made "visual" through the option of the McCabe-Thiele plot program.⁴ Conclusions based on simplistic observations of selected output only, such as decontamination or concentration factors, should be avoided since many other variables are necessarily involved, and proper context must be observed. Program input and output is discussed fully in the following sections.

Equipment component sizes may be estimated in a straightforward manner by coupling the steady-state (i.e., converged) solutions with empirical performance factors such as HTU's, column flooding, etc. Performance comparisons for actual pilot plant tests enable specific plant characteristics to be incorporated into the generalized model; thus effects of parameter variations on the selected (specific) plant may be estimated, thereby reducing in-plant testing and the associated time and costs. Possibly the most important use of the present model will be in the evaluation of various equipment configurations which may differ substantially from the prototype or conceptual flowsheet. For example, it has been determined in model formulation runs that more effective utilization of individual stages in the stripper can be achieved by (1) elimination of the final condenser and (2) intermediate location

of the feed stream. Thus the area of operating considerations (such as costs) not explicitly a part of the present model can be inferred and, if desired, incorporated into the model once the specific objectives are delineated. As a final example of model utility, it is noted that during model evaluations it was observed that feed and recycle fractionator stream enthalpies are very important in total system performance. Moreover, and somewhat simplistically, the "heat" of the absorber feed components lighter than krypton must be overcome by the liquid CO_2 absorbent in order to recover the krypton. Thus energy is expended in coabsorbing the lighter gases, and subsequently more energy is expended in desorbing these same gases in the fractionator. The obvious first attempt to reduce such energy requirements, as suggested strictly by the study of model performance, is to route the process feed stream to the lower section of the fractionator. In essence, the feed enthalpy would be used to reduce the fractionator energy cost by circumventing some of the lighter gas absorption-desorption attendant in the krypton recovery.

PROGRAM INPUTS

User inputs to the computer model have been minimized as much as possible for the general system selected. Some variability of feed plate location and cooling loads is permitted in a straightforward manner as discussed below. (Complex changes in system configuration will require reference to earlier documents^{3,4} in this series and should be attempted only with complete understanding of the algebraic matrix technique employed. Just as the matrix technique is variable and

therefore powerful, it is consequently subtle in some areas and its use requires caution.) A typical set of computer required input data is presented in Appendix A as part of the program listing for the computer model. The discussion which follows associates individual input datum with program variables (all capital lettering).

Component specification. Six components are considered in the fluid phases. The components are identified as follows: (1) carbon dioxide, (2) xenon, (3) oxygen, (4) carbon monoxide, (5) nitrogen, and (6) krypton.

Stage numbers. The following number of stages must be specified: (N) - the total number of stages to be considered; (NA) - the number of stages in the absorber; (NFR) - the number of stages above the fractionator feed stage excluding the fractionator condenser; (NFS) - the number of stages below the fractionator feed stage excluding the fractionator reboiler; and (NSR) - the number of stages above the stripper feed stage excluding the final stripper condenser. In the present model, the stripper has two condensers: (1) the final condenser (the topmost stripper stage); and (2) the main condenser (the first stage below the final condenser). For the equipment configuration in the present example $NA = 8$, $NFR = 0$, and $NSR = 1$. Thus liquid from the bottom of the absorber is routed to the first stage below the fractionator condenser, and fractionator bottoms are routed to the first stage below the main stripper condenser. Stages are numbered sequentially in the following order: beginning at the top of the absorber (stage 1) through stage NA at the absorber bottom; continuing with $(NA + 1)$ for the top stage of the fractionator (i.e., the condenser) through NF at the fractionator

bottom (i.e., the reboiler); and finally, $(NF + 1)$ for the top of the stripper (the final stripper condenser) through the stripper reboiler stage (N) .

System temperatures. Reasonable estimates of the following system temperatures are required (in $^{\circ}\text{C}$):

- (a) feed gas, FGAST,
- (b) absorber scrub liquid, SLTC,
- (c) absorber top stage, TC(1),
- (d) absorber bottom stage, TC(NA),
- (e) fractionator condenser stage, TC(NA+1),
- (f) fractionator second stage, TC(NA+2),
- (g) fractionator reboiler stage, TC(NF),
- (h) final stripper condenser stage, TC(NF+1),
- (i) main stripper condenser stage, TC(NF+1),
- (j) stripper reboiler stage, TC(N).

The initial estimates given for temperatures (a), (b), (g), and (j) are important for the program calculation of the following items:

- (k) absorber feed enthalpy, QF(NA,1),
- (l) change in the fractionator recycle gas enthalpy, QCOMP,
- (m) fractionator reboiler vapor rate, VS(NF,NF),
- (n) stripper reboiler vapor rate, VS(N,N),
- (p) scrub liquid cooling load, Q(1,1).

Items (k), (l), and (p) are calculated and remain fixed throughout the program calculation; these heat quantities, rather than the temperatures per se, are treated by the program as constants in much the same manner as feed rate, stages per column, and other "plant" operation parameters

System pressures. Although the program could accept different pressures for each stage, only the top and bottom stage pressures for each of the three columns [P(1), P(NA), P(NA+1), P(NF), P(NF+1), and P(N)] are required [in atm (abs)]. The program linearly interpolates between the respective top and bottom stage pressures and apportions the results to the intermediate stages.

Process feed gas composition. The composition of the process feed gas (YPFED) must be supplied in the form of mole fractions of components 2 through 6 identified previously; the balance is assumed to be carbon dioxide. YPFED elements must be nonzero since various output items require the presence of all components.

Recycle gas composition. In order to properly evaluate the recycle gas heating, which is an important in-plant operational consideration, the recycle gas composition (YRECY) for components 2,...,6 must be specified as mole fractions. Zero values are permitted for any or all YRECY elements. The program assumes the balance to be carbon dioxide and performs an enthalpy balance to estimate the amount of heat required for the recycle gas to change from its fractionator exit condition to its given absorber inlet condition (see paragraph on "System Pressures").

Reboiler heats. Fractionator (QNFR) and stripper (QN) heating loads (in Btu/hr, positive for heat input) are required as inputs. These are converted in the program to computer variables Q(NF,1) and Q(N,1), respectively.

Condenser loads. Condenser loads are not required as inputs. The loads on the fractionator [Q(NA+1)] and final stripper condenser

$[Q(NF+1,1)]$ are effectively specified by fixing the respective off-gas rates (see following paragraph on "Flow rates"). The main condenser load $[Q(NF+2,1)]$ is specified by inputting a fraction $[XQN]$ of the stripper reboiler heat value to be used. Thus a fraction of 0.5 or 1.5 would indicate to the program that -50% or -150% of the stripper reboiler heating duty specified is to be assigned to the main condenser stage.

Flow rates. The flow rates of the following streams must be supplied as input to the program (in equivalent scfm, 70°F, 1 atm, real gas):

- (a) process feed gas, FDRAT,
- (b) absorber off-gas, ARATE,
- (c) fractionator recycle gas, FRATE,
- (d) stripper off-gas, SRATE,
- (e) scrub liquid, SOLRT.

The program treats flows (a), (c), (d), and (e) as constants throughout the remaining calculations.

Order for inputting data. Appendix A contains a listing of the process model computer program; a sample of the required input is given in the "data" portion of the appendix. Note that the data are input in free format, with the various items separated with a comma and/or a space. The input is identified as follows:

Card 1: 42 6 'RWG09NØV43'

Total number of stages = $N = 42$

Number of fluid components = $M = 6$

Run identification = $IDRUN = 'RWG09NØV43'$

Card 2: 8 0 16 1

Number of stages in absorber = NA = 8

Number of stages in fractionator above the feed stage excluding

condenser = NFR = 0

Number of stages in fractionator below the feed stage excluding

reboiler = NFS = 16

Number of stages above the stripper feed stage excluding the final

condenser = NSR = 1

Card 3: 18.89 -27.78 -21 -22 -38 -24 -19 -24 -23 -22.78

Temperature of absorber feed gas as it enters the absorber =

FGAST = 18.89°C

Temperature of recycled scrub liquid as it enters the absorber =

SLTC = -27.78°C

Temperature of the top absorber stage = TC(1) = -21°C

Temperature of the bottom absorber stage = TC(NA) = -22°C

Temperature of the fractionator condenser = TC(NA+1) = -38°C

Temperature of the second fractionator stage = TC(NA+2) = -24°C

Temperature of the fractionator reboiler = TC(NF) = -19°C

Temperature of the final stripper condenser = TC(NF+1) = -24°C

Temperature of the main stripper condenser = TC(NF+2) = -23°C

Temperature of the stripper reboiler = TC(N) = -22.78°C

Card 4: 22 22 20 20 18 18

Pressure at the top of the absorber column = P(1) = 22 atm (abs)

Pressure at the bottom of the absorber column = P(NA) = 22 atm (abs)

Pressure at the top of the fractionator column = $P(NA+1) = 20$ atm (abs)

Pressure at the bottom of the fractionator column = $P(NF) = 20$ atm (abs)

Pressure at the top of the stripper column = $P(NF+1) = 18$ atm (abs)

Pressure at the bottom of the stripper column = $P(N) = 19$ atm (abs)

Card 5: 1.0E-12 8.0E-2 1.0E-12 1.0E-7

Feed gas composition (YPFED, mole fractions):

$X_e = YPFED(2) = 1.0E-12$

$O_2 = YPFED(3) = 8.0E-2$

$CO = YPFED(4) = 1.0E-12$

$N_2 = YPFED(5) = 1.0E-12$

$KR = YPFED(6) = 1.0E-7$

Card 6: 0.0 0.265 0.0 0.0 0.0

Fractionator recycle gas composition (YRECY, mole fractions):

$X_e = YRECY(2) = 0.0$

$O_2 = YRECY(3) = 0.265$

$CO = YRECY(4) = 0.0$

$N_2 = YRECY(5) = 0.0$

$Kr = YRECY(6) = 0.0$

Card 7: 10300 16000 1.0

Heat input of fractionator reboiler = $QNFR = 10300$ Btu/hr

Heat input of stripper reboiler = $QN = 16000$ Btu/hr

Fraction of stripper reboiler heat value to be assumed by main

stripper condenser = $XQN = 1.0$

This means that the program is to assume a constant value of $(-1.0 \times$

16000 Btu/hr) as the main condenser duty

Card 8: 6.6 3.2 2.4 0.61 125

Process feed gas flow rate = FDRAT = 6.6 scfm[†]

Absorber off-gas flow rate = ARATE = 3.2 scfm[†]

Fractionator off-gas flow rate = FRATE = 2.4 scfm[†]

Stripper off-gas flow rate = SRATE = 0.061 scfm[†]

Scrub liquid flow rate = SOLRT = 125 scfm[†] (equivalent)

MODEL CALCULATIONS

Based on the data that are input to the program, certain initial calculations are performed to "fill up" the various program matrices for flow, temperatures, enthalpies, etc. For some of the input data reasonable estimates will suffice, whereas other input (to be discussed shortly) should be carefully chosen.

Flow-rate values that are input to the program, with the exception of the absorber off-gas flow rate, are treated as constants by the program. Thus the specification of the fractionator and final stripper condenser off-gas rates will result in condenser loads necessary to effect these rates.

Reboiler heat loads input are also assumed to be constants by the program. The effect of a scrub liquid cooler is accounted for by initial calculations using the scrub liquid temperature (at the point of entry into the absorber), the stripper reboiler temperature, and

[†]Conditions: 70°F, 1 atm, real gas.

the recycle liquid flow rate. Basically, the program calculates the necessary enthalpy change required to heat (or cool) the specified amount of recycle liquid CO_2 from the temperature of the stripper reboiler to the temperature of the liquid entering the absorber. Once this enthalpy change is determined (from the initial input data) it is considered to be a constant and represents a processing condition.

Similarly, the net enthalpy change required for the fractionator off-gas as it is recycled to the absorber column is calculated from the values that are input for the fractionator off-gas composition, flow rate, temperature, etc.

PROGRAM OUTPUTS

Once initial calculations have been performed, the program proceeds to the iterative calculations. If reasonable and consistent data have been used as input, the program will converge in approximately seven to nine iterations. Convergence is based on both material and energy balance criteria.

The printed output consists of the following items:

- (1) equilibrium constants and parameters used in the model calculations, including constants for the heat capacity equations, parameters used in the Henry's Constant correlations, Margules Constants, critical constants, and Redlich-Kwong parameters (Tables 1 and 2);
- (2) a summary of specified information, including the number of stages in the columns, stage numbers associated with condensers, feed stages, etc., system temperatures, pressures, flow rates, heating loads, and gas feed composition (Table 3);

Table 1. Physical constants used in model calculations.

CONSTANTS FOR THE IDEAL GAS (P=0) HEAT CAPACITY EQUATIONS

$$***** (CP = A + B \cdot T + C \cdot T^2) *****$$

COMPONENT	A	B	C
CO2	6.637E+00	1.395E-03	2.045E-05
XE	4.968E+00	0.000E+00	0.000E+00
O2	7.011E+00	-8.100E-04	2.800E-06
CO	6.962E+00	-9.500E-05	3.500E-07
N2	6.958E+00	-3.500E-05	1.500E-07
KR	4.968E+00	0.000E+00	0.000E+00

*** NOTE: CP <=> CAL/GMOL-DEG K, T <=> DEG K.

CONSTANTS ASSOCIATED WITH THE HENRYS CONSTANT EQUATIONS

$$***** (LN(H) = A + B \cdot LN(T) + C/T) *****$$

COMPONENT	A	B	C
XE	2.996147E+01	-3.670936E+00	-1.423981E+03
O2	1.082571E+02	-1.598780E+01	-3.478370E+03
CO	1.241770E+02	-1.824561E+01	-4.316305E+03
N2	7.820483E+01	-1.142092E+01	-2.194547E+03
KR	3.632376E+01	-4.782289E+00	-1.185152E+03

*** NOTE: H <=> ATM, T <=> DEGR.

CONSTANTS ASSOCIATED WITH THE ACTIVITY COEFFICIENT SUBROUTINE

ALPHA (I, J)	J=1	J=2	J=3	J=4	J=5	J=6
I=1	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I=2	0.000E+00	0.000E+00	4.963E+02	2.242E+02	9.088E+02	0.000E+00
I=3	0.000E+00	4.963E+02	9.926E+02	7.205E+02	1.405E+03	4.963E+02
I=4	0.000E+00	2.242E+02	7.205E+02	4.483E+02	1.133E+03	2.242E+02
I=5	0.000E+00	9.088E+02	1.405E+03	1.133E+03	1.818E+03	9.088E+02
I=6	0.000E+00	0.000E+00	4.963E+02	2.242E+02	9.088E+02	0.000E+00

*** NOTE: ALPHA <=> GMOL/CAL, CO2, XE, O2, CO, N2, KR <=> 1, 2, 3, 4, 5, 6 RESPECTIVELY.

Table 2. Physical constants used in model calculations.

CONSTANTS ASSOCIATED WITH THE REDLICH-KWONG EQUATION OF STATE FOR THE GAS PHASE

COMPONENT	TC	PC	VC	ZC	W	KIJ	AII	BII	OMGA	OMGB
CO2	304.20	72.8	0.0936	0.2730	0.225	0.000	6.673E+01	3.124E-02	0.4470	0.0911
XE	289.70	57.6	0.1201	0.2910	0.000	0.045	7.144E+01	3.578E-02	0.4278	0.0867
O2	154.60	49.8	0.0737	0.2893	0.021	0.033	1.719E+01	2.209E-02	0.4278	0.0867
CO	132.90	34.5	0.0909	0.2877	0.041	0.002	1.700E+01	2.741E-02	0.4278	0.0867
N2	126.20	33.5	0.0890	0.2878	0.040	0.013	1.538E+01	2.680E-02	0.4278	0.0867
KR	209.40	54.3	0.0921	0.2910	0.000	0.004	3.366E+01	2.744E-02	0.4278	0.0867

*** NOTE: TC <=> DEGR, PC <=> ATM, VC <=> LITER/GHOL, A <=> (LITER,ATM,GHOL,DEGR), B <=> LITER/GHOL.

MIXTURE COEFFICIENTS

A (I, J)	J=1	J=2	J=3	J=4	J=5	J=6
I=1	6.673E+01	6.453E+01	3.227E+01	3.358E+01	3.140E+01	4.708E+01
I=2	6.453E+01	7.144E+01	3.539E+01	3.496E+01	3.328E+01	4.918E+01
I=3	3.227E+01	3.539E+01	1.719E+01	1.713E+01	1.629E+01	2.410E+01
I=4	3.358E+01	3.496E+01	1.713E+01	1.700E+01	1.617E+01	2.392E+01
I=5	3.140E+01	3.328E+01	1.629E+01	1.617E+01	1.538E+01	2.276E+01
I=6	4.708E+01	4.918E+01	2.410E+01	2.392E+01	2.276E+01	3.366E+01

*** NOTE: A <=> (LITER,ATM,GHOL,DEGR), TC <=> DEGR, VC <=> LITER/GHOL,
B <=> LITER/GHOL, PC <=> ATM.

CONSTANTS ASSOCIATED WITH THE REDLICH-KWONG DERIVED PARTIAL MOLAR LIQUID VOLUMES

COMPONENT	TC	PC	VC	ZC	W	KIJ	AII	BII	OMGA	OMGB
CO2	304.20	72.8	93.607	0.2730	0.225	0.000	6.246E+07	2.722E+01	0.4184	0.0794
XE	289.70	57.6	120.098	0.2910	0.000	0.000	0.000E+00	3.578E+01	0.4278	0.0867
O2	154.60	49.8	73.701	0.2893	0.021	0.000	0.000E+00	2.209E+01	0.4278	0.0867
CO	132.90	34.5	90.948	0.2877	0.041	0.000	0.000E+00	2.741E+01	0.4278	0.0867
N2	126.20	33.5	88.966	0.2878	0.040	0.000	0.000E+00	2.680E+01	0.4278	0.0867
KR	209.40	54.3	92.005	0.2910	0.000	0.000	0.000E+00	2.744E+01	0.4278	0.0867

*** NOTE: TC <=> DEGR, PC <=> ATM, VC <=> CC/GHOL, A <=> (CC,ATM,GHOL,DEGR), B <=> CC/GHOL.

Table 3. Summary of user specified information.

RUN NUMBER RWG09 NOV43

A SUMMARY OF USER SPECIFIED INPUT INFORMATION

=====

STAGE ALLOCATIONS:

ABSORBER (ABS)	8
FRACTIONATOR (FRC)	19
STRIPPER (STR)	15

SPECIFIC STAGE NUMBERS:

FRC CONDENSER	9
... FEED PLATE	10
... REBOILER	27
STR FINAL CONDENSER	28
... REBOILER	42

SYSTEM PRESSURES (ATM):

ABSORBER	22.00
FRACTIONATOR	20.00
STRIPPER	18.00

SYSTEM TEMPERATURES (DEG C):

ABS FEED GAS	18.89
SOLVENT (ENTERING ABS)	-27.78
FRC REBOILER	-19.00
STR REBOILER	-22.78

GAS COMPOSITIONS (MOL PERCENT):

	PROCESS FEED	FRC RECYCLE
CO2	9.20E+01	7.4E+01
XE	1.00E-10	0.0E+00
O2	8.00E+00	2.6E+01
CO	1.00E-10	0.0E+00
N2	1.00E-10	0.0E+00
KR	1.00E-05	0.0E+00

FIXED FLOWRATES (SCFM):

PROCESS FEED	6.60E+00
FRC RECYCLE	2.40E+00
STR OFF-GAS	6.10E-02
SOLVENT RECYCLE	1.25E+02

HEATING LOADS (BTU/HR):

FRC REBOILER	1.03E+04
STR REBOILER	1.60E+04
STR MAIN CONDENSER	-1.60E+04
GAS COMPRESSOR	3.50E+02
SOLVENT COOLER	-3.65E+03

=====

- (3) component feed rates and initial heat loads (Table 4);
- (4) a series of tables of values for each iteration of temperature, pressure, flow rates, enthalpies for each stage as well as material and energy balance errors (Table 5 is given as an example for "iteration" which also in this example happens to be the first iteration meeting both material and energy balance convergence criteria), and Table 6 which illustrates the beginning of the final (i.e., converged) results.
- (5) flow rates (described in detail in the early reports)^{3,4} are organized into a matrix storage technique. These matrices include Total Vapor Flow Rates (Table 7), Total Liquid Flow Rates (Table 8), Fixed Vapor Flow Rates (Table 9), Fixed Liquid Flow Rates (Table 10), Variable Vapor Flow Rates (Table 11), Variable Liquid Flow Rates (Table 12), Vapor Distribution Factors (Table 13), and Liquid Distribution Factors (Table 14). Only the first page of each of these tables is reproduced here. Total steam flow is composed of a fixed portion and a variable portion:

$$\bar{T} = \bar{F} + (\bar{D})(\bar{V})$$

where:

$\bar{T}$ represents the total steam rates

$\bar{F}$ represents the fixed portions

$\bar{V}$ represents the variable portions

$\bar{D}$ represents the distribution factors.

Distribution factors allow a multiplicative matrix operation to "route" portions (or all) of a stream to any desired stage from

Table 4. Initial system feed streams and enthalpies.

STAGE NO.	COMPONENT FEED RATES (GMOL) PER 100 GMOLS TOTAL FEED						ENTHALPY	
	CO ₂	XE	O ₂	CO	N ₂	KR	LOADS	FEED
ABS...								
1	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	-197861	0
2	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
4	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
6	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
7	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
8	9.200E+01	1.000E-10	8.000E+00	1.000E-10	1.000E-10	1.000E-05	0	366886
PRC...								
9	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	-391109	0
10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
17	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
19	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
20	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
21	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
22	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
23	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
24	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
25	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
26	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
27	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	558728	0
STR...								
28	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	-130189	0
29	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	-867927	0
30	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
31	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
33	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
34	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
35	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
36	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
37	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
38	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
39	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
40	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
41	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
42	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	867927	0

*** NOTE: HEAT LOADS AND FEED ENTHALPIES ARE GIVEN AS CAL/100 GMOLS FEED.

Table 5. Iteration table at convergence.

ENERGY MATERIAL ITERATION
 BALANCE ERROR... 8.457E+01 BALANCE ERROR... 7.504E-05 NUMBER..... 9

STAGE NO.	TEMP DEGC	LIQUID RATE	VAPOUR RATE	LIQUID ENTHALPY	VAPOUR ENTHALPY	PRESS ATM
1	-21.10	1997.1	66.83	389.63	2921.7	22.00
2	-21.29	1994.9	169.98	385.48	2903.6	22.00
3	-21.48	1992.9	167.84	381.52	2886.3	22.00
4	-21.66	1990.9	165.80	377.64	2869.4	22.00
5	-21.84	1988.9	163.81	373.77	2852.6	22.00
6	-22.03	1986.9	161.82	369.84	2835.4	22.00
7	-22.23	1984.8	159.81	365.75	2817.5	22.00
8	-22.43	1963.5	157.71	361.37	2798.5	22.00
9	-39.17	114.3	36.36	17.17	1597.3	20.00
10	-24.05	2058.7	150.68	326.24	2919.3	20.00
11	-22.81	2072.4	131.58	352.14	3039.9	20.00
12	-21.66	2085.3	145.33	376.22	3152.8	20.00
13	-20.75	2095.5	158.16	395.40	3243.0	20.00
14	-20.11	2102.8	168.42	408.94	3306.9	20.00
15	-19.70	2107.5	175.68	417.74	3348.6	20.00
16	-19.44	2110.4	180.41	423.17	3374.3	20.00
17	-19.29	2112.2	183.33	426.41	3389.7	20.00
18	-19.20	2113.2	185.07	428.31	3398.7	20.00
19	-19.15	2113.8	186.11	429.42	3403.9	20.00
20	-19.12	2114.2	186.71	430.06	3407.0	20.00
21	-19.10	2114.3	187.04	430.42	3408.7	20.00
22	-19.09	2114.5	187.24	430.63	3409.6	20.00
23	-19.09	2114.5	187.36	430.74	3410.2	20.00
24	-19.08	2114.6	187.42	430.81	3410.5	20.00
25	-19.08	2114.6	187.45	430.85	3410.7	20.00
26	-19.08	2114.6	187.47	430.87	3410.8	20.00
27	-19.08	1927.1	187.49	430.89	3410.9	20.00
28	-22.51	45.2	0.92	357.07	3404.8	18.00
29	-22.47	329.7	46.14	357.78	3408.4	18.00
30	-22.47	2210.7	330.64	357.83	3408.6	18.00
31	-22.47	2210.7	284.50	357.82	3408.5	18.00
32	-22.47	2210.7	284.50	357.82	3408.5	18.00
33	-22.47	2210.7	284.50	357.83	3408.6	18.00
34	-22.47	2210.7	284.50	357.83	3408.6	18.00
35	-22.47	2210.7	284.50	357.82	3408.6	18.00
36	-22.47	2210.7	284.49	357.82	3408.6	18.00
37	-22.47	2210.7	284.50	357.83	3408.6	18.00
38	-22.47	2210.7	284.50	357.83	3408.6	18.00
39	-22.47	2210.7	284.50	357.82	3408.6	18.00
40	-22.47	2210.7	284.50	357.83	3408.6	18.00
41	-22.47	2210.7	284.50	357.83	3408.6	18.00
42	-22.47	1926.2	284.50	357.82	3408.6	18.00

*** NOTE: FLOWS <=> GMOL/100 GMOL FEED, ENTHALPIES <=> CAL/GMOL.

*** DA DA DA DAT'S ALL FOLKS ***

Table 6. Final system feed streams and enthalpies.

FINAL VALUES FOR CASE RWG09NOV4J...

STAGE NO.	COMPONENT FEED RATES (GMOL) PER 100 GHOLS TOTAL FEED						ENTHALPY	
	CO2	XE	O2	CO	N2	KR	LOADS	FEED
ABS...								
1	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	-197861	0
2	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
4	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
6	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
7	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
8	9.200E+01	1.000E-10	8.000E+00	1.000E-10	1.000E-10	1.000E-05	0	366886
FRC...								
9	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	-379834	0
10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
17	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
19	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
20	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
21	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
22	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
23	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
24	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
25	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
26	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
27	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	558728	0
STR...								
28	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	-137971	0
29	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	-867927	0
30	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
31	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
33	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
34	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
35	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
36	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
37	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
38	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
39	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
40	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
41	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0	0
42	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	867927	0

*** NOTE: HEAT LOADS AND FEED ENTHALPIES ARE GIVEN AS CAL/100 GHOLS FEED.

Table 7. Total vapor flow rates.

PINAL VALUES PCR CASE RWG09NOV43...

TOTAL VAPOR FLOW (GMOL/100 GMOL FEED) MATRIX										

ABSORBER										

STAGE NO. 1:	-66.83	169.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STAGE NO. 2:	0.00	-169.98	167.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STAGE NO. 3:	0.00	0.00	-167.84	165.80	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STAGE NO. 4:	0.00	0.00	0.00	-165.80	163.81	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STAGE NO. 5:	0.00	0.00	0.00	0.00	-163.81	161.82	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STAGE NO. 6:	0.00	0.00	0.00	0.00	0.00	-161.82	159.81	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STAGE NO. 7:	0.00	0.00	0.00	0.00	0.00	0.00	-159.81	157.71	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STAGE NO. 8:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-157.71	36.36	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 8. Total liquid flow rates.

TOTAL LIQUID FLOW (GHOL/100 GHOL FEED) MATRIX

ABSORBER										
STAGE NO. 1:	-1997.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	1893.94								
STAGE NO. 2:	1997.08	-1994.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00								
STAGE NO. 3:	0.00	1994.95	-1992.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00								
STAGE NO. 4:	0.00	0.00	1992.91	-1990.92	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00								
STAGE NO. 5:	0.00	0.00	0.00	1990.92	-1988.93	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00								
STAGE NO. 6:	0.00	0.00	0.00	0.00	1988.93	-1986.92	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00								
STAGE NO. 7:	0.00	0.00	0.00	0.00	0.00	1986.92	-1984.82	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00								
STAGE NO. 8:	0.00	0.00	0.00	0.00	0.00	0.00	1984.82	-1983.47	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00								

Table 9. "Fixed" vapor flow rates.

[illegible]

Table 10. "Fixed" liquid flow rates.

[illegible]

Table 11. "Variable" vapor flows.

VARIABLE VAPOR FLOW(GMOL/100 GMOL FEED) MATRIX										

ABSORBER										

STAGE NO. 1:	66.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STAGE NO. 2:	0.00	169.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STAGE NO. 3:	0.00	0.00	167.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STAGE NO. 4:	0.00	0.00	0.00	165.80	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STAGE NO. 5:	0.00	0.00	0.00	0.00	163.81	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STAGE NO. 6:	0.00	0.00	0.00	0.00	0.00	161.82	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STAGE NO. 7:	0.00	0.00	0.00	0.00	0.00	0.00	159.81	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STAGE NO. 8:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	157.71	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 12. "Variable" liquid flows.

[illegible]

Table 13. Vapor distribution matrix.

[illegible]

Table 14. Liquid distribution matrix.

[illegible]

a given stage. Generally, all streams are totally variable and are routed completely to successive stages (successively increasing stage numbers for liquid streams and successively decreasing numbers for vapor streams). At certain stages, even in the "typical" arrangement considered by the present example, both totally fixed flows and nonsuccessive routing is required. Each of the matrix tables indicates a stage number (by row) to which a stream value (by column; wherein columns continue in groups of ten as necessary to allow for every stage to contribute to each specified stage) is assigned. Total flow leaving a stage is given as a negative quantity.

- (6) a table of stagewise temperatures, flows, enthalpies, and pressures at convergence (Table 15).
- (7) a table of stagewise vapor phase mole fractions for each component at convergence (Table 16).
- (8) a table of stagewise liquid phase mole fractions for each component at convergence (Table 17).
- (9) a table of stagewise equilibrium ratios for each component at convergence (Table 18).
- (10) a table of stagewise absorption factors for each component, based on total flows at convergence (Table 19).
- (11) a table of interstage operating ratios for each component at convergence (Table 20).
- (12) a table of interstage absorption factors for each component, based on total flows at convergence (Table 21).

Table 15. Summary of converged temperatures, pressures, flow rates, and enthalpies for all stages.

FINAL VALUES FOR CASE RWG09NOV43...

STAGE	T, DEGC	L-RATES	V-RATES	H-LIQD	H-VAPOR	P, ATM
ABS...						
1	-21.10	1997.08	66.832	389.63	2921.74	22.00
2	-21.29	1994.95	169.976	385.48	2903.62	22.00
3	-21.40	1992.91	167.842	381.52	2886.30	22.00
4	-21.66	1990.92	165.804	377.64	2869.37	22.00
5	-21.84	1988.93	163.814	373.77	2852.56	22.00
6	-22.03	1986.92	161.821	369.84	2835.35	22.00
7	-22.23	1984.82	159.808	365.75	2817.54	22.00
8	-22.43	1963.47	157.713	361.37	2798.49	22.00
FRC...						
9	-39.17	114.32	36.364	17.17	1597.33	20.00
10	-24.05	2058.69	150.680	326.24	2919.29	20.00
11	-22.81	2072.43	131.584	352.14	3039.90	20.00
12	-21.66	2085.27	145.328	376.22	3152.77	20.00
13	-20.75	2095.52	158.161	395.40	3243.04	20.00
14	-20.11	2102.79	168.417	408.94	3306.95	20.00
15	-19.70	2107.52	175.684	417.74	3348.64	20.00
16	-19.44	2110.44	180.410	423.17	3374.34	20.00
17	-19.29	2112.18	183.333	426.41	3389.74	20.00
18	-19.20	2113.21	185.075	428.31	3398.70	20.00
19	-19.15	2113.81	186.105	429.42	3403.93	20.00
20	-19.12	2114.15	186.706	430.06	3406.96	20.00
21	-19.10	2114.34	187.044	430.42	3408.70	20.00
22	-19.09	2114.46	187.237	430.63	3409.64	20.00
23	-19.09	2114.53	187.357	430.74	3410.21	20.00
24	-19.08	2114.56	187.419	430.81	3410.53	20.00
25	-19.08	2114.58	187.454	430.85	3410.75	20.00
26	-19.08	2114.59	187.471	430.87	3410.82	20.00
27	-19.08	1927.11	187.487	430.89	3410.90	20.00
STR...						
28	-22.51	45.22	0.924	357.07	3404.78	18.00
29	-22.47	329.72	46.141	357.78	3408.38	18.00
30	-22.47	2210.68	330.643	357.83	3400.56	18.00
31	-22.47	2210.68	284.498	357.82	3408.52	18.00
32	-22.47	2210.68	284.500	357.82	3408.54	18.00
33	-22.47	2210.68	284.500	357.83	3408.60	18.00
34	-22.47	2210.68	284.497	357.83	3408.57	18.00
35	-22.47	2210.68	284.499	357.82	3408.56	18.00
36	-22.47	2210.68	284.495	357.82	3408.55	18.00
37	-22.47	2210.68	284.497	357.83	3408.59	18.00
38	-22.47	2210.68	284.497	357.83	3408.61	18.00
39	-22.47	2210.68	284.496	357.82	3408.56	18.00
40	-22.47	2210.68	284.499	357.83	3408.59	18.00
41	-22.47	2210.68	284.498	357.83	3408.60	18.00
42	-22.47	1926.18	284.496	357.82	3408.56	18.00

*** NOTE: FLOWRATES (GMOL/100 GMOL FEED) AND ENTHALPIES (CAL/GMOL) REFER TO STREAMS LEAVING THAT STAGE.

Table 16. Vapor phase compositions for each stage.

FINAL VALUES FOR CASE RWG09NOV43...

STAGE NO.	CO2	IE	VAPOR PHASE MOLE FRACTIONS				SUM OF Y' S	
			O2	CO	N2	KR		
ABS...								
1	8.8035E-01	1.0655E-12	1.1969E-01	1.4962E-12	1.4962E-12	6.9053E-09	1.0000	
2	8.7594E-01	1.0610E-12	1.2410E-01	1.4425E-12	1.3217E-12	1.0683E-08	1.0000	
3	8.7173E-01	1.0567E-12	1.2831E-01	1.4279E-12	1.2498E-12	1.6061E-08	1.0000	
4	8.6761E-01	1.0526E-12	1.3242E-01	1.4350E-12	1.2274E-12	2.3801E-08	1.0000	
5	8.6352E-01	1.0489E-12	1.3652E-01	1.4548E-12	1.2291E-12	3.5057E-08	1.0000	
6	8.5934E-01	1.0469E-12	1.4070E-01	1.4826E-12	1.2434E-12	5.1614E-08	1.0000	
7	8.5501E-01	1.0518E-12	1.4504E-01	1.5161E-12	1.2645E-12	7.6243E-08	1.0000	
8	8.5038E-01	1.0872E-12	1.4966E-01	1.5546E-12	1.2904E-12	1.1334E-07	1.0000	
FRC...								
9	5.6292E-01	2.4226E-12	4.3711E-01	4.0448E-12	2.8674E-12	4.4496E-07	1.0000	
10	8.8011E-01	1.2317E-12	1.1992E-01	1.1043E-12	7.6139E-13	1.4280E-07	1.0000	
11	9.0945E-01	1.2669E-12	9.0583E-02	7.4997E-13	4.3424E-13	1.6393E-07	1.0000	
12	9.3696E-01	1.2997E-12	6.3078E-02	4.6768E-13	2.2857E-13	1.8279E-07	1.0000	
13	9.5899E-01	1.3257E-12	4.1054E-02	2.7165E-13	1.1255E-13	1.9681E-07	1.0000	
14	9.7460E-01	1.3440E-12	2.5439E-02	1.4984E-13	5.2796E-14	2.0545E-07	1.0000	
15	9.8480E-01	1.3559E-12	1.5258E-02	7.9869E-14	2.3944E-14	2.0948E-07	1.0001	
16	9.9109E-01	1.3633E-12	8.9677E-03	4.1676E-14	1.0679E-14	2.0999E-07	1.0001	
17	9.9486E-01	1.3677E-12	5.2053E-03	2.1469E-14	4.6983E-15	2.0785E-07	1.0001	
18	9.9705E-01	1.3702E-12	2.9981E-03	1.0974E-14	2.0524E-15	2.0358E-07	1.0000	
19	9.9833E-01	1.3717E-12	1.7178E-03	5.5825E-15	8.9277E-16	1.9743E-07	1.0000	
20	9.9908E-01	1.3725E-12	9.7986E-04	2.8298E-15	3.8728E-16	1.8938E-07	1.0001	
21	9.9950E-01	1.3729E-12	5.5617E-04	1.4295E-15	1.6762E-16	1.7924E-07	1.0001	
22	9.9973E-01	1.3727E-12	3.1343E-04	7.1867E-16	7.2351E-17	1.6670E-07	1.0000	
23	9.9987E-01	1.3713E-12	1.7453E-04	3.5825E-16	3.1068E-17	1.5130E-07	1.0000	
24	9.9995E-01	1.3661E-12	9.5100E-05	1.7562E-16	1.3191E-17	1.3245E-07	1.0000	
25	1.0000E+00	1.3480E-12	4.9696E-05	8.3127E-17	5.4517E-18	1.0943E-07	1.0001	
26	1.0000E+00	1.2854E-12	2.3750E-05	3.6288E-17	2.1021E-18	8.1312E-08	1.0000	
27	1.0000E+00	1.0696E-12	8.9235E-06	1.2572E-17	6.5238E-19	4.6986E-08	1.0000	
STR...								
28	9.9912E-01	2.0084E-11	9.4255E-04	1.1767E-15	5.2191E-17	1.0316E-05	1.0001	
29	1.0000E+00	6.0149E-12	5.9481E-05	6.9130E-17	2.7341E-18	1.1914E-06	1.0001	
30	1.0000E+00	1.7663E-12	5.2429E-06	6.0136E-18	2.3594E-19	1.4458E-07	1.0000	
31	1.0000E+00	1.7662E-12	1.7915E-06	1.8468E-18	6.0560E-20	1.0852E-07	1.0000	
32	1.0000E+00	1.7661E-12	6.1214E-07	5.6719E-19	1.5544E-20	8.1220E-08	1.0000	
33	1.0001E+00	1.7659E-12	2.0916E-07	1.7419E-19	3.9898E-21	6.0553E-08	1.0001	
34	1.0000E+00	1.7652E-12	7.1467E-08	5.3494E-20	1.0241E-21	4.4907E-08	1.0000	
35	1.0000E+00	1.7639E-12	2.4417E-08	1.6428E-20	2.6284E-22	3.3062E-08	1.0000	
36	1.0000E+00	1.7608E-12	8.3404E-09	5.0442E-21	6.7461E-23	2.4096E-08	1.0000	
37	1.0001E+00	1.7541E-12	2.8472E-09	1.5483E-21	1.7312E-23	1.7308E-08	1.0001	
38	1.0001E+00	1.7392E-12	9.7013E-10	4.7468E-22	4.4402E-24	1.2169E-08	1.0001	
39	1.0000E+00	1.7062E-12	3.2876E-10	1.4496E-22	1.1363E-24	8.2783E-09	1.0000	
40	1.0001E+00	1.6331E-12	1.0961E-10	4.3702E-23	2.8835E-25	5.3332E-09	1.0001	
41	1.0001E+00	1.4711E-12	3.4732E-11	1.2604E-23	7.0695E-26	3.1036E-09	1.0001	
42	1.0000E+00	1.1122E-12	9.1448E-12	3.0536E-24	1.4829E-26	1.4157E-09	1.0000	

*** NOTE: MOLE FRACTIONS REFER TO VAPOR LEAVING THAT STAGE.

Table 17. Summary of liquid phase compositions for each stage.

FINAL VALUES FOR CASE RWG09NOV43...

STAGE	LIQUID PHASE MOLE FRACTIONS						SUM OF
NO.	CO2	XE	O2	CO	N2	KR	X' S
ADS...							
1	9.9348E-01	3.5537E-13	6.5569E-03	7.2706E-14	6.2421E-14	8.0900E-10	1.0000
2	9.9325E-01	3.5426E-13	6.7858E-03	7.0007E-14	5.5029E-14	1.2509E-09	1.0000
3	9.9303E-01	3.5320E-13	7.0038E-03	6.9213E-14	5.1938E-14	1.8797E-09	1.0000
4	9.9282E-01	3.5220E-13	7.2157E-03	6.9476E-14	5.0909E-14	2.7841E-09	1.0000
5	9.9261E-01	3.5133E-13	7.4261E-03	7.0352E-14	5.0887E-14	4.0988E-09	1.0000
6	9.9240E-01	3.5103E-13	7.6400E-03	7.1615E-14	5.1378E-14	6.0316E-09	1.0000
7	9.9218E-01	3.5309E-13	7.8613E-03	7.3147E-14	5.2150E-14	8.9053E-09	1.0000
8	9.9194E-01	3.6540E-13	8.0958E-03	7.4911E-14	5.3105E-14	1.3232E-08	1.0000
PRC...							
9	9.8102E-01	8.5280E-13	1.9019E-02	1.6889E-13	9.1435E-14	4.6684E-08	1.0000
10	9.9425E-01	3.8668E-13	5.7898E-03	4.7933E-14	2.7753E-14	1.5237E-08	1.0000
11	9.9561E-01	3.9482E-13	4.4234E-03	3.2794E-14	1.6027E-14	1.7546E-08	1.0000
12	9.9692E-01	4.0236E-13	3.1140E-03	2.0603E-14	8.5361E-15	1.9626E-08	1.0000
13	9.9799E-01	4.0835E-13	2.0448E-03	1.2042E-14	4.2431E-15	2.1188E-08	1.0000
14	9.9876E-01	4.1258E-13	1.2752E-03	6.6732E-15	2.0037E-15	2.2161E-08	1.0000
15	9.9927E-01	4.1533E-13	7.6808E-04	3.5682E-15	9.1420E-16	2.2626E-08	1.0000
16	9.9959E-01	4.1702E-13	4.5260E-04	1.8655E-15	4.0817E-16	2.2699E-08	1.0000
17	9.9978E-01	4.1803E-13	2.6312E-04	9.6213E-16	1.7987E-16	2.2479E-08	1.0000
18	9.9989E-01	4.1862E-13	1.5169E-04	4.9215E-16	7.8646E-17	2.2025E-08	1.0000
19	9.9995E-01	4.1897E-13	8.6959E-05	2.5046E-16	3.4230E-17	2.1363E-08	1.0000
20	9.9999E-01	4.1915E-13	4.9619E-05	1.2699E-16	1.4853E-17	2.0493E-08	1.0000
21	1.0000E+00	4.1923E-13	2.8169E-05	6.4157E-17	6.4300E-18	1.9397E-08	1.0000
22	1.0000E+00	4.1915E-13	1.5876E-05	3.2257E-17	2.7756E-18	1.8040E-08	1.0000
23	1.0000E+00	4.1872E-13	8.8410E-06	1.6080E-17	1.1920E-18	1.6374E-08	1.0000
24	1.0000E+00	4.1713E-13	4.8175E-06	7.8833E-18	5.0610E-19	1.4335E-08	1.0000
25	1.0000E+00	4.1159E-13	2.5175E-06	3.7315E-18	2.0917E-19	1.1843E-08	1.0000
26	1.0000E+00	3.9246E-13	1.2031E-06	1.6289E-18	8.0652E-20	8.8002E-09	1.0000
27	1.0000E+00	3.2658E-13	4.5205E-07	5.6433E-19	2.5031E-20	5.0852E-09	1.0000
STR...							
28	1.0000E+00	5.7274E-12	4.1433E-05	4.6493E-17	1.7233E-18	1.0049E-06	1.0001
29	1.0000E+00	1.7149E-12	2.6155E-06	2.7321E-18	9.0310E-20	1.1607E-07	1.0000
30	1.0000E+00	5.0360E-13	2.3055E-07	2.3767E-19	7.7937E-21	1.4086E-08	1.0000
31	1.0000E+00	5.0358E-13	7.8778E-08	7.2992E-20	2.0004E-21	1.0572E-08	1.0000
32	1.0000E+00	5.0355E-13	2.6918E-08	2.2417E-20	5.1345E-22	7.9128E-09	1.0000
33	1.0000E+00	5.0347E-13	9.1977E-09	6.8844E-21	1.3179E-22	5.8994E-09	1.0000
34	1.0000E+00	5.0329E-13	3.1426E-09	2.1142E-21	3.3826E-23	4.3750E-09	1.0000
35	1.0000E+00	5.0290E-13	1.0737E-09	6.4925E-22	8.6820E-24	3.2211E-09	1.0000
36	1.0000E+00	5.0203E-13	3.6675E-10	1.9936E-22	2.2283E-24	2.3475E-09	1.0000
37	1.0000E+00	5.0012E-13	1.2520E-10	6.1194E-23	5.7184E-25	1.6862E-09	1.0000
38	1.0000E+00	4.9587E-13	4.2660E-11	1.8761E-23	1.4667E-25	1.1855E-09	1.0000
39	1.0000E+00	4.8646E-13	1.4457E-11	5.7292E-24	3.7535E-26	8.0652E-10	1.0000
40	1.0000E+00	4.6561E-13	4.8201E-12	1.7272E-24	9.5247E-27	5.1958E-10	1.0000
41	1.0000E+00	4.1943E-13	1.5273E-12	4.9814E-25	2.3352E-27	3.0236E-10	1.0000
42	1.0000E+00	3.1710E-13	4.0213E-13	1.2069E-25	4.8983E-28	1.3792E-10	1.0000

*** NOTE: MOLE FRACTIONS REFER TO LIQUID LEAVING THAT STAGE.

Table 18. Summary of equilibrium ratios for each stage.

FINAL VALUES FOR CASE RWG09NOV43...

STAGE NO.	STAGewise EQUILIBRIUM RATIOS (Y/X)					
	CO2	XE	O2	CO	N2	KR
ABS...						
1	8.861E-01	2.998E+00	1.825E+01	2.058E+01	2.397E+01	8.536E+00
2	8.819E-01	2.995E+00	1.829E+01	2.061E+01	2.402E+01	8.540E+00
3	8.778E-01	2.992E+00	1.832E+01	2.063E+01	2.406E+01	8.545E+00
4	8.739E-01	2.989E+00	1.835E+01	2.065E+01	2.411E+01	8.549E+00
5	8.699E-01	2.986E+00	1.838E+01	2.068E+01	2.415E+01	8.553E+00
6	8.659E-01	2.982E+00	1.842E+01	2.070E+01	2.420E+01	8.557E+00
7	8.617E-01	2.979E+00	1.845E+01	2.073E+01	2.425E+01	8.562E+00
8	8.573E-01	2.975E+00	1.849E+01	2.075E+01	2.430E+01	8.566E+00
PRC...						
9	5.738E-01	2.841E+00	2.298E+01	2.395E+01	3.136E+01	9.531E+00
10	8.852E-01	3.185E+00	2.071E+01	2.304E+01	2.743E+01	9.372E+00
11	9.135E-01	3.209E+00	2.048E+01	2.287E+01	2.709E+01	9.343E+00
12	9.398E-01	3.230E+00	2.026E+01	2.270E+01	2.678E+01	9.314E+00
13	9.609E-01	3.246E+00	2.008E+01	2.256E+01	2.653E+01	9.289E+00
14	9.758E-01	3.256E+00	1.995E+01	2.245E+01	2.635E+01	9.271E+00
15	9.855E-01	3.265E+00	1.987E+01	2.238E+01	2.623E+01	9.258E+00
16	9.915E-01	3.269E+00	1.981E+01	2.234E+01	2.616E+01	9.251E+00
17	9.951E-01	3.272E+00	1.978E+01	2.231E+01	2.612E+01	9.246E+00
18	9.972E-01	3.273E+00	1.976E+01	2.230E+01	2.610E+01	9.243E+00
19	9.984E-01	3.274E+00	1.975E+01	2.229E+01	2.608E+01	9.242E+00
20	9.991E-01	3.275E+00	1.975E+01	2.228E+01	2.607E+01	9.241E+00
21	9.995E-01	3.275E+00	1.974E+01	2.228E+01	2.607E+01	9.240E+00
22	9.997E-01	3.275E+00	1.974E+01	2.228E+01	2.607E+01	9.240E+00
23	9.998E-01	3.275E+00	1.974E+01	2.228E+01	2.606E+01	9.240E+00
24	9.999E-01	3.275E+00	1.974E+01	2.228E+01	2.606E+01	9.240E+00
25	1.000E+00	3.275E+00	1.974E+01	2.228E+01	2.606E+01	9.240E+00
26	1.000E+00	3.275E+00	1.974E+01	2.228E+01	2.606E+01	9.240E+00
27	1.000E+00	3.275E+00	1.974E+01	2.228E+01	2.606E+01	9.240E+00
STR...						
28	9.991E-01	3.507E+00	2.275E+01	2.531E+01	3.029E+01	1.027E+01
29	1.000E+00	3.507E+00	2.274E+01	2.530E+01	3.027E+01	1.026E+01
30	1.000E+00	3.507E+00	2.274E+01	2.530E+01	3.027E+01	1.026E+01
31	1.000E+00	3.507E+00	2.274E+01	2.530E+01	3.027E+01	1.026E+01
32	1.000E+00	3.507E+00	2.274E+01	2.530E+01	3.027E+01	1.026E+01
33	1.000E+00	3.507E+00	2.274E+01	2.530E+01	3.027E+01	1.026E+01
34	1.000E+00	3.507E+00	2.274E+01	2.530E+01	3.027E+01	1.026E+01
35	1.000E+00	3.507E+00	2.274E+01	2.530E+01	3.027E+01	1.026E+01
36	1.000E+00	3.507E+00	2.274E+01	2.530E+01	3.027E+01	1.026E+01
37	1.000E+00	3.507E+00	2.274E+01	2.530E+01	3.027E+01	1.026E+01
38	1.000E+00	3.507E+00	2.274E+01	2.530E+01	3.027E+01	1.026E+01
39	1.000E+00	3.507E+00	2.274E+01	2.530E+01	3.027E+01	1.026E+01
40	1.000E+00	3.507E+00	2.274E+01	2.530E+01	3.027E+01	1.026E+01
41	1.000E+00	3.507E+00	2.274E+01	2.530E+01	3.027E+01	1.026E+01
42	1.000E+00	3.507E+00	2.274E+01	2.530E+01	3.027E+01	1.026E+01

*** NOTE: Y AND X REFER TO STREAMS LEAVING THAT STAGE.

Table 19. Summary of absorption factors for each stage.

FINAL VALUES FOR CASE RWG09NOV43...

STAGE NO.	L/V RATIO	STAGewise ABSORPTION FACTORS (L/VK)					
		CO2	XE	O2	CO	N2	KR
ABS...							
1	2.988E+01	3.372E+01	9.966E+00	1.637E+00	1.452E+00	1.247E+00	3.501E+00
2	1.174E+01	1.331E+01	3.919E+00	6.410E-01	5.696E-01	4.807E-01	1.374E+00
3	1.187E+01	1.353E+01	3.969E+00	6.481E-01	5.756E-01	4.934E-01	1.390E+00
4	1.201E+01	1.374E+01	4.018E+00	6.543E-01	5.814E-01	4.981E-01	1.405E+00
5	1.214E+01	1.396E+01	4.067E+00	6.604E-01	5.872E-01	5.027E-01	1.420E+00
6	1.228E+01	1.418E+01	4.117E+00	6.667E-01	5.931E-01	5.074E-01	1.435E+00
7	1.242E+01	1.441E+01	4.169E+00	6.732E-01	5.992E-01	5.122E-01	1.451E+00
8	1.245E+01	1.452E+01	4.184E+00	6.735E-01	5.999E-01	5.124E-01	1.453E+00
PRC...							
9	3.144E+00	5.479E+00	1.107E+00	1.368E-01	1.313E-01	1.002E-01	3.298E-01
10	1.366E+01	1.543E+01	4.289E+00	6.596E-01	5.930E-01	4.980E-01	1.458E+00
11	1.575E+01	1.724E+01	4.908E+00	7.691E-01	6.887E-01	5.813E-01	1.686E+00
12	1.435E+01	1.527E+01	4.442E+00	7.084E-01	6.321E-01	5.359E-01	1.541E+00
13	1.325E+01	1.379E+01	4.081E+00	6.599E-01	5.874E-01	4.995E-01	1.426E+00
14	1.249E+01	1.280E+01	3.833E+00	6.259E-01	5.561E-01	4.739E-01	1.347E+00
15	1.200E+01	1.217E+01	3.674E+00	6.039E-01	5.359E-01	4.573E-01	1.296E+00
16	1.170E+01	1.180E+01	3.578E+00	5.904E-01	5.236E-01	4.471E-01	1.265E+00
17	1.152E+01	1.158E+01	3.521E+00	5.824E-01	5.163E-01	4.411E-01	1.246E+00
18	1.142E+01	1.145E+01	3.488E+00	5.777E-01	5.121E-01	4.375E-01	1.235E+00
19	1.136E+01	1.138E+01	3.469E+00	5.750E-01	5.096E-01	4.355E-01	1.229E+00
20	1.132E+01	1.133E+01	3.458E+00	5.734E-01	5.081E-01	4.343E-01	1.225E+00
21	1.130E+01	1.131E+01	3.452E+00	5.725E-01	5.073E-01	4.336E-01	1.223E+00
22	1.129E+01	1.130E+01	3.448E+00	5.720E-01	5.069E-01	4.332E-01	1.222E+00
23	1.129E+01	1.129E+01	3.446E+00	5.717E-01	5.066E-01	4.330E-01	1.221E+00
24	1.128E+01	1.128E+01	3.445E+00	5.715E-01	5.064E-01	4.329E-01	1.221E+00
25	1.128E+01	1.128E+01	3.444E+00	5.715E-01	5.064E-01	4.328E-01	1.221E+00
26	1.128E+01	1.128E+01	3.444E+00	5.714E-01	5.063E-01	4.328E-01	1.221E+00
27	1.028E+01	1.028E+01	3.138E+00	5.207E-01	4.614E-01	3.944E-01	1.112E+00
STR...							
28	4.897E+01	4.897E+01	1.395E+01	2.151E+00	1.933E+00	1.615E+00	4.766E+00
29	7.146E+00	7.146E+00	2.037E+00	3.142E-01	2.024E-01	2.360E-01	6.962E-01
30	6.686E+00	6.686E+00	1.906E+00	2.940E-01	2.643E-01	2.209E-01	6.514E-01
31	7.770E+00	7.771E+00	2.215E+00	3.417E-01	3.071E-01	2.567E-01	7.570E-01
32	7.770E+00	7.770E+00	2.215E+00	3.417E-01	3.071E-01	2.567E-01	7.570E-01
33	7.770E+00	7.770E+00	2.215E+00	3.417E-01	3.071E-01	2.567E-01	7.570E-01
34	7.770E+00	7.770E+00	2.215E+00	3.417E-01	3.071E-01	2.567E-01	7.570E-01
35	7.770E+00	7.770E+00	2.215E+00	3.417E-01	3.071E-01	2.567E-01	7.570E-01
36	7.771E+00	7.771E+00	2.215E+00	3.417E-01	3.071E-01	2.567E-01	7.570E-01
37	7.770E+00	7.770E+00	2.215E+00	3.417E-01	3.071E-01	2.567E-01	7.570E-01
38	7.770E+00	7.770E+00	2.215E+00	3.417E-01	3.071E-01	2.567E-01	7.570E-01
39	7.771E+00	7.770E+00	2.215E+00	3.417E-01	3.071E-01	2.567E-01	7.570E-01
40	7.770E+00	7.770E+00	2.215E+00	3.417E-01	3.071E-01	2.567E-01	7.570E-01
41	7.770E+00	7.770E+00	2.215E+00	3.417E-01	3.071E-01	2.567E-01	7.570E-01
42	6.771E+00	6.770E+00	1.930E+00	2.977E-01	2.676E-01	2.236E-01	6.996E-01

*** NOTE: K <=> Y/X. L,V,Y, AND X REFER TO STREAMS LEAVING THAT STAGE.

Table 20. Summary interstage of operating ratios.

FINAL VALUES FOR CASE RWG09NOV43...

BETWEEN STAGE NOS	INTERSTAGE OPERATING RATIOS (Y/X)					
	CO2	XE	O2	CO	N2	KR
ABS.....						
1- 2	8.817E-01	2.986E+00	1.893E+01	1.984E+01	2.117E+01	1.321E+01
2- 3	8.776E-01	2.983E+00	1.891E+01	2.040E+01	2.271E+01	1.284E+01
3- 4	8.737E-01	2.980E+00	1.891E+01	2.073E+01	2.363E+01	1.266E+01
4- 5	8.698E-01	2.978E+00	1.892E+01	2.094E+01	2.414E+01	1.259E+01
5- 6	8.657E-01	2.980E+00	1.895E+01	2.107E+01	2.443E+01	1.259E+01
6- 7	8.616E-01	2.996E+00	1.898E+01	2.117E+01	2.461E+01	1.264E+01
7- 8	8.571E-01	3.079E+00	1.904E+01	2.125E+01	2.474E+01	1.273E+01
PRC.....						
9-10	8.971E-01	1.444E+00	6.305E+00	6.539E+00	8.327E+00	3.059E+00
10-11	9.147E-01	3.276E+00	1.565E+01	1.565E+01	1.565E+01	1.076E+01
11-12	9.411E-01	3.292E+00	1.426E+01	1.426E+01	1.426E+01	1.042E+01
12-13	9.619E-01	3.295E+00	1.318E+01	1.318E+01	1.319E+01	1.003E+01
13-14	9.766E-01	3.291E+00	1.244E+01	1.244E+01	1.244E+01	9.697E+00
14-15	9.860E-01	3.286E+00	1.197E+01	1.197E+01	1.197E+01	9.452E+00
15-16	9.918E-01	3.282E+00	1.168E+01	1.168E+01	1.168E+01	9.281E+00
16-17	9.953E-01	3.280E+00	1.150E+01	1.151E+01	1.151E+01	9.157E+00
17-18	9.973E-01	3.278E+00	1.139E+01	1.141E+01	1.141E+01	9.057E+00
18-19	9.984E-01	3.277E+00	1.132E+01	1.134E+01	1.135E+01	8.964E+00
19-20	9.991E-01	3.276E+00	1.127E+01	1.130E+01	1.131E+01	8.865E+00
20-21	9.995E-01	3.275E+00	1.121E+01	1.126E+01	1.129E+01	8.746E+00
21-22	9.997E-01	3.274E+00	1.113E+01	1.120E+01	1.125E+01	8.594E+00
22-23	9.998E-01	3.272E+00	1.099E+01	1.111E+01	1.119E+01	8.387E+00
23-24	9.999E-01	3.263E+00	1.076E+01	1.092E+01	1.107E+01	8.089E+00
24-25	1.000E+00	3.232E+00	1.032E+01	1.054E+01	1.077E+01	7.634E+00
25-26	1.000E+00	3.123E+00	9.434E+00	9.725E+00	1.005E+01	6.866E+00
26-27	1.000E+00	2.725E+00	7.417E+00	7.718E+00	8.089E+00	5.339E+00
STR.....						
28-29	1.000E+00	1.050E+00	1.436E+00	1.487E+00	1.587E+00	1.186E+00
29-30	1.000E+00	1.030E+00	2.005E+00	2.201E+00	2.613E+00	1.246E+00
30-31	1.000E+00	3.507E+00	7.770E+00	7.770E+00	7.770E+00	7.704E+00
31-32	1.000E+00	3.507E+00	7.771E+00	7.771E+00	7.771E+00	7.682E+00
32-33	1.000E+00	3.507E+00	7.770E+00	7.770E+00	7.771E+00	7.653E+00
33-34	1.000E+00	3.506E+00	7.770E+00	7.770E+00	7.770E+00	7.612E+00
34-35	1.000E+00	3.505E+00	7.770E+00	7.770E+00	7.770E+00	7.557E+00
35-36	1.000E+00	3.501E+00	7.768E+00	7.769E+00	7.770E+00	7.481E+00
36-37	1.000E+00	3.494E+00	7.763E+00	7.766E+00	7.769E+00	7.373E+00
37-38	1.000E+00	3.478E+00	7.749E+00	7.757E+00	7.765E+00	7.217E+00
38-39	1.000E+00	3.441E+00	7.707E+00	7.727E+00	7.748E+00	6.983E+00
39-40	1.000E+00	3.357E+00	7.582E+00	7.628E+00	7.682E+00	6.613E+00
40-41	1.000E+00	3.159E+00	7.206E+00	7.297E+00	7.422E+00	5.973E+00
41-42	1.000E+00	2.652E+00	5.988E+00	6.130E+00	6.350E+00	4.682E+00

*** NOTE: Y AND X REFER TO STREAMS PASSING ONE ANOTHER BETWEEN THESE STAGES.

Table 21. Summary of interstage absorption factors.

FINAL VALUES FOR CASE RWG09NOV43...

BETWEEN STAGE NOS	L/V RATIO	INTERSTAGE ABSORPTION FACTORS (L/VK)					
		CO2	XE	O2	CO	N2	RR
ABS.....							
1- 2	1.175E+01	1.333E+01	3.935E+00	6.208E-01	5.922E-01	5.549E-01	8.897E-01
2- 3	1.189E+01	1.354E+01	3.985E+00	6.286E-01	5.828E-01	5.233E-01	9.257E-01
3- 4	1.207E+01	1.376E+01	4.033E+00	6.357E-01	5.797E-01	5.086E-01	9.493E-01
4- 5	1.215E+01	1.397E+01	4.081E+00	6.424E-01	5.804E-01	5.034E-01	9.652E-01
5- 6	1.229E+01	1.420E+01	4.125E+00	6.487E-01	5.832E-01	5.030E-01	9.761E-01
6- 7	1.243E+01	1.443E+01	4.149E+00	6.549E-01	5.873E-01	5.052E-01	9.836E-01
7- 8	1.258E+01	1.468E+01	4.087E+00	6.611E-01	5.921E-01	5.086E-01	9.888E-01
FRC.....							
9-10	7.587E-01	8.457E-01	5.253E-01	1.203E-01	1.160E-01	9.111E-02	2.480E-01
10-11	1.565E+01	1.710E+01	4.775E+00	1.000E+00	9.999E-01	9.999E-01	1.454E+00
11-12	1.426E+01	1.515E+01	4.332E+00	1.000E+00	9.999E-01	9.999E-01	1.369E+00
12-13	1.318E+01	1.371E+01	4.002E+00	1.000E+00	1.000E+00	9.999E-01	1.315E+00
13-14	1.244E+01	1.274E+01	3.780E+00	1.000E+00	1.000E+00	1.000E+00	1.283E+00
14-15	1.197E+01	1.214E+01	3.642E+00	1.000E+00	1.000E+00	1.000E+00	1.266E+00
15-16	1.168E+01	1.178E+01	3.559E+00	1.001E+00	1.000E+00	1.000E+00	1.259E+00
16-17	1.151E+01	1.157E+01	3.510E+00	1.001E+00	1.000E+00	1.000E+00	1.257E+00
17-18	1.141E+01	1.144E+01	3.482E+00	1.002E+00	1.001E+00	1.000E+00	1.260E+00
18-19	1.135E+01	1.137E+01	3.465E+00	1.003E+00	1.001E+00	1.000E+00	1.267E+00
19-20	1.132E+01	1.133E+01	3.456E+00	1.005E+00	1.002E+00	1.001E+00	1.277E+00
20-21	1.130E+01	1.131E+01	3.451E+00	1.008E+00	1.004E+00	1.002E+00	1.292E+00
21-22	1.129E+01	1.130E+01	3.449E+00	1.015E+00	1.008E+00	1.004E+00	1.314E+00
22-23	1.129E+01	1.129E+01	3.450E+00	1.027E+00	1.016E+00	1.008E+00	1.346E+00
23-24	1.128E+01	1.128E+01	3.458E+00	1.049E+00	1.033E+00	1.020E+00	1.395E+00
24-25	1.128E+01	1.128E+01	3.491E+00	1.093E+00	1.070E+00	1.047E+00	1.478E+00
25-26	1.128E+01	1.128E+01	3.612E+00	1.196E+00	1.160E+00	1.122E+00	1.643E+00
26-27	1.128E+01	1.128E+01	4.138E+00	1.521E+00	1.461E+00	1.394E+00	2.112E+00
STR.....							
28-29	9.800E-01	9.800E-01	9.331E-01	6.826E-01	6.591E-01	6.177E-01	8.266E-01
29-30	9.972E-01	9.972E-01	9.682E-01	4.975E-01	4.531E-01	3.817E-01	8.006E-01
30-31	7.770E+00	7.770E+00	2.216E+00	1.000E+00	1.000E+00	1.000E+00	1.009E+00
31-32	7.770E+00	7.770E+00	2.216E+00	1.000E+00	1.000E+00	1.000E+00	1.011E+00
32-33	7.770E+00	7.770E+00	2.316E+00	1.000E+00	1.000E+00	1.000E+00	1.015E+00
33-34	7.770E+00	7.770E+00	2.216E+00	1.000E+00	1.000E+00	1.000E+00	1.021E+00
34-35	7.770E+00	7.770E+00	2.217E+00	1.000E+00	1.000E+00	1.000E+00	1.028E+00
35-36	7.771E+00	7.771E+00	2.219E+00	1.000E+00	1.000E+00	1.000E+00	1.039E+00
36-37	7.770E+00	7.770E+00	2.224E+00	1.001E+00	1.001E+00	1.000E+00	1.054E+00
37-38	7.770E+00	7.770E+00	2.234E+00	1.003E+00	1.002E+00	1.001E+00	1.077E+00
38-39	7.771E+00	7.770E+00	2.258E+00	1.008E+00	1.006E+00	1.003E+00	1.113E+00
39-40	7.770E+00	7.770E+00	2.315E+00	1.025E+00	1.019E+00	1.012E+00	1.175E+00
40-41	7.770E+00	7.770E+00	2.459E+00	1.078E+00	1.065E+00	1.047E+00	1.301E+00
41-42	7.771E+00	7.770E+00	2.930E+00	1.298E+00	1.268E+00	1.224E+00	1.660E+00

*** NOTE: K <=> Y/X. L, V, Y, AND X REFER TO STREAMS PASSING ONE ANOTHER BETWEEN THESE STAGES.

- (13) a table summarizing system performance indicators upon convergence, such as material and energy balance errors, heating/cooling loads, system decontamination and concentration factors, etc. (Table 22).

The following notes are pertinent to the performance summary table:

- (1) All heat loads are in units of Btu/hr.
- (2) The Krypton Process Decontamination Factor (PDF) is defined as the total amount of krypton entering in the feed stream, divided by the krypton leaving the process via the absorber off-gas and liquid CO₂ streams.
- (3) The Krypton Column Decontamination Factor (CKRDF) is defined as the total amount of krypton entering the absorber in the absorber feed-gas stream, divided by the total krypton leaving the absorber in the absorber off-gas.
- (4) The Krypton Process Concentration Factor (CFKR) is defined as the mole fraction of krypton in the stripper off-gas, divided by the mole fraction of krypton in the process feed gas.
- (5) The Krypton Concentration Factor Relative to the Light Gas (CFKRLG) is defined as the ratio of the mole fraction of krypton in the stripper off-gas, divided by the sum of the mole fractions of all light gases present in the stripper off-gas, to the mole fraction of krypton in the process feed gas, divided by the sum of the mole fractions of all light gases present in the process feed gas.

Table 22. Summary of miscellaneous performance data.

FINAL VALUES FOR CASE RWG09NOV43...

SUMMARY OF PERFORMANCE

ENERGY BALANCE ERROR	8.456511E+01
MATERIAL BALANCE ERROR	7.504040E-05
FEED STAGES	8 10 30
FRC CONDENSER LOAD, BTU/HR	-7.002129E+03
" REBOILER HEAT, BTU/HR	1.030000E+04
STR FINAL CONDENSER LOAD, BTU/HR	-2.543460E+03
" MAIN CONDENSER LOAD, BTU/HR	-1.600000E+04
" REBOILER HEAT, BTU/HR	1.600000E+04
SCRUB COOLING LOAD, BTU/HR	-3.647517E+03
KRYPTON PROCESS DF	21.46
" COLUMN DF	56.73
" PROCESS CF	103.16
" CF, REL/LG	8660.66
FRACTION KR RECOVERED	0.953411
" KR VENTED	0.046150
" KR BYPASSED	0.000445
" LG RECOVERED	0.000110
KRYPTON RECYCLE RATIO	1.618044
" CAP/LOSS RATIO	20.46
LIGHT GAS RECYCLE RATIO	1.986870
" CAP/LOSS RATIO	0.000881
ABS FEED GAS TEMP, C	18.89
ABS FEED LIQ TEMP, C (EST)	-27.78

- (6) The Fraction of Krypton Recovered (FLGR) is defined as the amount of krypton in the stripper off-gas; divided by the amount of krypton in the process feed gas.
- (7) The Fraction of Krypton Vented (FKRV) is defined as the amount of krypton in the absorber off-gas, divided by the amount of krypton in the process feed gas.
- (8) The Fraction of Krypton Bypassed (FKRB) is defined as the amount of krypton leaving the stripper reboiler as a liquid but not recycled to the absorber (i.e., present in the excess liquid CO_2), divided by the total amount of krypton present in the process feed gas.
- (9) The Fraction of Light Gas Recovered (FLGR) is defined as the total amount of light gas present in the stripper off-gas, divided by the total amount of light gas present in the process feed gas.
- (10) The Krypton Recycle Ratio (RKRR) is defined as the amount of krypton in the fractionator off-gas, divided by the total amount of krypton in the process feed gas.
- (11) The Krypton Capture-to-Loss Ratio (CLRKR) is defined as the krypton in the stripper off-gas, divided by the sum of the krypton present in the absorber off-gas plus that present in the excess CO_2 liquid.
- (12) The Light Gas Recycle Ratio (RLGR) is defined as the total light gas in the fractionator off-gas, divided by the total light gas present in the process feed gas.

- (13) The Light Gas Capture-to-Loss Ratio (CTRLRG) is defined as the total light gas present in the stripper off-gas, divided by the sum of the light gas in the absorber off gas plus that present in the excess liquid CO₂.

The process performance parameters with reference to Fig. 2 are as follows:

Process DF for krypton (PDF)

$$PDF \equiv \frac{F y_{Kr}^F}{A y_{Kr}^A + B x_{Kr}^B} .$$

Column DF for krypton (CKRDF)

$$CKRDF \equiv \frac{F y_{Kr}^F + R y_{Kr}^R}{A y_{Kr}^A} .$$

Krypton concentration factor (CFKR)

$$CFKR \equiv \frac{P y_{Kr}^P}{F y_{Kr}^F} .$$

Krypton-to-light gas concentration factor (CFKRLG)

$$CFKRLG \equiv \frac{P y_{Kr}^P}{F y_{Kr}^F} \frac{\sum y_{LG}^F}{\sum y_{LG}^F}$$

Fraction of light gas recovered (FLGR)

$$FLGR \equiv \frac{P \sum y_{LG}^P}{F \sum y_{LG}^F} .$$

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NOTES:

F = PROCESS FEED GAS RATE
 A = ABSORBER OFF-GAS RATE
 R = FRACTIONATOR OFF-GAS RATE
 P = STRIPPER OFF-GAS RATE
 S = SCRUB LIQUID RATE
 B = EXCESS SCRUB LIQUID RATE
 x = LIQUID MOLE FRACTIONS
 y = VAPOR MOLE FRACTIONS

ASSUMPTIONS:

$$\begin{aligned}
 x^S &= x^B \\
 F &= A + P + B \\
 Fy^F &= Ay^A + Py^P + Bx^B
 \end{aligned}$$

Fig. 2. Identification of streams for performance parameters.

Fraction of krypton vented (FKRV)

$$FKRV \equiv \frac{A y_{Kr}}{F y_{Kr}} .$$

Fraction of krypton bypassed (FKRB)

$$FKRB \equiv \frac{B x_{Kr}}{F y_{Kr}} .$$

Krypton recycle ratio (RKRR)

$$RKRR \equiv \frac{R y_{Kr}}{F y_{Kr}} .$$

Krypton capture-to-loss ratio (CTLRKR)

$$CRLRKR \equiv \frac{P y_{Kr}^B}{A y_{Kr}^A + B x_{Kr}^B} .$$

Light gas recycle ratio (RLGR)

$$RLGR \equiv \frac{R \Sigma y_{LG}^R}{F \Sigma y_{LG}^F} .$$

Light gas capture-to-loss ratio (CTLR LG)

$$CTLR LG \equiv \frac{P \Sigma y_{LG}^P}{A \Sigma y_{LG}^A + B \Sigma x_{LG}^B} .$$

MCCABE-THIELE PLOTS

In addition to the printed output described above, the program also returns a deck of punched cards which may be used to construct McCabe-Thiele plots of krypton and oxygen for each of the three process columns. The plotting programs, complete with a typical data set, are listed in Appendix B. No data input other than the punched deck provided by the program is necessary. Plots provided by the plotting routine listed in Appendix B are shown in Figs. 3-8. All of the plots are log-log type except for oxygen in the absorber. Feed stages are indicated by a dashed line from the point on the 45° line which represents the feed composition to that stage. Three pieces of information are included on each plot to provide ready identification:

- (1) The IBM-360 job notation is printed in the upper left corner (RWGC02 in Fig. 3 through Fig. 8).
- (2) The column designation is printed in the upper right corner (ABS, FRC, and STR for absorber, fractionator, and stripper, respectively).
- (3) The component name is printed in the lower right corner (KR and O2 for krypton and oxygen, respectively).

CONCLUDING NOTES

The most important single fact to be noted is that the program represents a model, and as such has the usual caveats associated with it. Although many program improvements are possible, these will be developed more effectively as a result of individual needs. Simple

Fig. 3. McCabe-Thiele diagram for krypton in the absorber.

Fig. 4. McCabe-Thiele diagram for krypton in the fractionator.

Fig. 5. McCabe-Thiele diagram for krypton in the stripper pen.

Fig. 6. McCabe-Thiele diagram for O_2 in the absorber.

Fig. 7. McCabe-Thiele diagram for O_2 in the fractionator.

Fig. 8. McCabe-Thiele diagram for O_2 in the stripper.

adjustments to the program might include a flooding curve correlation⁹ for the packed columns, distributed condenser loads, additional process performance criteria. The current version is written in the IBM 360/91 (ORNL) PL/I language, PL/I optimizing compiler, version 1 R3.0 PTF65. The sample program presented in Appendix A requires approximately 600 K storage (42 stages) and 16 min (nine iterations) to execute. Present convergence criteria are $ADE < 10^{+3}$ and $ADM < 10^{-4}$ for energy and material balances, respectively. ADE is the sum of the absolute values of energy errors for all components on all stages; ADM is the sum of the absolute values of material balance errors for all components on all stages.

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4. R. W. Glass and R. E. Barker, A Computer Model for the KALC Process Studies in the ORGDP Off-Gas Decontamination Pilot Plant, ORNL/TM-5457 (September 1976).
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7. J. W. Tierney and J. L. Yanosik, "Simultaneous Flow and Temperature Correction in the Equilibrium Stage Problem," A.I.Ch.E. J. 15, 897-901 (1969).
8. J. M. Prausnitz, Molecular Thermodynamics of Fluid-Phase Equilibria, Prentice-Hall, Englewood Cliffs, N.J., 1969.

*Professor, Department of Chemical Engineering, Clemson University, Clemson, South Carolina.

9. R. W. Glass et al., Krypton Absorption in Liquid CO₂ (KALC):
Campaign II in the Experimental Engineering Section Off-Gas
Decontamination Facility, ORNL/TM-5095 (February 1976).

APPENDIX A:
THE KALC PROGRAM LISTING

```

/*NOSEQCARD
//RWGCO2 JOB (XXXXX),'BIN G GLASS',MSGLEVEL=1
/*ROUTE PRINT LOCAL
/*CLASS CPU91=20M,R=600K,IO=16
/*ROUTE XEQ CPU1
// EXEC PLIXCLG,PARM.PLI='WEST',PARM.LKED='NOXREF,NOLIST',
// REGION.GO=600K,PARM.GO='REPORT,ISASIZE(409600)'
//PLI.SYSLIN DD SPACE=(80,(1700,100))
//PLI.SYSIN DD *

```

THE STAGE PROCEDURE SHOULD BE INSERTED HERE

=====

```

/*
//GO.PUNCH DD SYSOUT=B,DCB=(RECFM=F,BLKSIZE=80)
//GO.PLIDUMP DD SYSOUT=A
//GO.SYSIN DD *

```

THE FOLLOWING IS THE EXAMPLE DATA

=====

```

42 6 'RWG09NOV43'
8 0 16 1
18.89 -27.78 -21 -22 -38 -24 -19 -24 -23 -22.78
22 22 20 20 18 18
1.0E-12 8.0E-2 1.0E-12 1.0E-12 1.0E-7
0.0 0.265 0.0 0.0 0.0
10300 16000 1.0
6.6 3.2 2.4 0.061 125

```

```

/*
//

```

THE FOLLOWING IS A LISTING OF THE STAGE PROCEDURE

=====

```

STAGE:  PROC OPTIONS(MAIN);  DCL N,M,NDIM,NA,NF,NFR,NFS,NSR;
        GET LIST(N,M);  NDIM=2*N;  BEGIN;  DCL (LOGP,LOGP1,K1) FLOAT;
        DCL ARATE,FDRAT,FRATE,QN,QNFR,SOLRT,SRATE,XQN,PD,TD;
        DCL IDRUN CHAR(10);  DCL IDENT(6) CHAR(4) STATIC INITIAL
        ('CO2 ','XE ','O2 ','CO ','N2 ','KR ');  DCL (P1S,QIN,
        FGAST,QCOMP,SLTC) BINARY FLOAT;  DCL TC(N) BINARY FLOAT;  DCL
        (YPPED(M),YRECY(M),DPHI(M),DDHBAR(M)) BINARY FLOAT;  DCL
        TO STATIC INITIAL(233.15);  DCL (HE(M,M),HE1(M,M),HE2(M,M));
        DCL (PSI(NDIM,NDIM),TSDNN(N,N)) BINARY FLOAT(53);  DCL
        (PHIG(N,M),GAM(N,M),DELHBAR(N,M)) BINARY FLOAT;  DCL
        (GSO(M),YFEED(M)) BINARY FLOAT;  DCL (L(N,N),V(N,N),Q(N,1),
        QF(N,1),ET(N,N),EV(N,N),JT(N,N),GT(N,N),GV(N,N),HT(N,N),
        HV(N,N),F(N,M),XX(N,M),YY(N,M),K(N,N),JV(N,N),HS(N,N),
        GS(N,N),DK(N,N),DH(N,N),DG(N,N),PF(N,1),X(N,1),Y(N,1),
        MO(N,N),XT(N,N),SUMM(N,1),B(N,N),A(N,N),R(N,N),M1(N,N),
        M2(N,N),M3(N,N),M4(N,N),XV(N,N),YV(N,N),H(N,1),G(N,1),
        DM(N,1),DE(N,1),UN(N,1),UM(M,1),W1(N,N),W2(N,N),C(NDIM,1),
        DEL(NDIM,1),VS(N,N),VP(N,N),LS(N,N),LP(N,N),ITZ(N,N),
        ITB(N,N),NORM(N,N),IPSI(NDIM,NDIM),SUMX(N,1),Z(N,N),TPS(M),
        SUMY(N,1),YT(N,N),TSNN(N,N),TSNM(N,M),TSN1(N,1),TSM(M),
        TAB(N,N),P(N)) BINARY FLOAT;  DCL ADE,ADM,PDF,CKRDF,FKRR,
        FLGR,FKRB,RKRR,RLGR,RT,TK,TK1,TK2,CTLRKR,FKRV,CTLRG,CFKR,
        CFKRLG,VS1,VBAR(M),CNV,VCOR,HS1,KOUNT,SLGA,SLGF,SLGL,SLGP,
        SLGR,FEED,DELH,DELTAH,MM,J,II,I;  DCL (D,DD,DDD,CON) BINARY
        FLOAT(53);  DCL ALPHA(6) STATIC INITIAL(6.637,4.968,7.011,
        6.962,6.958,4.968);  DCL BETA(6) STATIC INITIAL(1.395E-3,
        0.0,-8.1E-4,-9.5E-5,-3.5E-5,0.0);  DCL GAMMA(6) STATIC
        INITIAL(2.045E-5,0.0,2.8E-6,3.5E-7,1.5E-7,0.0);  DCL KAPA(6)
        FLOAT STATIC INITIAL(0.0,-1.028859E-2,3.854812E-2,
        -3.211558E-2,0);  CALL SETUP(N,M);

```

```

SETUP:  PROC(N,M);  DCL I,J;
        F=0; Q,QF=0; YPPED,YRECY=0; A,B,VS,VP,LS,LP=0;
        GET LIST(IDRUN,NA,NFR,NFS,NSR);  NF=NA+NFR+NFS+3;
        GET LIST(FGAST,SLTC,TC(1),TC(NA),TC(NA+1),TC(NA+2),
        TC(NF),TC(NF+1),TC(NF+2),TC(N));
        GET LIST(P(1),P(NA),P(NA+1),P(NF),P(NF+1),P(N));
        GET LIST((YPPED(J) DO J=2 TO M));  YPPED(1)=1-SUM(YPPED);
        GET LIST((YRECY(J) DO J=2 TO M));  YRECY(1)=1-SUM(YRECY);
        DO J=1 TO M;  P(NA,J)=100*YPPED(J);  END;
        GET LIST(QNFR,QN,XQN);
        GET LIST(FDRAT,ARATE,FRATE,SRATE,SOLRT);  CNV=358.02/FDRAT;
        VS(1,1)=(100*ARATE)/FDRAT;
        VP(NA+1,NA+1)=- (100*FRATE)/FDRAT;
        VP(NF+1,NF+1)=- (100*SRATE)/FDRAT;
        LP(N,N)=- (100*SOLRT)/FDRAT;
        Q(NF,1)=QNFR*CNV;  Q(NA+1,1)=-0.7*Q(NF,1);
        Q(N,1)=QN*CNV;  Q(NF+2,1)=-XQN*Q(N,1);

```

```

Q(NF+1,1)=0.15*Q(NF+2,1); VS(NF,NF)=VBOIL(Q(NF,1),TC(NF));
VS(N,N)=VBOIL(Q(N,1),TC(N)); VS(NF+2,NF+2)=(1.16-XQN)*VS(N,N);
TK1=SLTC+273.2; TK2=TC(N)+273.2;
Q(1,1)=-LP(N,N)*(279.097*(TK1-TK2)-1.10491*(TK1**2-TK2**2)+
1.57081E-3*(TK1**3-TK2**3));
TD=(TC(NA)-TC(1))/(NA-1); PD=(P(NA)-P(1))/(NA-1);
DO I=2 TO NA-1; TC(I)=TC(1)+(I-1)*TD; P(I)=P(1)+(I-1)*PD; END;
PD=(P(NF)-P(NA+1))/(NF-NA-1);
DO I=NA+2 TO NF-1; P(I)=P(NA+1)+(I-NA-1)*PD; END;
TD=(TC(NF)-TC(NA+2))/(NF-NA-2);
DO I=NA+2 TO NF-1; TC(I)=TC(NA+2)+(I-NA-2)*TD; END;
PD=(P(N)-P(NF+1))/(N-NF-1);
DO I=NF+2 TO N-1; P(I)=P(NF+1)+(I-NF-1)*PD; END;
TD=(TC(N)-TC(NF+2))/(N-NF-2);
DO I=NF+2 TO N; TC(I)=TC(NF+2)+(I-NF-2)*TD; END;
DO I=1 TO N-1; A(I,I)=-1; B(I,I)=-1;
A(I,I+1)=1; B(I+1,I)=1; END;
A(N,N),B(N,N)=-1;
A(NF,NF+1),A(NA+1,NA+1),A(NA,NA+1),A(NF+1,NF+1)=0;
B(NF+1,NF)=0; B(NF+NSR+2,NF)=1;
VS(NA,NA)=100.0-VP(NA+1,NA+1);
LS(1,1)=-LF(N,N)+VS(NA,NA)-VS(1,1);
DO I=2 TO NA; LS(I,I)=LS(1,1); VS(I,I)=VS(NA,NA); END;
LS(NA+1,NA+1)=VS(NF,NF)+VP(NA+1,NA+1);
DO I=NA+2 TO NA+NFR+2; LS(I,I)=LS(NA+1,NA+1);
VS(I,I)=VS(NF,NF); END;
DO I=NA+NFR+2 TO NF; LS(I,I)=LS(NA,NA)+LS(NA+1,NA+1);
VS(I,I)=VS(NF,NF); END;
LS(NF,NF)=LS(NF,NF)-VS(NF,NF); LP(NF,NF)=0;
VP(NA,NA+1)=-VP(NA+1,NA+1); LP(1,N)=-LP(N,N);
LS(NF+1,NF+1)=VS(NF+2,NF+2)+VP(NF+1,NF+1);
LS(NF+2,NF+2)=VS(N,N)+VP(NF+1,NF+1);
DO I=NF+3 TO N-1; VS(I,I)=VS(N,N); END;
IF NSR>=2 THEN DO; DO I=NF+3 TO NF+NSR+1;
LS(I,I)=LS(NF+2,NF+2); END; END;
DO I=NF+NSR+2 TO N; LS(I,I)=LS(NF,NF)+LS(NF+2,NF+2); END;
LS(N,N)=LS(N-1,N-1)-VS(N,N)+LP(N,N);
VS(NA+1,NA+1)=0; /***** FOR FIXED COND FLOW *****/
VS(NF+1,NF+1)=0; /***** FOR FIXED COND FLOW *****/
B(NA+NFR+2,NA)=1; /**** FOR BYPASSING CONDENSER ****/
B(NA+1,NA)=0; /**** FOR BYPASSING CONDENSER ****/

```

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VBOIL: PROC(Q,T); DCL H,V; DCL(Q,T,TK) BINARY FLOAT; TK=T+40;
H=137.8-0.729036*TK-1.42469E-3*TK*TK-8.115044E-5*TK**3;
H=24.45*H; V=Q/H; RETURN(V); END VBOIL; END SETUP;
PUT PAGE EDIT('CONSTANTS FOR THE IDEAL GAS (P=0) HEAT ',
'CAPACITY EQUATIONS')(SKIP(3),X(24),A,A); PUT SKIP
EDIT('***** (CP = A + B*T + C*T**2) *****')(X(35),A);
PUT SKIP(2) EDIT((49)'-')(X(29),A);
PUT SKIP EDIT('COMPONENT','A','B','C')(X(30),A,X(7),A,X(12),
A,X(12),A); PUT SKIP EDIT((49)'-')(X(29),A); PUT SKIP;
DO I=1 TO 6; PUT SKIP EDIT(IDENT(I),ALPHA(I),BETA(I),

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GAMMA(I)) (X(33),A(4),X(4),3 (E(10,3),X(3))) ; END;
PUT SKIP(2) EDIT((49)'-') (X(29),A);
PUT SKIP EDIT('*** NOTE: CP <=> CAL/GMOL-DEG K, ',
'T <=> DEG K.')(X(29),A,A);
CALL HENRYS(1,M,VS1,TK,HE);
CALL ACTCO(1,M,TK,XX(1,*),GAM(1,*));
CALL RKWONG(1,M,Y(1,*),P(1),TK,PHIG(1,*),DELHBAR(1,*),DELH);
CALL PMVOL(1,TK,VS1,VBAR); TK=FGAST+273.15;
CALL RKWONG(2,M,YPFED,P(NA),TK,DPhi,DDHBAR,DELH);
CALL FINDH(FGAST,YPFED,100,DDHBAR,DELTAH); QF(NA,1)=DELTAH;
CALL RKWONG(2,M,YRECY,P(NA),TK,DPhi,DDHBAR,DELH); QIN=DELTAH;
CALL FINDH(FGAST,YRECY,-V F(NA+1,NA+1),DDHBAR,DELTAH);
QF(NA,1)=QF(NA,1)+DELTAH; TK=TC(NA+1)+273.15;
CALL RKWONG(2,M,YRECY,P(NA+1),TK,DPhi,DDHBAR,DELH);
CALL FINDH(TC(NA+1),YRECY,-V P(NA+1,NA+1),DDHBAR,DELTAH);
QF(NA,1)=QF(NA,1)-DELTAH; QCOMP=(QF(NA,1)-QIN)/CNV;

```

/* ** NOTE: TWO-PHASE ABSORBER FEED NOT ALLOWED ** */

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PUT PAGE EDIT('RUN NUMBER ',IDRUN,(25)'-') (X(9),A,A,SKIP,
X(9),A); PUT SKIP(3) EDIT('A SUMMARY OF USER ',
'SPECIFIED INPUT INFORMATION',(45)'-',(45)'-') (X(9),A,A,SKIP,
X(9),A,SKIP(0),X(9),A); PUT SKIP(2) EDIT('STAGE ALLOCATIONS:',
(18)'-', 'ABSCBBER (ABS)',NA,'FRACTIONATOR (FRC)',NF-NA,
'STRIPPER (STR)',N-NF) (X(14),A,SKIP,X(14),A,SKIP,X(17),A(29),
F(3),SKIP,X(17),A(29),F(3),SKIP,X(17),A(29),F(3)); PUT
SKIP(2) EDIT('SPECIFIC STAGE NUMBERS:',(23)'-', 'FRC CONDENSER',
NA+1,'... FEED PLATE',NA+NFR+2,'... REBOILER',NF,
'STR FINAL CONDENSER',NF+1,'... REBOILER',N) (X(14),A,SKIP,
X(14),A,5 (SKIP,X(17),A(29),F(3))); PUT SKIP(2) EDIT
('SYSTEM PRESSURES (ATM):',(23)'-', 'ABSORBER',P(NA),
'FRACTIONATOR',P(NF), 'STRIPPER',P(N)) (X(14),A,SKIP,X(14),A,
3 (SKIP,X(17),A(25),F(7,2))); PUT SKIP(2) EDIT
('SYSTEM TEMPERATURES (DEG C):',(28)'-', 'ABS FEED GAS',FGAST,
'SOLVENT (ENTERING ABS)',SLTC,'FRC REBOILER',TC(NF),
'STR REBOILER',TC(N)) (X(14),A,SKIP,X(14),A,4 (SKIP,X(17),
A(24),F(8,2))); PUT SKIP(2) EDIT('GAS COMPOSITIONS ',
'(MOL PERCENT):',(31)'-', 'PROCESS FEED FRC RECYCLE ',
(IDENT(I),F(NA,I),100*YRECY(I) DO I=1 TO 6)) (X(14),A,A,SKIP,
X(14),A,SKIP,X(21),A,6 (SKIP,X(17),A(4),E(11,2),E(14,1)));
PUT SKIP(2) EDIT('FIXED FLOWRATES (SCFM):',(23)'-',
'PROCESS FEED',FDRAT,'FRC RECYCLE',FRATE,'STR OFF-GAS',SRATE,
'SOLVENT RECYCLE',SOLRT) (X(14),A,SKIP,X(14),A,4 (SKIP,X(17),
A(20),E(12,2))); PUT SKIP(2) EDIT('HEATING LOADS ',
'(BTU/HR):',(23)'-', 'FRC REBOILER',QNFR,'STR REBOILER',QN,
'STR MAIN CONDENSER',-XQN*QN,'GAS COMPRESSOR',QCOMP,
'SOLVENT COOLER',Q(1,1)/CNV) (X(14),A,A,SKIP,X(14),A,5 (SKIP,
X(17),A(20),E(12,2))); PUT SKIP EDIT((45)'-',(45)'-')
(X(9),A,SKIP(0),X(9),A);

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START: CALL MMGG(A,VS,N,N,N,TSNN); V=TSNN+VP;
CALL MMGG(B,LS,N,N,N,TSNN); L=TSNN+LP;
MH=1; CON=0.0; KOUNT=0; PUT PAGE; CALL CHART;

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CHART: PROCEDURE; DCL I,J;
PUT SKIP(2) EDIT((98)'-', 'STAGE', (8)'_', 'COMPONENT FEED ',
'RATES (GMOL) PER 100 GMOLS TOTAL FEED ', (8)'_',
'___ ENTHALPY ___', 'NO.', 'CO2', 'XE', 'O2', 'CO', 'N2', 'KR',
'LOADS FEED', (98)'-')(X(9),A,SKIP,X(10),A,X(3),A,A,A,A,
X(3),A,SKIP,X(11),A,X(7),A,X(9),4 (A,X(10)),
A,X(8),A,SKIP,X(9),A); DO I=1 TO N;
IF I=1 THEN PUT SKIP(2) EDIT('ABS...')(X(11),A);
IF I=NA+1 THEN PUT SKIP(2) EDIT('PRC...')(X(11),A);
IF I=NF+1 THEN PUT SKIP(2) EDIT('STR...')(X(11),A);
PUT SKIP EDIT(I, (F(I,J) DO J=1 TO M),Q(I,1),QF(I,1))
(X(11),F(2),X(4),6 (E(10,3),X(2)),F(8,0),F(9,0)); BND;
PUT SKIP(2) EDIT((98)'-', (X(9),A); PUT SKIP EDIT
('*** NOTE: HEAT LOADS AND FEED ENTHALPIES ARE ',
'GIVEN AS CAL/100 GMOLS FEED.')(X(9),A,A); END CHART;

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TABLE: PROCEDURE; TAB=V; PUT SKIP(5) EDIT((15)'_',
'TOTAL VAPOR FLOW(GMOL/100 GMOL FEED) MATRIX ', (15)'_',
(X(24),A,A,A); CALL TABIT; TAB=L; PUT PAGE EDIT((15)'_',
'TOTAL LIQUID FLOW(GMOL/100 GMOL FEED) MATRIX ', (15)'_')(SKIP(
5),X(22),A,A,A); CALL TABIT; TAB=VP; PUT PAGE EDIT((15)'_',
'FIXED VAPOR FLOW(GMOL/100 GMOL FEED) MATRIX ', (15)'_')(SKIP(
5),X(22),A,A,A); CALL TABIT; TAB=LP; PUT PAGE EDIT((15)'_',
'FIXED LIQUID FLOW(GMOL/100 GMOL FEED) MATRIX ', (15)'_')(SKIP
(5),X(24),A,A,A); CALL TABIT; TAB=VS; PUT PAGE EDIT((15)'_',
'VARIABLE VAPOR FLOW(GMOL/100 GMOL FEED) MATRIX ', (15)'_')
(SKIP(5),X(23),A,A,A); CALL TABIT; TAB=LS; PUT PAGE EDIT(
(15)'_', 'VARIABLE LIQUID FLOW(GMOL/100 GMOL FEED) MATRIX ',
(15)'_')(SKIP(5),X(22),A,A,A); CALL TABIT; TAB=A; PUT PAGE
EDIT((15)'_', 'VAPOR DISTRIBUTION MATRIX ', (15)'_')(SKIP(5),
X(31),A,A,A); CALL TABIT; TAB=B;
PUT PAGE EDIT((15)'_', 'LIQUID DISTRIBUTION MATRIX ',
(15)'_')(SKIP(5),X(31),A,A,A); CALL TABIT;

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TABIT: PROCEDURE; DCL I,J; PUT SKIP(2) EDIT((116)'-', (X(2),A);
DO I=1 TO N; IF I=1 THEN PUT SKIP(3) EDIT((20)'_', 'ABSORBER ',
(20)'_')(X(45),A,A,A); IF I=NA+1 THEN PUT PAGE EDIT
((18)'_', 'FRACTIONATOR ', (18)'_')(X(45),A,A,A); IF I=NF+1
THEN PUT PAGE EDIT((20)'_', 'STRIPPER ', (20)'_')(X(45),A,A,
A); PUT SKIP(2) EDIT('STAGE NO. ',I,': ', (TAB(I,J)
DO J=1 TO N)(X(3),A,F(2),A,(N/10+1)(10 F(10,2),SKIP,X(17)));
END; PUT SKIP(2) EDIT((116)'-', (X(2),A); END TABIT; END TABLE;

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START1: ET,EV,JT,JV,GT,GV,HT,HV,R=0; KOUNT=KOUNT+1; TPS=1;
IF KOUNT=1 THEN IC; CALL HENRYS(2,M,VS1,T0-.5,HE1);
CALL HENRYS(2,M,VS1,T0+.5,HE2);
DO I=2 TO M; GSO(I)=-(LOG(HE2(I,1))-LOG(HE1(I,1)))/
(1/(T0+.5)-1/(T0-.5))*1.98726; END;
TSM=0; TSM(1)=1; P15=VPPUNCT(T0);

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CALL RKWONG(2,M,TSM,P1S,T0,PHIG(1,*),DELHBAR(1,*),DELH);
GSO(1)=DELH+3369.2; END; /**** HEAT OF VAP FROM PERRY ****/
/*****NOTE: GSO(I=1,...,6) = IDEAL GAS ENTHALPIES AT -40 C****/
/** 3513.04 1128.74 -495.138 125.278 -930.111 139.805 **/
/*****
FF=0; DEL=0; PSI=0; K,HS,GS,DK,DH,DG=0; UM=1;
UN=1; J=0; NORM=0; SUMY=0; SUMX=0; H,G=0;
IF KOUNT=1 THEN LC; PHIG=1; DELHBAR=0; GAM=1.0; END;
ELSE DO; DO I=1 TO N; TK=TC(I)+273.15;
CALL RKWONG(2,M,YY(I,*),P(I),TK,PHIG(I,*),DELHBAR(I,*),DELH);
CALL ACTCO(2,M,TK,XX(I,*),GAM(I,*)); END; END;

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START2: J=J+1; M0,M1,M2,M3,M4=0;
DO I=1 TO N; FF(I,1)=F(I,J); TK=TC(I)+273.15;
RT=82.0574*TK; TK1=TC(I)+274.15; TK2=TC(I)+275.15;
P1S=VPPUNCT(TK);
IF J=1 THEN DO; CALL HENRYS(2,M,VS1,TK,HE); TSM=0; TSM(1)=1;
CALL RKWONG(2,M,TSM,P1S,TK,TPS,TSNM(I,*),DELH);
K(I,I)=GAM(I,1)*TPS(1)*P1S*EXP((VS1*(P(I)-P1S))/RT)/
(P(I)*PHIG(I,1)); DK(I,I)=DVPPUNCT(TK)/P(I); END;
ELSE DO; CALL HENRYS(2,M,VS1,TK1,HE1);
CALL HENRYS(2,M,VS1,TK2,HE2); CALL HENRYS(2,M,VS1,TK,HE);
K(I,I)=HE(J,1)/P(I); /**** FOR DERIVATIVE USE ONLY ****/
K1=HE1(J,1)/P(I); DK(I,I)=K1-K(I,I);
CALL FNVOL(2,TK,VS1,VBAR);
VCOR=(1+KAPA(J)*P1S)*(P(I)-P1S)-KAPA(J)*(P(I)*P(I)-
P1S*P1S)/2; VCOR=EXP(VCOR*VBAR(J)/RT);
K(I,I)=(K(I,I)*GAM(I,J)*VCOR)/PHIG(I,J); END;
GS(I,I)=ALPHA(J)*(TK-T0)+BETA(J)*(TK**2-T0**2)/2+
GAMMA(J)*(TK**3-T0**3)/3+GSO(J)-DELHBAR(I,J);
DG(I,I)=ALPHA(J)+BETA(J)*TK+GAMMA(J)*TK*TK;
IF J=1 THEN DO; HS(I,I)=2.790974416E+02*(TK-T0)-2.209824996*
(TK**2-T0**2)/2+4.712433563E-03*(TK**3-T0**3)/3; DH(I,I)=
2.790974416E+2-2.209824996*TK+4.712433563E-3*TK*TK; END;
ELSE DO; HS(I,I)=(LOG(HE1(J,1))-LOG(HE(J,1)))/(1/TK1-1/TK)*
1.98726+GS(I,I)+DELHBAR(I,J); HS1=(LOG(HE2(J,1))-
LOG(HE1(J,1)))/(1/TK2-1/TK1)*1.98726+GS(I,I)+
DELHBAR(I,J); DH(I,I)=HS1-HS(I,I); END; END;
CALL MMGG(V,K,N,N,N,TSNN); Z=L+TSNN; TSDNN=Z;
CALL MINV#(TSDNN,N,D,CON); ITZ=-TSDNN;
CALL MMGG(ITZ,FF,N,N,N,MM,X); CALL MMGG(K,X,N,N,N,MM,Y);
DO I=1 TO N; M0(I,I)=DK(I,I)*X(I,1); END;
CALL MMGG(ITZ,V,N,N,N,TSNN); CALL MMGG(TSNN,M0,N,N,N,XT);
CALL MMGG(K,XT,N,N,N,TSNN); YT=M0+TSNN; TSDNN=B;
CALL MINV#(TSDNN,N,DD,CON); ITB=TSDNN;
CALL MMGG(ITB,A,N,N,N,R); DO I=1 TO N; DO II=1 TO N;
M1(I,II)=R(I,II)*X(I,1); M2(I,II)=A(I,II)*Y(II,1); END;
M3(I,I)=DH(I,I)*X(I,1); M4(I,I)=DG(I,I)*Y(I,1); END;
CALL MMGG(P,M1,N,N,N,TSNN); TSNN=TSNN-M2; ITZ=-ITZ;
CALL MMGG(ITZ,TSNN,N,N,N,XV); CALL MMGG(K,XV,N,N,N,YV);
ET=ET+XT-YT; EV=EV+XV-YV; CALL MMGG(HS,XT,N,N,N,TSNN);

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HT=HT+TSNN+M3; CALL MMGG(GS,YT,N,N,N,TSNN);
GT=GT+TSNN+M4; CALL MMGG(HS,XV,N,N,N,TSNN); HV=HV+TSNN;
CALL MMGG(GS,YV,N,N,N,TSNN); GV=GV+TSNN;
DO I=1 TO N; XX(I,J)=X(I,1); YY(I,J)=Y(I,1); END;
SUMX=SUMX+X; SUMY=SUMY+Y; CALL MMGG(HS,X,N,N,MM,TSN1);
H=H+TSN1; CALL MMGG(GS,Y,N,N,MM,TSN1); G=G+TSN1;
IF J<M THEN GO TO START2;
DO I=1 TO N; NORM(I,I)=1/SUMX(I,1); END;
CALL MMGG(ET,NORM,N,N,N,TSNN); ET=TSNN; TSNM=XX-YY;
CALL MMGG(TSNM,UM,N,N,M,MM,DM); CALL MMGG(L,H,N,N,MM,TSN1);
DE=TSN1+Q+QF; CALL MMGG(V,G,N,N,MM,TSN1); DE=DE+TSN1;
ADM=SUM(DM*DM); ADE=SUM(DE*DE); ADM=SQRT(ADM); ADE=SQRT(ADE);
CALL MMGG(L,HT,N,N,N,TSNN); JT=TSNN;
CALL MMGG(V,GT,N,N,N,TSNN); JT=TSNN+JT;
DO I=1 TO N; DO II=1 TO N; W1(I,II)=R(I,II)*H(I,1);
W2(I,II)=A(I,II)*G(II,1); END; END;
CALL MMGG(B,W1,N,N,N,TSNN); JV=-TSNN;
CALL MMGG(L,HV,N,N,N,TSNN); JV=JV+TSNN;
CALL MMGG(V,GV,N,N,N,TSNN); JV=JV+TSNN+W2;
DO I=1 TO N; DO II=1 TO N; PSI(I,II)=ET(I,II);
PSI(I,II+N)=EV(I,II); PSI(I+N,II)=JT(I,II);
PSI(I+N,II+N)=JV(I,II); END;
PSI(I,N+NA+1)=0; /**** FOR VARIABLE Q(NA+1) ****/
PSI(I,N+NF+1)=0; /**** FOR VARIABLE Q(NF+1) ****/
PSI(I+N,N+NA+1)=0; /**** FOR VARIABLE Q(NA+1) ****/
PSI(I+N,N+NF+1)=0; /**** FOR VARIABLE Q(NF+1) ****/
DEL(I,1)=DM(I,1); DEL(I+N,1)=DE(I,1); END;
PSI(N+NA+1,N+NA+1)=1; /**** FOR VARIABLE Q(NA+1) ****/
PSI(N+NF+1,N+NF+1)=1; /**** FOR VARIABLE Q(NF+1) ****/
CALL MINV*(PSI,NDIM,DDD,COM); IPSI=PSI; DEL=-DEL;
CALL MMGG(IPSI,DEL,NDIM,NDIM,MM,C);
DO I=1 TO N; TC(I)=TC(I)+C(I,1); END;
DO I=1 TO NA,NA+2 TO NF,NF+2 TO N; /**** FOR VARIABLE Q'S ****/
VS(I,I)=VS(I,I)+C(I+N,1); END;
Q(NA+1,1)=Q(NA+1,1)+C(N+NA+1,1); /**** FOR VARIABLE Q'S ****/
Q(NF+1,1)=Q(NF+1,1)+C(N+NF+1,1); /**** FOR VARIABLE Q'S ****/
CALL MMGG(A,VS,N,N,N,TSNN); V=TSNN+VP;
CALL MMGG(F,UM,N,N,MM,SUMM); CALL MMGG(V,UN,N,N,MM,TSN1);
SUMM=SUMM+TSN1; CALL MMGG(LP,UN,N,N,MM,TSN1);
SUMM=SUMM+TSN1; SUMM=-SUMM; CALL MMGG(ITB,SUMM,N,N,MM,TSN1);
DO I=1 TO N; LS(I,I)=TSN1(I,1); END;
CALL MMGG(E,LS,N,N,N,TSNN); L=TSNN+LP;
PUT PAGE EDIT('ENERGY','MATERIAL','ITERATION','BALANCE ERROR',
'....',ADE,'BALANCE ERROR....',ADM,'NUMBER.....',KOUNT)
(X(5),A,X(24),A,X(22),A,SKIP,X(5),A,A,E(10,3),X(4),A,
E(10,3),X(4),A,F(1)); PUT SKIP EDIT((75)'-')(X(4),A);
PUT SKIP(3) EDIT((65)'-')(X(9),A); PUT SKIP EDIT('STAGE',
'TEMP','LIQUID','VAPOUR','LIQUID','VAPOUR','PRESS','NO.',
'DEGC','RATE','RATE','ENTHALPY','ENTHALPY','ATM')(X(10),
A,X(4),A,X(5),A,X(4),A,X(4),A,X(4),A,X(4),A,SKIP,X(11),A,
X(5),A,X(6),A,X(6),A,X(4),A,X(2),A,X(4),A); PUT SKIP EDIT

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((65)'-') (X(9),A); DO I=1 TO N; IF I=1|I=NA+1|I=NF+1 THEN
PUT SKIP; PUT SKIP EDIT(I,TC(I),-L(I,I),-V(I,I),H(I,1),
G(I,1),P(I))(F(13),F(11,2),F(10,1),F(10,2),F(10,2),
F(10,1),F(9,2)); END; PUT SKIP(2) EDIT((65)'-') (X(9),A);
PUT EDIT('*** NOTE: FLOWS <=> GMOL/100 GMOL FEED, ',
'ENTHALPIES <=> CAL/GMOL.') (SKIP,X(9),A,A);

IF ADM<1E-4 THEN IF ADE<1E+3 THEN GO TO PRINT; ELSE; ELSE;
CALL MMGG(NORM,XX,N,N,M,TSNM); XX=TSNM;
DO I=1 TO N; NORM(I,I)=1/SUMY(I,1); END;
CALL MMGG(NORM,YY,N,N,M,TSNM); YY=TSNM; GO TO START1;

PRINT: PUT SKIP(2) EDIT('*** DA DA DA DAT'S ALL FOLKS ***') (X(26),A);
SLGF,SLGA,SLGR,SLGP,SLGL=0.0;
DO J=2 TO M; SLGF=SLGF+F(NA,J);
SLGR=SLGR-V(NA+1,NA+1)*YY(NA+1,J);
SLGA=SLGA-V(1,1)*YY(1,J);
SLGL=SLGL-(L(N,N)+LP(1,N))*XX(N,J);
SLGP=SLGP-V(NF+1,NF+1)*YY(NF+1,J); END;
FEED=0.0; DO J=1 TO M; FEED=FEED+F(NA,J); END;
PKRR=(-V(NF+1,NF+1)*YY(NF+1,M))/F(NA,M);
PDF=1.0/(1.0-PKRR); PLGR=SLGP/SLGF;
PKRB=(-(L(N,N)+LP(1,N))*XX(N,M))/F(NA,M);
RKRR=(-V(NA+1,NA+1)*YY(NA+1,M))/F(NA,M);
PKRV=(-V(1,1)*YY(1,M))/F(NA,M);
CPKR=(YY(NF+1,M)/F(NA,M))*FEED;
CPKRLG=((PCF-1.0)/PDF)*(SLGF/SLGP);
CKRDF=(1.0+RKRR)/PKRV; RLGR=SLGR/SLGF;
CTLRKR=PKRR/(1.0-PKRR); CTLRLG=SLGP/(1.0-SLGP);

FRMT1: FORMAT(X(10),A(35),E(15,6));
FRMT2: FORMAT(X(10),A(35),F(15,2));
FRMT3: FORMAT(X(10),A(35),F(15,6));

PFINL: PROCEDURE; PUT PAGE EDIT('FINAL VALUES FOR CASE ',IDRUN,
'...',(38)'-') (SKIP,X(5),A,A,A,SKIP,X(5),A); END PFINL;
CALL PFINL; CALL CHART; CALL PFINL; CALL TABLE;
CALL PFINL; PUT SKIP(3) EDIT((67)'-') (X(9),A); PUT SKIP EDIT
('STAGE','T,DEGC','L-RATES','V-RATES','H-LIQD','H-VAPOR',
'P,ATM')(X(10),A,X(2),A,5(X(4),A)); PUT SKIP EDIT((67)'-')
(X(9),A); DO I=1 TO N; IF I=1 THEN PUT SKIP(2) EDIT
('ABS...' ) (X(10),A); IF I=NA+1 THEN PUT SKIP(2) EDIT
('FRC...' ) (X(10),A); IF I=NF+1 THEN PUT SKIP(2) EDIT
('STR...' ) (X(10),A); PUT SKIP EDIT(I,TC(I),-L(I,I),-V(I,I),
H(I,1),G(I,1),P(I))(X(11),F(2),F(10,2),F(11,2),
F(11,3),F(10,2),F(11,2),F(9,2)); END;
PUT SKIP(2) EDIT((67)'-') (X(9),A); PUT SKIP EDIT
('*** NOTE: FLOWRATES(GMOL/100 GMOL FEED) AND ENTHALPIES',
'(CAL/GMOL)', 'REFER TO STREAMS LEAVING THAT STAGE.')
(X(9),A,A,SKIP,X(21),A);
CALL PFINL; PUT SKIP(3) EDIT((99)'-', 'STAGE', (26)'-',
' VAPOR PHASE MOLE FRACTIONS ', (26)'-', 'SUM OF', 'NO.', 'CO2',
'XE', 'O2', 'CO', 'N2', 'KR', 'Y' S', (99)'-') (X(9),A,SKIP,X(10),A,
X(2),A,A,A,X(4),A,SKIP,X(11),A,X(6),A,X(11),4 (A,X(12)),A,X(10)

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,A,SKIP,X(9),A); DO I=1 TO N; IF I=1 THEN PUT SKIP EDIT
('ABS...')(X(10),A); IF I=NA+1 THEN PUT SKIP EDIT('PRC...')
(X(10),A); IF I=NF+1 THEN PUT SKIP EDIT('STR...')(X(10),A);
PUT SKIP EDIT(I,(YY(I,J) DO J=1 TO M),SUMY(I,1))(X(11),
F(2),6 (E(14,4)),F(10,4)); END; PUT SKIP(2) EDIT((99)'-')(X(9),
A); PUT SKIP EDIT('*** NOTE: MOLE FRACTIONS REFER TO ',
'VAPOR LEAVING THAT STAGE.')(X(9),A,A);
CALL PFINL; PUT SKIP(3) EDIT((99)'-', 'STAGE', (26)'-',
' LIQUID PHASE MOLE FRACTIONS ', (25)'-', 'SUM OF', 'NO.', 'CO2',
'XE', 'O2', 'CO', 'N2', 'KR', 'X' S', (99)'-')(X(9),A,SKIP,X(10),
A,X(2),A,A,A,X(4),A,SKIP,X(11),A,X(6),A,X(11),4 (A,X(12)),A,
X(10),A,SKIP,X(9),A); DO I=1 TO N; IF I=1 THEN PUT SKIP EDIT
('ABS...')(X(10),A); IF I=NA+1 THEN PUT SKIP EDIT('PRC...')
(X(10),A); IF I=NF+1 THEN PUT SKIP EDIT('STR...')(X(10),A);
PUT SKIP EDIT(I,(XX(I,J) DO J=1 TO M),SUMX(I,1))(X(11),
F(2),6 (E(14,4)),F(10,4)); END; PUT SKIP(2) EDIT((99)'-')(X(9),
A); PUT SKIP EDIT('*** NOTE: MOLE FRACTIONS REFER TO ',
'LIQUID LEAVING THAT STAGE.')(X(9),A,A);
CALL PFINL; PUT SKIP(3) EDIT((83)'-', 'STAGE ', (19)'-',
' STAGewise EQUILIBRIUM RATIOS (Y/X) ', (19)'-', 'NO.', 'CO2',
'XE', 'O2', 'CO', 'N2', 'KR', (83)'-')(X(9),A,SKIP,X(10),A,A,A,A,
SKIP,X(11),A,X(6),A,X(10),A,4 (X(11),A),SKIP,X(9),A); PUT SKIP;
DO I=1 TO N; IF I=1 THEN PUT SKIP EDIT('ABS...')(X(10),A);
IF I=NA+1 THEN PUT SKIP EDIT('PRC...')(X(10),A); IF I=NF+1
THEN PUT SKIP EDIT('STR...')(X(10),A); PUT SKIP EDIT
(I,(YY(I,J)/XX(I,J) DO J=1 TO M))(X(11),F(2),6 (E(13,3))); END;
PUT SKIP(2) EDIT((83)'-')(X(9),A); PUT SKIP EDIT('*** NOTE: ',
'Y AND X REFER TO STREAMS LEAVING THAT STAGE.')(X(9),A,A);
CALL PFINL; PUT SKIP(3) EDIT((96)'-')(X(9),A); PUT SKIP EDIT
('STAGE', 'L/V', (19)'-', ' STAGewise ABSORPTION FACTORS (L/VK) ',
(18)'-')(X(10),A,X(5),A,X(7),A,A,A); PUT SKIP EDIT('NO.',
'RATIO', 'CO2', 'XE', 'O2', 'CO', 'N2', 'KR')(X(11),A,X(5),
A,X(9),A,X(10),A,4 (X(11),A)); PUT SKIP EDIT((96)'-')(X(9),A);
DO I=1 TO N; IF I=1 THEN PUT SKIP EDIT('ABS...')(X(10),A);
IF I=NA+1 THEN PUT SKIP EDIT('PRC...')(X(10),A); IF I=NF+1
THEN PUT SKIP EDIT('STR...')(X(10),A); PUT SKIP EDIT
(I,L(I,I)/V(I,I),((L(I,I)*XX(I,J))/(V(I,I)*YY(I,J)
DO J=1 TO M))(X(11),F(2),7 (E(13,3))); END; PUT SKIP(2) EDIT
((96)'-')(X(9),A); PUT SKIP EDIT
('*** NOTE: K <=> Y/X. L,V,Y, AND X REFER TO STREAMS ',
'LEAVING THAT STAGE.')(X(9),A,A); CALL PFINL;
PUT SKIP(3) EDIT((87)'-', 'BETWEEN ', (19)'-',
' INTERSTAGE OPERATING RATIOS (Y/X) ', (20)'-', 'STAGE NOS',
'CO2', 'XE', 'O2', 'CO', 'N2', 'KR', (87)'-')(X(9),A,SKIP,X(11),A,
A,A,A,SKIP,X(10),A,X(5),A,X(10),A,4 (X(11),A),SKIP,X(9),A);
DO I=1 TO NA-1, NA+1 TO NF-1, NF+1 TO N-1; IF I=1 THEN PUT SKIP
EDIT('ABS.....')(X(10),A); IF I=NA+1 THEN PUT SKIP EDIT
('PRC.....')(X(10),A); IF I=NF+1 THEN PUT SKIP EDIT('STR.....')
(X(10),A); PUT SKIP EDIT(I,'-',I+1,(YY(I+1,J)/XX(I,J) DO J=1
TO M))(X(12),F(2),A,F(2),6 (E(13,3))); END; PUT SKIP(2) EDIT(
(87)'-')(X(9),A); PUT SKIP EDIT('*** NOTE: Y AND X REFER TO ',
'STREAMS PASSING ONE ANOTHER BETWEEN THESE STAGES.')(X(9),A,A);

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CALL PFINL; PUT SKIP(3) EDIT((100)'-', 'BETWEEN', 'L/V', (18)'-',
' INTERSTAGE ABSORPTION FACTORS (L/VK) ', (18)'-', 'STAGE NOS',
'RATIO', 'CO2', 'XE', 'O2', 'CO', 'N2', 'KR', (100)'-') (X(9), A, SKIP,
X(11), A, X(6), A, X(7), A, A, A, SKIP, X(10), A, X(4), A, X(9), A, X(10), A,
4 (X(11), A), SKIP, X(9), A); DO I=1 TO NA-1, NA+1 TO NF-1, NF+1
TO N-1; IF I=1 THEN PUT SKIP EDIT('ABS.....') (X(10), A);
IF I=NA+1 THEN PUT SKIP EDIT('FRC.....') (X(10), A); IF I=NF+1
THEN PUT SKIP EDIT('STR.....') (X(10), A); PUT SKIP EDIT
(I, '-', I+1, (L(I, I)/V(I+1, I+1)), ((L(I, I)*XX(I, J))/(V(I+1, I+1)*
YY(I+1, J)) DO J=1 TO M)) (X(12), F(2), A, F(2), 7 (E(13, 3))); END;
PUT SKIP(2) EDIT((100)'-', (X(9), A); PUT SKIP EDIT('*** NOTE:',
' K <=> Y/X. L, V, Y, AND X REFER TO STREAMS PASSING ONE ',
'ANOTHER BETWEEN THESE STAGES.') (X(9), A, A, A);
CALL PFINL; PUT SKIP(3) EDIT((52)'-', 'SUMMARY OF ',
'PERFORMANCE', (52)'-') (X(9), A, SKIP, X(24), A, A, SKIP, X(9), A);
PUT SKIP(2) EDIT('ENERGY BALANCE ERROR', ADE) (R(FRMT1));
PUT SKIP(2) EDIT('MATERIAL BALANCE ERROR', ADM) (R(FRMT1));
PUT SKIP(2) EDIT('FEED STAGES', NA, NA+NFR+2, NF+NSR+2)
(X(10), A(35), X(3), 3 F(4));
PUT SKIP(2) EDIT('FRC CONDENSER LOAD, BTU/HR',
Q(NA+1, 1)/CNV) (R(FRMT1));
PUT SKIP EDIT(' " REBOILER HEAT, BTU/HR',
Q(NF, 1)/CNV) (R(FRMT1));
PUT SKIP(2) EDIT('STR FINAL CONDENSER LOAD, BTU/HR',
Q(NF+1, 1)/CNV) (R(FRMT1));
PUT SKIP EDIT(' " MAIN CONDENSER LOAD, BTU/HR',
Q(NF+2, 1)/CNV) (R(FRMT1));
PUT SKIP EDIT(' " REBOILER HEAT, BTU/HR',
Q(N, 1)/CNV) (R(FRMT1));
PUT SKIP(2) EDIT('SCRUB COOLING LOAD, BTU/HR',
Q(1, 1)/CNV) (R(FRMT1));
PUT SKIP(2) EDIT('KRYPTON PROCESS DF', PDF) (R(FRMT2));
PUT SKIP EDIT(' " COLUMN DF', CKRDF) (R(FRMT2));
PUT SKIP EDIT(' " PROCESS CF', CPKR) (R(FRMT2));
PUT SKIP EDIT(' " CF, REL/LG', CPKRLG) (R(FRMT2));
PUT SKIP(2) EDIT('FRACTION KR RECOVERED', FKRR) (R(FRMT3));
PUT SKIP EDIT(' " KR VENTED', FKRV) (R(FRMT3));
PUT SKIP EDIT(' " KR BYPASSED', FKRB) (R(FRMT3));
PUT SKIP EDIT(' " LG RECOVERED', FLGR) (R(FRMT3));
PUT SKIP(2) EDIT('KRYPTON RECYCLE RATIO', RKRR) (R(FRMT3));
PUT SKIP EDIT(' " CAP/LOSS RATIO', CTLRKR) (R(FRMT2));
PUT SKIP(2) EDIT('LIGHT GAS RECYCLE RATIO', RLGR) (R(FRMT3));
PUT SKIP EDIT(' " CAP/LOSS RATIO', CTLRLG) (R(FRMT3));
PUT SKIP(2) EDIT('ABS FEED GAS TEMP, C', FGAST) (R(FRMT2));
PUT SKIP(2) EDIT('ABS FEED LIQ TEMP, C (EST)', SLTC) (R(FRMT2));
PUT SKIP(2) EDIT((52)'-', (X(9), A);
DO I=6, 3; YFEED(I) = (F(NA, I) + VP(NA, NA+1)*YY(NA+1, I))/
(FEED+VP(NA, NA+1)); END;
PUT FILE (PUNCH) SKIP EDIT('$JOB GES)6452,22(',
'$PASSWORD RGLASS', '$DECK RPIPT.RG')
(A(17), SKIP, A(16), SKIP, A(15));
PUT FILE (PUNCH) SKIP EDIT(N, NA, NA+NFR+2, NF, NF+NSR+2,

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      ' 2', (YFEED(I) DO I = 6,3))
      (5 (F(2),X(6)),A(2),X(6),2 E(10,3));
DO I=1 TO N; PUT FILE (PUNCH) SKIP EDIT
      (I,XX(I,6),YY(I,6)) (X(5),F(2),2 E(15,4)); END;
DO I=1 TO N; PUT FILE (PUNCH) SKIP EDIT
      (I,XX(I,3),YY(I,3)) (X(5),F(2),2 E(15,4)); END;
PUT FILE (PUNCH) SKIP EDIT('$EOD') (A(4));

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FINDH: PROCEDURE(T,Y,V,DELHBAR,DELTAH);
DCL H(6),I,T2; DCL (Y(*),V,T,DELHBAR(*)) BINARY FLOAT;
T2=T+273.15; DELTAH=0.0;
H(1)=3513.04; H(2)=1128.74; H(3)=-495.138;
H(4)=125.278; H(5)=-930.111; H(6)=139.805;
DO I=1 TO 6;
  DELTAH=DELTAH+V*Y(I)*(H(I)-DELHBAR(I)+
    ALPHA(I)*(T2-T0)+BETA(I)*(T2*T2-T0*T0)/2.0+
    GAMMA(I)*(T2**3-T0**3)/3.0); END; END FINDH;

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VPPUNCT: PROC(T); /***** MICHELS, PHYSICA,XVI(5),P501,1950 *****/
DCL LOGVP FLOAT,T,VP;
LOGVP=24.61930-1353.202/T-8.142537*LOG10(T)+6.259156E-03*T;
VP=10.0*LCGVP; RETURN(VP); END VPPUNCT;

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DVPPUNCT: PROC(T); /***** CALCULATES VP DERIVATIVE *****/
DCL T,DPDT,LN10 FLOAT; LN10=LOG(10); DPDT=VPPUNCT(T);
DPDT=DPDT*(LN10*1353.202/(T*T)-8.142537/T+LN10*6.259156E-03);
RETURN(DPDT); END DVPPUNCT;

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PMVOL: PROC(L,T,VS1,VBAR); /** PARTIAL MOLAR VOLUME VIA R-K EQTN **/
DCL T,RT,VS1,VBAR(*),SCRAP,S(2) LABEL,I,VMB,VPB,L;
DCL (A(6,6),B(6),R) STATIC;
DCL (TC(6,6),PC(6),ZC(6),K(6,6) FLOAT,W(6),OMEGA(6),OMEGB(6),
  VC(6)) CTL; GO TO S(1);
S(1): ALLOCATE ZC,VC,TC,K,W INITIAL(0.225,0,0.021,0.041,0.040,0),
  PC INITIAL(72.8,57.6,49.8,34.5,33.5,54.3),
  OMEGA INITIAL(0.4184,0.4278,0.4278,0.4278,0.4278,0.4278),
  OMEGB INITIAL(0.0794,0.0867,0.0867,0.0867,0.0867,0.0867);
TC,A,K=0; ZC,VC=0; R=82.0574;
TC(1,1)=304.2; TC(2,2)=289.7; TC(3,3)=154.6;
TC(4,4)=132.9; TC(5,5)=126.2; TC(6,6)=209.4;
K(1,1)=0.0000; K(1,2)=0.0455; K(1,3)=0.0332;
K(1,4)=0.0020; K(1,5)=0.0133; K(1,6)=0.0042;
DO I=1 TO 6; ZC(I)=0.291-0.08*W(I);
  VC(I)=ZC(I)*R*TC(I,I)/PC(I); B(I)=OMEGB(I)*R*TC(I,I)/PC(I);
  TC(I,1)=SQRT(TC(I,I)*TC(1,1))*(1-K(1,I));
  A(I,1)=0.25*(OMEGA(I)+OMEGA(1))*R*(TC(I,1)**1.5)*
    (VC(I)+VC(1))/(0.291-0.04*(W(I)+W(1))); END;
PUT SKIP(5) EDIT(' CONSTANTS ASSOCIATED WITH THE ',
  'REDLICH-KWONG ', 'DERIVED PARTIAL MOLAR LIQUID VOLUMES ')
(X(19),A,A,A); PUT SKIP(2) EDIT(' (102) '-' ) (X(9),A);
PUT SKIP EDIT('COMPONENT','TC','PC','VC','ZC','W','KIJ',

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'AII','BII','OMGA','OMGB')(X(10),A,X(4),A,X(6),A,X(7),
A,X(6),A,X(7),A,X(6),A,X(7),A,X(9),A,X(7),A,X(5),A);
PUT SKIP EDIT((102)'-')(X(9),A); PUT SKIP; DO I=1 TO 6;
PUT SKIP EDIT(IDENT(I),TC(I,I),PC(I),VC(I),ZC(I),W(I),K(I,I),
A(I,I),B(I),OMEGA(I),OMEGB(I))(X(13),A,F(10,2),F(7,1),F(10,3),
F(8,4),F(8,3),F(8,3),E(12,3),E(12,3),F(9,4),F(9,4)); END;
PUT SKIP(2) EDIT((102)'-')(X(9),A); PUT SKIP EDIT
('*** NOTE: TC <=> DEGK, PC <=> ATM, VC <=> CC/GMOL,',
'A <=> (CC,ATM,GMOL,DEGK), B <=> CC/GMOL.')(X(9),A,A);
FREE ZC,VC,TC,PC,K; RETURN;
S(2): RT=R*T; VMB=VS1-B(1); VPB=VS1+B(1);
DO I=1 TO 6; VBAR(I)=RT*(1+B(I)/VMB)/VMB;
VBAR(I)=VBAR(I)-(2*A(I,1)-(A(1,1)*B(I))/VPB)/
(VS1*VPB*SQR(T)); SCRAP=RT/(VMB*VMB);
SCRAP=SCRAP-A(1,1)*(2*VS1+B(1))/(VS1*VS1*VPB*VPB*SQR(T));
VBAR(I)=VBAR(I)/SCRAP; END; END PMVOL;

ACTCO: PROC(L,M,T,X,GAM); /***** EQS D3 & D4,ORNL/TM-5099 *****/
DCL RT,S(2) LABEL,I,J,K; DCL (GAM(*),X(*)) BINARY FLOAT;
DCL L,M,T,SUM1,SUM2,A(6,6) STATIC; GO TO S(L);
S(1): A=0; A(2,2)=0.0; A(3,3)=992.6501; A(4,4)=448.3456;
A(6,6)=0.0; A(5,5)=1817.661;
DO I=2 TO M; DO J=I+1 TO M;
A(I,J)=(A(I,I)+A(J,J))/2; A(J,I)=A(I,J); END; END;
PUT SKIP(5) EDIT(' CONSTANTS ASSOCIATED WITH THE ',
'ACTIVITY COEFFICIENT SUBROUTINE ')(X(22),A,A);
PUT SKIP(2) EDIT((89)'-')(X(9),A); PUT SKIP EDIT('ALPHA (I,J)',
'J=1','J=2','J=3','J=4','J=5','J=6')(X(10),A,X(5),A,5 (X(10),
A(3))); PUT SKIP EDIT((89)'-')(X(9),A); PUT SKIP;
DO I=1 TO 6; PUT SKIP EDIT('I=',I,(A(I,J) DO J=1 TO 6))
(X(14),A,F(1),X(2),6 (X(3),E(10,3))); END;
PUT SKIP(2) EDIT((89)'-')(X(9),A);
PUT SKIP EDIT('*** NOTE: ALPHA <=> GMOL/CAL, CO2,XE,O2,',
'CO,N2,KR <=> 1,2,3,4,5,6 RESPECTIVELY.')(X(9),A,A); RETURN;
S(2): SUM1=0.0; RT=1.98726*T; DO J=2 TO M; DO I=2 TO M;
SUM1=SUM1+A(I,J)*X(I)*X(J); END; END;
DO K=2 TO M; SUM2=0.0; DO I=2 TO M;
SUM2=SUM2+X(I)*A(I,K); END;
GAM(K)=EXP((SUM1-2*SUM2)/RT); END;
GAM(1)=EXP(SUM1/RT); RETURN; END ACTCO;

HENRYS: PROC(L,M,VS1,T,H); /***** VALENTINER, Z PHYSIK,P253,1927 *****/
DCL S(2) LABEL,H(*),VS1,T,I;
DCL(A(6),B(6),C(6)) STATIC; GO TO S(L);
S(1): A=0; B=0; C=0;
A(2)=29.96148; B(2)=-3.670936; C(2)=-1423.981;
A(3)=108.2571; B(3)=-15.98780; C(3)=-3478.370;
A(4)=124.1770; B(4)=-18.24561; C(4)=-4316.308;
A(5)=78.20484; B(5)=-11.42092; C(5)=-2194.547;
A(6)=36.32377; B(6)=-4.782289; C(6)=-1185.152;
PUT SKIP(5) EDIT(' CONSTANTS ASSOCIATED WITH THE ',
' HENRYS CONSTANT EQUATIONS ',

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***** ( LN(H) = A + B*LN(T) + C/T ) ***** (X(25),A,A,SKIP,
X(33),A); PUT SKIP(2) EDIT((61)'-', 'COMPONENT', 'A',
'B', 'C') (X(23),A,SKIP,X(24),A,X(9),A,X(16),A,X(16),A);
PUT SKIP EDIT((61)'-', 'C') (X(23),A); PUT SKIP;
DO I=2 TO 6; PUT SKIP EDIT(IDENT(I),A(I),B(I),
C(I)) (X(27),A(4),X(5),3 (E(13,6),X(4))); END;
PUT SKIP (2) EDIT((61)'-', 'C') (X(23),A); PUT SKIP EDIT
('*** NOTE: H <=> ATM, T <=> DEGK.') (X(23),A); RETURN;
S(2): CALL CDVOL(T,VS1); DO I=2 TO M;
H(I,1)=A(I)+B(I)*LOG(T)+C(I)/T;
H(I,1)=EXP(H(I,1)); END; RETURN;

CDVOL: PROC(T,VS1); DCL T,TCMT,VS1; TCMT=304.15-T;
VS1=0.4638+1.206792E-1*TCMT**3.794458E-1+
5.156581E-4*TCMT+1.289524E-6*TCMT*TCMT;
VS1=44.01/VS1; END CDVOL; END HENRYS;

RKWONG: PROC(L,M,Y,P,T,PHIG,DELHBAR,DELH); /*** FOR THE GAS PHASE ***/
DCL MT,AM,EM,I,J,VG,EX,VBAR(M);
DCL R STATIC INITIAL(0.0820574),S(2) LABEL;
DCL (P,Y(*),PHIG(*),DELHBAR(*)) BINARY FLOAT;
DCL A(6,6),B(6) STATIC; DCL OMEGA(6) FLOAT STATIC INITIAL
(0.4470,0.4278,0.4278,0.4278,0.4278,0.4278);
DCL OMEGB(6) FLOAT STATIC INITIAL
(0.0911,0.0867,0.0867,0.0867,0.0867,0.0867);
DCL W(6) STATIC INITIAL(0.225,0.0,0.021,0.041,0.040,0.0);
DCL (ZC(6,6),TC(6,6),PC(6,6),VC(6,6),K(6,6) FLOAT) CONTROLLED;
GO TO S(1);
S(1): ALLOCATE TC,PC,VC,ZC,K;
A=0; ZC=0; TC=0; PC=0; VC=0; K=0; EX=1/3;
TC(1,1)=304.2; TC(2,2)=289.7; TC(3,3)=154.6;
TC(4,4)=132.9; TC(5,5)=126.2; TC(6,6)=209.4;
PC(1,1)=72.8; PC(2,2)=57.6; PC(3,3)=49.8;
PC(4,4)=34.5; PC(5,5)=33.5; PC(6,6)=54.3;
K(1,1)=0.0000; K(1,2)=0.0455; K(1,3)=0.0332;
K(1,4)=0.0020; K(1,5)=0.0133; K(1,6)=0.0042;
DO I=1 TO M; DO J=I TO M;
ZC(I,J)=0.291-0.04*(W(I)+W(J)); END; END;
DO I=1 TO M; VC(I,I)=7C(T,I)*R*TC(I,I)/PC(I,I);
B(I)=OMEGB(I)*R*TC(I,I)/PC(I,I); END;
DO I=1 TO M; DO J=I+1 TO M;
VC(I,J)=((VC(I,I)**EX+VC(J,J)**EX)/2)**3;
TC(I,J)=SQRT(TC(I,I)*TC(J,J))*(1-K(I,J));
PC(I,J)=ZC(I,J)*R*TC(I,J)/VC(I,J);
VC(J,I)=VC(I,J); TC(J,I)=TC(I,J); PC(J,I)=PC(I,J); END; END;
DO I=1 TO M; DO J=I TO M;
A(I,J)=(OMEGA(I)+OMEGA(J))*R*(TC(I,J)**2.5)/(2*PC(I,J));
A(J,I)=A(I,J); END; END;
PUT PAGE EDIT(' CONSTANTS ASSOCIATED WITH THE REDLICH-KWONG ',
'EQUATION OF STATE FOR THE GAS PHASE ') (SKIP(5),X(19),A,A);
PUT SKIP(2) EDIT((101)'-', 'C') (X(9),A);
PUT SKIP EDIT('COMPONENT', 'TC', 'PC', 'VC', 'ZC', 'W',

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'KIJ', 'AII', 'BII', 'OMGA', 'OMGB') (X(10), A, X(3), A, X(6), A,
X(6), A, X(7), A, X(7), A, X(6), A, X(7), A, X(9), A, X(7), A, X(5), A);
PUT SKIP EDIT((101)'-') (X(9), A); PUT SKIP;
DO I=1 TO 6; PUT SKIP EDIT (IDENT(I), TC(I,I), PC(I,I),
VC(I,I), ZC(I,I), W(I), K(1,I), A(I,I), B(I), OMEGA(I),
OMEGA(I)) (X(13), A, X(2), F(7,2), X(2), F(5,1), X(2), F(7,4),
X(2), F(7,4), X(2), F(6,3), X(2), F(6,3), X(2), E(10,3),
X(2), E(10,3), X(2), F(7,4), X(2), F(7,4)); END;
PUT SKIP(2) EDIT((101)'-') (X(9), A); PUT SKIP EDIT
('*** NOTE: TC <=> DEGK, PC <=> ATM, VC <=> LITER/',
'GMOL, A <=> (LITER, ATM, GMOL, DEGK); B <=> LITER/GMOL.')
(X(9), A, A); PUT SKIP(3) EDIT(' MIXTURE COEFFICIENTS ')
(X(48), A); PUT SKIP(2) EDIT((81)'-') (X(19), A);
PUT SKIP EDIT('A (I,J)', 'J=1', 'J=2', 'J=3', 'J=4', 'J=5',
'J=6') (X(20), A, X(6), A, 5 (X(9), A));
PUT SKIP EDIT((81)'-') (X(19), A); PUT SKIP;
DO I=1 TO 6; PUT SKIP EDIT('I=', I, (A(I,J) DO J=1 TO 6))
(X(22), A, F(1), X(4), E(10,3), 5 (X(2), E(10,3))); END;
PUT SKIP(2) EDIT((81)'-') (X(19), A); PUT SKIP EDIT
('*** NOTE: A <=> (LITER, ATM, GMOL, DEGK), TC <=> DEGK,
'VC <=> LITER/GMOL, 'B <=> LITER/GMOL, PC <=> ATM.')
(X(19), A, A, SKIP, X(31), A); FREE ZC, TC, PC, VC, K; RETURN;
S(2): AM=0; RT=R*T; BM=0; DO I=1 TO M; BM=BM+Y(I)*B(I);
DO J=1 TO M; AM=AM+Y(I)*Y(J)*A(I,J); END; END; CALL VOLG;
DELH=RT*(1.5*AM/(BM*RT**0.5)*LOG((VG+BM)/VG)+1-P*VG/RT);
DELH=(1.98726/0.0820574)*DELH;
DO I=1 TO M; PHIG(I)=FUNCT(I);
VBAR(I)=VFUNCT(I); DELHBAR(I)=HFUNCT(I); END;

FUNCT: PROC(I); /***** EQ B11, ORNL/TM-5099 *****/ DCL X,J;
X=0; DO J=1 TO M; X=X+Y(J)*A(J,I); END;
X=((-2*X)/(R*BM*T**1.5))*LOG((VG+BM)/VG)+LOG(VG/(VG-BM))+
B(I)/(VG-BM)+AM*B(I)*(LOG((VG+BM)/VG)-BM/(VG+BM))/
(R*T**1.5*BM*BM)-LOG(P*VG/(R*T)));
X=EXP(X); RETURN(X); END FUNCT;

VFUNCT: PROC(I); /***** EQ B14, ORNL/TM-5099 *****/ DCL X,XX,J,T12;
T12=SQRT(T); X=0; DO J=1 TO M; X=X+Y(J)*A(J,I); END;
X=-2*X/(T12*VG*(VG+BM)); X=X+(RT/(VG-BM))*(1+B(I)/(VG-BM));
X=X+AM*B(I)/(T12*VG*(VG+BM)**2); XX=RT/(VG-BM)**2;
XX=XX-(AM/T12)*(2*VG+BM)/(VG*VG*(VG+BM)**2);
X=X/XX; RETURN(X); END VFUNCT;

HFUNCT: PROC(I); /***** EQ B13, ORNL/TM-5099 *****/ DCL X,J;
X=0; DO J=1 TO M; X=X+Y(J)*A(J,I); END;
X=(2*X-AM*B(I)/BM)/BM; X=X*LOG((VG+BM)/VG);
X=X+(AM/BM)*(VG*B(I)-VBAR(I)*BM)/(VG*(VG+BM));
X=1.5*X/SQRT(T)+RT-P*VBAR(I);
X=X*1.98726/R; RETURN(X); END HFUNCT;

VOLG: PROC; /***** SOLVES R-K USING CUBIC SOLUTION *****/
DCL A,B,C(4),D(4),PHI,VGAS(3),A3,B3,L,M,MM,RR,K,T12;

```

```

L=2; M=3; T12=SQRT(T); C(1)=1; C(2)=-RT/P;
C(3)=-BM**2-RT*BM/P+AM/(T12*P); C(4)=-AM*BM/(P*T12);
D(1)=1; D(2)=0; D(3)=(3*C(3)-C(2)**L)/3;
D(4)=(27*C(4)-9*C(2)*C(3)+2*C(2)**M)/27;
RR=(D(3)/3)**M+(D(4)/2)**L; IF RR<0 THEN DO; MM=1;
PHI=ATAND(SQRT(-(D(3)**M/27+D(4)**L/4)/(D(4)**L/4)));
DO K=0 TO 2; VGAS(K+1)=2*SQRT(-D(3)/3)*COSD(PHI/3+120*K);
VGAS(K+1)=VGAS(K+1)-C(2)/3; END;
VG=MAX(VGAS(1),VGAS(2),VGAS(3)); END;
ELSE DO; MM=0; A3=(-D(4)/2+SQRT(RR));
B3=(-D(4)/2-SQRT(RR)); A=ABS(A3)**(1/3);
IF A3<0 THEN A=-A; B=ABS(B3)**(1/3); IF B3<0 THEN B=-B;
VG=A+B-C(2)/3; END; RETURN; END VOLG; END RKWONG;

MMGG: PROCEDURE(A,B,K,L,M,C);
/**** GENERAL MATRIX MULT OF C = A X B COPIED FROM PL1 SSR ****/
DCL (A(*,*),B(*,*),C(*,*)) BINARY FLOAT;
DCL S BINARY FLOAT(53); DCL (K,L,M,I,J,N) BINARY FIXED;
DCL ERROR EXTERNAL CHARACTER(1); ERROR='D';
IF K > 0 THEN IF L > 0 THEN IF M > 0 THEN DO; I=0;
NEXTI: I=I+1; J=0;
NEXTJ: J=J+1; S=0; DO N=1 TO L; S=S*MULTIPLY(A(I,N),B(N,J),53); END;
C(I,J)=S; IF J < M THEN GO TO NEXTJ;
ELSE IF I < K THEN GO TO NEXTI; ERROR='O'; END; END MMGG;
MINV#: PROC(A,N,D,CON); /****MINV# IS THE DOUBLE PRECISION MATRIX***/
/****INVERSION SUBROUTINE FROM THE SSP, THE CALCULATION OF***/
/****THE DETERMINANT HAS BEEN OMITTED*****/
DCL ERROR EXTERNAL CHARACTER(1);
DCL (I,J,K,N,L(N),M(N)) FIXED BINARY;
DCL (A(*,*),BIGA,HOLD,D,CON,S) BINARY FLOAT(53); ERROR='O';
IF N <= 0 THEN DO; ERROR='1'; GO TO FIN; END;
IF CON=0 THEN S=1.0E-15; ELSE S=CON;
IF N=1 THEN DO; D=A(1,1); IF ABS(D)<=S THEN DO;
ERROR='2'; END; ELSE A(1,1)=1/D; GO TO FIN; END;
D=1.0; DO K=1 TO N; L(K)=K; M(K)=K; BIGA=A(K,K);
DO I=K TO N; DO J=K TO N; IF ABS(BIGA)<ABS(A(I,J)) THEN DO;
BIGA=A(I,J); L(K)=I; M(K)=J; END; END; END;
J=L(K); IF L(K) > K THEN DO; DO I=1 TO N; HOLD=-A(K,I);
A(K,I)=A(J,I); A(J,I)=HOLD; END; END;
I=M(K); IF M(K) > K THEN DO; DO J=1 TO N;
HOLD=-A(J,K); A(J,K)=A(J,I); A(J,I)=HOLD; END; END;
IF ABS(BIGA) <= S THEN DO; D=0.0; END;
DO I=1 TO N; IF I=K THEN A(I,K)=A(I,K)/(-A(K,K)); END;
DO I=1 TO N; IF I=K THEN DO; DO J=1 TO N;
IF J=K THEN A(I,J)=A(I,K)*A(K,J)+A(I,J); END; END; END;
DO J=1 TO N; IF J=K THEN A(K,J)=A(K,J)/A(K,K); END;
A(K,K)=1.0/A(K,K); END;
K=N;
LOOP: K=K-1; IF K>0 THEN DO; I=L(K); IF I>K THEN DO; DO J=1 TO N;
HOLD=A(J,K); A(J,K)=-A(J,I); A(J,I)=HOLD; END; END;
J=M(K); IF J>K THEN DO; DO I=1 TO N; HOLD=A(K,I);
A(K,I)=-A(J,I); A(J,I)=HOLD; END; END; GO TO LOOP; END;
FIN: RETURN; END MINV#; END; END STAGE;

```

APPENDIX B:**McCABE-THIELE PLOTTING PROGRAM LISTING**

```
//RWGCO2 JOB (XXXXX),'BIN G GLASS',CLASS=G,TYPRUN=HOLD
//*PLOT NUM=6
//*ROUTE PRINT LOCAL
//*CLASS CPU91=30S,R=270K,IO=10,SPECIAL=TAPE
// EXEC FORTHCLG,REGION.GO=256K
//FORT.SYSIN DD *
```

THE PLOTTING PROGRAM SHOULD BE INSERTED HERE
=====

```
//LKED.SYSLIB DD DSNAME=LABLIB,DISP=SHR
// DD DSNAME=A8.G1.P31394.C10207.CHANDLER.GRAPHICS,
// VOLUME=REF=ZZZZZZ,DISP=SHR
//GO.PLOTTAPE DD UNIT=TAPE7,LABEL=(,NL),DISP=OLD,VOLUME=SER=25
//GO.FT51F001 DD SYSOUT=A,ICB=(RECFM=VBA,LRECL=137,BLKSIZE=1100)
//GO.FT05F001 DD *
```

THE PLOTTING PROGRAM DATA SHOULD BE INSERTED HERE
=====

```
/*
//
```

THE FOLLOWING IS A LISTING OF THE PLOTTING PROGRAM
=====

```

DIMENSION X(100),Y(100),ISTG(100),YFEED(2)
COMMON /XYT/ TX(100),TY(100),K,NAME(2),KOLM(2),JBNUM(2)
DATA X/100*0.0/,Y/100*0.0/,ISTG/100*0/
CALL QQQCPA(48,0.1)
CALL QQQCPA(42,0.5)
CALL QQQCPA(41,0)
CALL JOBNUM(JBNUM)
READ (5,100) N,NA,NFF,NF,NSF,NDS,YFEED(1),YFEED(2)
100 FORMAT(6(I2,6X),2E10.3)
DO 901 K=1,NDS
READ (5,200,END=999) (ISTG(I),X(I),Y(I),I=1,N)
200 FORMAT(5X,I2,2E15.4)
DO 104 I=1,NA
TX(I)=X(I)
104 TY(I)=Y(I)
CALL ABSORB(NA,X(N),YFEED(K))
NT=NF-NA
NTF=NFF-NA
ZF=X(NA)
DO 102 I=1,NT
TX(I)=X(NA+I)
102 TY(I)=Y(NA+I)
CALL FRCSTR(NT,NTF,ZF,1)
NT=N-NF
NTF=NSF-NF
ZF=X(NF)
DO 103 I=1,NT
TX(I)=X(NF+I)
103 TY(I)=Y(NF+I)
CALL FRCSTR(NT,NTF,ZF,2)
901 CONTINUE
999 CALL ADVANS
STOP
END
SUBROUTINE FRCSTR(NT,NTF,ZF,KPS)
COMMON /XYT/ TX(100),TY(100),K,NAME(2),KOLM(2),JBNUM(2)
COMMON /BM3/ XM3,B3
DIMENSION BUFFER(4000),TIX(100),TIY(100)
TX(NT+1)=TX(NT)
TY(NT+1)=TY(NT)
TX(NT+2)=TX(1)
TY(NT+2)=TY(NT+2)
TX(NT+3)=TX(NT)/2.0
TY(NT+3)=TX(NT+3)
TX(NT+4)=TY(1)*2.0
TY(NT+4)=TX(NT+4)
TX(NT+5)=SQRT(TX(NTF-1)/TX(NTF))*TX(NTF)
TY(NT+5)=SQRT(TY(NTF)/TY(NTF+1))*TY(NTF+1)

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```

TX(NT+6)=ZF
TY(NT+6)=ZF
NI=NT+6
CALL SETPLT(TX,TY,NI,'LOG ','MECH',-1.,-1.,BUFFER,4000,'BARKERS$')
CALL CNVRT(TIX,TIY,TX,TY,NI)
XM3=(TIY(NT+5)-TIY(NT+6))/(TIX(NT+5)-TIX(NT+6))
B3=TIY(NT+6)-XM3*TIX(NT+6)
CALL QQLINE(TX(NT+3),TY(NT+3),TX(NT+4),TY(NT+4),0)
CALL QQLINE(TX(NT+2),TY(NT+2),TX(1),TY(1),0)
NI=NT+1
CALL LINPLT(TIX,TIY,NI,-1,0)
NI=NT-1
DO 100 I=1,NI
CALL QQLINE(TX(I),TY(I),TX(I),TY(I+1),0)
100 CALL QQLINE(TX(I),TY(I+1),TX(I+1),TY(I+1),0)
CALL QQLINE(TX(NT+2),TY(NT+2),TX(1),TY(2),0)
DO 200 I=1,NI
200 CALL QQLINE(TX(I),TY(I+1),TX(I+1),TY(I+2),0)
XMAXQ=AMAX1(TIX(NT+6),TIX(NT+5))
XMINQ=AMIN1(TIX(NT+6),TIX(NT+5))
CALL PLTFNC(0.01,XMINQ,XMAXQ,2)
CALL TITLE(0.4,'KALC STUDIES$', 'X$', 'Y$')
CALL QQSYM(8.5,10.1,0.25,KOLM(KPS),0.0,4)
CALL QQSYM(9.0,0.25,0.25,NAME(K),0.0,4)
CALL QQSYM(0.1,10.1,0.2,JBNUM,0.0,8)
RETURN
END
SUBROUTINE ABSORB(NA,X0,YFEED)
COMMON /XYT/ TX(100),TY(100),K,NAME(2),KOLM(2),JBNUM(2)
DIMENSION BUFFER(4000),TIX(100),TIY(100)
REAL MULT(2) /2.0,1.05/
DO 100 I=1,NA
TX(NA-I+2)=TX(NA-I+1)
100 TY(NA-I+2)=TY(NA-I+1)
IF (K .EQ. 1) TX(1)=X0
TX(NA+2)=TX(NA+1)
TY(NA+2)=YFEED
TY(NA+3)=YFEED*MULT(K)
TX(NA+3)=TX(NA+1)*MULT(K)
TY(NA+4)=TY(1)/MULT(K)
TX(NA+4)=TX(1)/MULT(K)
NI=NA+4
IF(K .EQ. 2) GO TO 120
CALL SETPLT(TX,TY,NI,'LOG ','MECH',-1.,-1.,BUFFER,4000,'BARKERS$')
GO TO 150
120 CALL SETPLT(TX,TY,NI,'LINE','MECH',-1.,-1.,BUFFER,4000,'BARKERS$')
150 NI=NA+2
CALL LINPLT(TX,TY,NI,-1,0)
NI=NA+4
CALL CNVRT(TIX,TIY,TX,TY,NI)
DO 200 I=1,NA
200 CALL QQLINE(TX(I),TY(I+1),TX(I+1),TY(I+2),0)

```

```

DO 300 I=2,NA
CALL QQLINE(TX(I),TY(I),TX(I),TY(I+1),0)
300 CALL QQLINE(TX(I),TY(I+1),TX(I+1),TY(I+1),0)
CALL TITLE(0.4,'KALC STUDIES$','K$','Y$')
CALL QQQSYM(8.5,10.1,0.25,'ABS',0.0,4)
CALL QQQSYM(9.0,0.25,0.25,NAME(K),0.0,4)
CALL QQQSYM(0.1,10.1,0.2,JBNJM,0.0,8)
RETURN
END
SUBROUTINE CNVRT(TIX,TIY,TX,TY,N)
DIMENSION TIX(100),TIY(100),TX(100),TY(100),TTT(100)
DO 100 I=1,N
CALL QQINCH(TX(I),TY(I),TIX(I),TIY(I))
TTT(I)=TX(I)
TX(I)=TIX(I)
TIX(I)=TTT(I)
TTT(I)=TY(I)
TY(I)=TIY(I)
TIY(I)=TTT(I)
100 CONTINUE
RETURN
END
REAL FUNCTION F(X)
COMMON /BM3/ XM3,B3
F=X*XM3+B3
RETURN
END
BLOCK DATA
COMMON /XYT/ TX(100),TY(100),K,NAME(2),KOLM(2),JBNJM(2)
DATA TX/100*0./,TY/100*0./,NAME/' KR ',' 02 '/,KOLM/' FRC',' STR'/
END

```


THE FOLLOWING IS THE PLOTTING PROGRAM EXAMPLE DATA

=====

42	8	10	27	30	2	1.920E-07	1.752E-01
1	8.0900E-10	6.9053E-09					
2	1.2509E-09	1.0683E-08					
3	1.8797E-09	1.6061E-08					
4	2.7841E-09	2.3801E-08					
5	4.0988E-09	3.5057E-08					
6	6.0316E-09	5.1614E-08					
7	8.9053E-09	7.6243E-08					
8	1.3232E-08	1.1334E-07					
9	4.6684E-08	4.4496E-07					
10	1.5237E-08	1.4280E-07					
11	1.7546E-08	1.6393E-07					
12	1.9626E-08	1.8279E-07					
13	2.1188E-08	1.9681E-07					
14	2.2161E-08	2.0545E-07					
15	2.2626E-08	2.0948E-07					
16	2.2699E-08	2.0999E-07					
17	2.2479E-08	2.0785E-07					
18	2.2025E-08	2.0358E-07					
19	2.1363E-08	1.9743E-07					
20	2.0493E-08	1.8938E-07					
21	1.9397E-08	1.7924E-07					
22	1.8040E-08	1.6670E-07					
23	1.6374E-08	1.5130E-07					
24	1.4335E-08	1.3245E-07					
25	1.1843E-08	1.0943E-07					
26	8.8002E-09	8.1312E-08					
27	5.0852E-09	4.6986E-08					
28	1.0049E-06	1.0316E-05					
29	1.1607E-07	1.1914E-06					
30	1.4086E-08	1.4458E-07					
31	1.0572E-08	1.0852E-07					
32	7.9128E-09	8.1220E-08					
33	5.8994E-09	6.0553E-08					
34	4.3750E-09	4.4907E-08					
35	3.2211E-09	3.3062E-08					
36	2.3475E-09	2.4096E-08					
37	1.6862E-09	1.7308E-08					
38	1.1855E-09	1.2169E-08					
39	8.0652E-10	8.2783E-09					
40	5.1958E-10	5.3332E-09					
41	3.0236E-10	3.1036E-09					
42	1.3792E-10	1.4157E-09					
1	6.5569E-03	1.1969E-01					
2	6.7858E-03	1.2410E-01					
3	7.0038E-03	1.2831E-01					
4	7.2157E-03	1.3242E-01					
5	7.4261E-03	1.3652E-01					

6	7.6400E-03	1.4070E-01
7	7.8613E-03	1.4504E-01
8	8.0958E-03	1.4966E-01
9	1.9019E-02	4.3711E-01
10	5.7898E-03	1.1992E-01
11	4.4234E-03	9.0583E-02
12	3.1140E-03	6.3078E-02
13	2.0448E-03	4.1054E-02
14	1.2752E-03	2.5439E-02
15	7.6808E-04	1.5258E-02
16	4.5260E-04	8.9677E-03
17	2.6312E-04	5.2053E-03
18	1.5169E-04	2.9981E-03
19	8.6959E-05	1.7178E-03
20	4.9619E-05	9.7986E-04
21	2.8169E-05	5.5617E-04
22	1.5876E-05	3.1343E-04
23	8.8410E-06	1.7453E-04
24	4.8175E-06	9.5100E-05
25	2.5175E-06	4.9696E-05
26	1.2031E-06	2.3750E-05
27	4.5205E-07	8.9235E-06
28	4.1433E-05	9.4255E-04
29	2.6155E-06	5.9481E-05
30	2.3055E-07	5.2429E-06
31	7.8778E-08	1.7915E-06
32	2.6918E-08	6.1214E-07
33	9.1977E-09	2.0916E-07
34	3.1426E-09	7.1467E-08
35	1.0737E-09	2.4417E-08
36	3.6675E-10	8.3404E-09
37	1.2520E-10	2.8472E-09
38	4.2660E-11	9.7013E-10
39	1.4457E-11	3.2876E-10
40	4.8201E-12	1.0961E-10
41	1.5273E-12	3.4732E-11
42	4.0213E-13	9.1448E-12

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