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SIDESTREAM TOWER FRACTIONATION -

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A SHORT-CUT CALCULATION METHOD

Ву

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Richard David Prickett

A THESIS

PRESENTED IN PARTIAL PULPTLLMENT OF

THE REQUIREMENTS FOR THE DEGREE

OF

MASTER OF SCIENCE IN CHEMICAL ENGINEERING

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NEWARK COLLEGE OF ENGINEERING

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Newark, New Jersey 1973

ARSTRACT

A short-cut procedure has been developed for making calculations on a complex fractionation tower. A Simplification of the Thiele-Geddes plote-to-plate procedure provided the basis for the short-cut procedure. The application discussed in this paper is for a tower with a liquid sidestream drawoff in the rectifying section.

The tower was broken at the feed point and sidestream drawoff locations into three calculation sections. The fractionation in each tower section can then be represented by a rigorous series solution expressed in terms of absorption or stripping factors. These rigorous equations can then be simplified by the use of average absorption or stripping factors.

The short-cut procedure has two methods of determining the average stripping or absorption factors for each tower section. The one method uses the assumption of a linear profile of absorption or stripping factors based on end values in each section and is called the Stand-Alone Simplified Thiele-Geddes Method. The other method determines average absorption or stripping factor for each tower section from a force-fit to a rigorous plate-to-plate solution. This method is called the Force-Fit Thiele-Geddes Method and is suitable for accurate parametric studies around a base case rigorous solution.

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Computer programs were prepared for the Thiele-Geddes plateto-plate method and the stand-alone short-cut procedure. In addition, a computer program was written to obtain the force-fit fractions required for the Force-Fit Thiele-Geddes Method. Parametric cases were then run for a five-component debutabler column, and the results of the short-cut method were compared with the rigorous solution for each case.

The results of these comparisons show the Stand-Alone Simplified Thiele-Geddes Method to be of suitable accuracy for preliminary design calculations. The Force-Fit Thiele-Geddes Method results in a higher degree of accuracy in most cases and is suitable for parametric studies on a final design. The degree of accuracy obtained from the Force-Fit Method is believed to be the highest available from a short-cut procedure.

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APPROVAL OF THESIS

SIDESTREAM TOWER FRACTIONATION -

A SHORT-CUT CALCULATION METHOD

ΒY

RICHARD DAVID PRICKETT

FOR

Department of Chemical Engineering

Newark College of Engineering

ΒY

Faculty Committee

Approved:



PREFACE

The procedure for simplifying the Rigorous Thiele-Geddes equations and applying them to short-cut, fractionation calculations was developed by Dr. Ralph Cecchetti while teaching stage equilibrium processes at Newark College of Engineering.

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INTRODUCTION

This section will first discuss the purpose of a fractionation tower with a liquid sidestream drawoff in the rectifying section. This will be followed by a discussion concerning the degrees of freedom and variables involved in developing a fractionation calculation procedure. The reasons as to why the Thiele-Geddes Method⁽²⁾ was selected as a bases for a short-cut fractionation procedure will then be enumerated.

Three products can be produced in a single tower by taking advantage of a sidestream drawoff. The conventional practice, for reasons of control and equipment costs, is to have a liquid sidestream drawoff in the rectifying section. The component distribution profiles that result from a sidestream tower can be exemplified by considering three components: LC = Light, MC = Middle, and HC = Heavy. These are to be separated into three streams, each enriched in one of the components.

For a liquid sidestream drawoff in the rectifying section, it is possible to provide sufficient reflux and stages in the top section of the tower to fractionate to any specification of MC in LC in the overhead. It is also possible to meet any specification on HC in the sidestream drawoff by the combination of reflux and stages in the middle tower section. The specification of MC in the bottoms can also be controlled by stages and stripping in the lower section. Figure 1 illustrates the splits that take place.

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COMPONENT DISTRIBUTION FOR A FRACTIONATION TOWER WITH A LIQUID SIDESTREAM DRAVOFF IN THE RECTIFYING SECTION



It is only the concentration of light components, LC, that are primarily leaving the tower in the distillate, that cannot be controlled. Their concentration depends on the relative equilibrium constant values of LC and MC, and the concentration of LC in the rising vapors. However, these rising vapors must include all the moles of LC coming in with the feed and whatever is in the liquid reflux below the sidestream drawoff. (It is assumed that no LC goes out the bottoms with HC.) Therefore, a sidestream product rich in MC and very low in HC can be produced. However, pure MC cannot be produced as this system is designed. A sidestream stripper tower can be used to control the concentration of LC in the sidestream product, but this option was net-considered.

Sidestream towers are difficult to control accurately. They are usually used when rough product cuts are desired.

Figure 2 illustrates the particular sidestream tower on which the fractionation calculations in this study were performed. The tower has one feed, liquid sidestream drawoff in the rectifying section, a total condenser, and a partial reboiler. The degrees of freedom or variables to be specified are expressed by the following equation:

DDF = NC + NTT + 10

where:

DDF = Design degrees of freedom NC = Number of components NTT = Number of stages 3





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The above equation assumes adiabatic operation except for the condenser and reboiler. The variables specified in the rigerous Thicle-Geddes program are:

Feed composition and rate	NC
Feed temperature and pressure	2
*Pressure drop per stage	NTT
Feed stage location	1
Sidestream location	1
*Condenser pressure	1
Reflux temperature (Bubble point of distillate)	1
Sidestream rate	1
Distillate rate]
Total number of stages]
Reflux rate	3.

The program therefore only handles the "design performance" case.

The difficulty of rigorous calculation for multicomponent mixtures is that the number of variables that can be specified is very small relative to the total number of variables in the system. The number that can be specified is dictated by the design degrees of freedom for the proposed system, as shown on page 3. The number of specified variables can neither exceed nor be less than the design degrees of freedom. Once these design specifications are set, then all remaining variables are established by the restrictions of equilibrium, enthalpy, and material balance.

* The pressure drops are specified as zero in the calculation program, therefore, resulting in a constant pressure operation.

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The problem is to determine the complete set of all system variables which satisfy the above restrictions and which leave the specified variables unchanged. Then with a knowledge of the values for all the variables, the ability of the proposed unit to meet all the desired specification can be reviewed by the engineer. If all specifications are not met, the values of the design variables are adjusted in the direction of the desired change in performance. If acceptable, the unit can be designed and built; or if the unit is an existing tower, the proposed operation can be reviewed to see if it is an acceptable performance.

Whenever we have a calculation in which the design variables allowed to be specified are far less in number than the total possibilities, there are two general techniques that can be used for solution:

- 1. Sequential Iterative Methods Make assumptions on sufficient additional variables so that calculations can be made to determine the remaining variables. The assumed variables are then calculated from this solution and, by means of a convergence procedure, a new set of assumptions is made in an effort to bring assumed and calculated variables together. The procedure is repeated until convergence of assumed and calculated variables is obtained.
- Matrix Methods A complete set of equations is written to satisfy all restrictions in the system, and these equations are solved simultaneously.

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Rigorous methods for all complex stage separation systems fall into either of these techniques. However, the nonlinear form of the equilibrium, heat, and material balance equations precludes a direct matrix analytical solution for fractionation systems unless some simplifications are made which convert the equations to linear form.

The Thiele-Geddes Method is of the Sequential Iterative type and it was selected as the method on which to base a short-cut procedure. The criteria for selecting the Thiele-Geddes Method were that it converges easily, it is a well established method and meets the following requirements which are necessary for a good reliable short-cut procedure:

- A broad flexibility to solve for a variety of process models and design parameters.
- 2. A sound theoretical foundation no empirical correlations.
- 3. Lends itself to simplification.
- 4. Allows itself to become "educated" by a plate-to-plate solution so that accurate parametric studies can be determined.
- 5. Reduces the cost of fractionation studies by permitting fast manual or computer solution.
- Improves the engineers' understanding of the effect of key tower design variables.

The proposed short-cut procedure can be used for either an initial short-cut design, with the usual inaccuracies of trying to estimate average stripping factors, or alternatively, a force-fit can be made to a solution from a plate-to-plate calculation in order to

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obtain more accurate absorption or stripping factors for subsequent parametric studies on reflux, stages, etc. The simplified procedure, like the Rigorous Thiele-Geddes, is a design performance calculation.

Computer programs were developed for the Thiele-Geddes plote-to-plate method and the short-cut procedure. In addition, a computer program was written to obtain force-fit fractions required from a plate-to-plate solution to "educate" the short-cut procedure. Parametric cases were run for a five-component debutanizer column, and the accuracies of the methods were compared.

The following chapters show the equations used in the Rigorous Thiele-Geddes Method and how they can be simplified for the short-cut procedure.

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The Thiele-Geddes Method for a column with a liquid sidestream in the rectifying section is based on calculating the following ratios:

$$\begin{pmatrix} \underline{l} \\ d \\ n,i & \text{in the rectifying section NTT} \ge n \ge NF \\ \begin{pmatrix} \underline{v} \\ b \\ n,i & \text{in the stripping section NF} \ge n \ge 1 \\ \end{cases}$$

where:

L	E	Liquid flow rate of component i off stage n
v	2	Vapor flow rate of component i off stage n
d		Distillate flow rate of component i
Ъ	===	Bottoms flow rate of component i
n	22	Any stage (stage] is the reboiler)
NF		Feed stage (Stage 1 is the reboiler)
NTT	m	Total number of stages including the reboiler but
		the condenser.

These ratios are calculated from equations based on component balances around the stage in question and the top or bottom of the column. The top and bottom component ratios can then be solved simultaneously to give individual component rates of the distillate and bottoms.

A material balance around a total condenser (ref. Figure 1) gives the following equations:

not

$$v_{\text{NTT},i} = \lambda_{\text{NTT}} + [1,i] + d_{1}$$
 (1)

$$\left(\frac{\mathbf{v}_{\mathrm{NTT}}}{d}\right)_{\underline{i}} = \left(\frac{\left(\frac{v_{\mathrm{NTT}}}{d}\right)_{\underline{i}}}{d} + 1\right)$$
(2)

by definition the absorption factor is:

$$A_{n,j} = \frac{L_n}{V_k K_{n,j}}$$
(3)

$$A_{n,i}$$
 = Absorption factor for component i on stage r
 L_n = Total liquid rate off stage n
 V_n = Total vapor rate off stage n
 $K_{n,i}$ = The equilibrium ratio value of component i on stage n

Multiplying both sides of equation (2) by $A_{NTT,1}$ and noting that $\left(\frac{k_{NTT}+1}{d}\right)_{i}$ is equal to the external reflux ratio (R):

$$\left(\frac{\ell}{d}\right)_{\rm NTT,i} = A_{\rm NTT,i} (R+1)$$
(4)

A material balance around any stage n below the top stage (NTT) and above the sidestream drawoff stage (NS) results in the following equation:

$$\mathbf{v}_{n,i} = \boldsymbol{\ell}_{n+1,i} + \boldsymbol{d}_{i} \tag{5}$$

Multiplying both sides of equation (5) by $\Lambda_{n,i}$ and dividing by d's:

$$\left(\frac{\pounds}{d}\right)_{n,i} = A_{n,i} \left(\left(\frac{\pounds}{d}\right)_{n+1,i} + 1 \right)$$
(6)

where:

A material balance around the top of the column and any stage between the sidestream drawoff stage and the feed stage results in the following equation:

$$v_{n,i} = {}^{\ell}_{n+1,i} + d_i + w_i$$
(7)

where:

 w_i = Flow rate of component i in sidestream drawoff Multiplying both sides of equation (7) by $A_{n,i}$ and dividing by d_i :

$$\left(\frac{\ell}{d}\right)_{n,i} = A_{n,i}\left(\left(\frac{\ell}{d}\right)_{n+1,i} + \left(\frac{w}{d}\right)_{i} + 1\right)$$
(8)

where:

$$n \leq NS-1$$
 (see equation 10 for $n = NS-1$)

N > NF

The $\left(\frac{w}{d}\right)_{1}$

ratios are obtained from the following equation:

$$\left(\frac{W}{d}\right)_{i} = \left(\frac{\varrho}{d}\right)_{NS,i} \left(\frac{W}{L_{NS}}\right)$$
 (9)

where:

W = Sidestream drawoff rate

For the stage below the sidestream (RS-1) equation (8) is used with $\left(\frac{\varrho}{d}\right)_{NS,j}$, representing the ratio after the sidestream has been drawn off to calculate $\left(\frac{\varrho}{d}\right)_{NS-1,j}$. This is calculated by:

$$\begin{pmatrix} \frac{l}{d} \\ \frac{l}{NS,1} \end{pmatrix}_{NS,1} = \begin{pmatrix} \frac{l}{d} \\ \frac{l}{NS,1} \end{pmatrix}$$
to be used in from equation (6)
equation (8)
$$(10)$$

The stripping section is represented by a material balance around the stage in question and the bottom of the column.

$$v_{n,i} + b_i = l_{n+1,i}$$
 (11)

Multiply both sides of equation (11) by $\Im_{n+1} = \left(\frac{VK}{L}\right)_{n+1}$, and dividing by b_i results in the following equation:

$$\left(\frac{\mathbf{v}}{\mathbf{b}}\right)_{n+1,i} = S_{n+1,i}\left(\left(\frac{\mathbf{v}}{\mathbf{b}}\right)_{n,i} + 1\right)$$
(12)

where:

n > 1n < NF

The $\left(\frac{v}{b}\right)_{1,i}$ is represented by the equilibrium relationship:

$$\left(\frac{v}{b}\right)_{1,i} = \frac{V_1 y_{1,i}}{B X_{1,i}} = \frac{K_{1,i} V_1}{B} = S_{1,i}$$
(13)

Using the assumed values of stage temperatures, total liquid and total vapor rates on each stage the $\left(\frac{k}{d}\right)$ ratios in the rectifying section and the $\left(\frac{v}{b}\right)$ ratios in the stripping section can be calculated from the previous equations. The directions of calculations are from the bottom of the column to the feed plate and the top of the column to the feed plate.

Rearrangement of an overall material balance around the column results in the following equation:

$$d_{i} = \frac{(F)(z_{F,i})}{1 + \left(\frac{b}{d}\right)_{i} + \left(\frac{w}{d}\right)_{i}}$$
(14)

The $\left(\frac{b}{d}\right)_i$ ratio in equation (14) is obtained from the following equation which is derived from an overall material balance, and a material balance equation around the top of the column and the tray above the feed plate. A material balance around the top of the column and the tray above the feed plate (see Figure 2) results in the following equation:

$$v_{F,i} + v_{f,i} = \ell_{f+1,i} + d_i + w_i$$
 (15)

Dividing by d_i:

$$\left(\frac{\mathbf{v}_{\mathrm{F}}}{\mathrm{d}}\right)_{\mathrm{i}} + \left(\frac{\mathbf{v}_{\mathrm{f}}}{\mathrm{d}}\right)_{\mathrm{i}} = \left(\frac{\ell_{\mathrm{f+I}}}{\mathrm{d}}\right)_{\mathrm{i}} + 1 + \left(\frac{\mathrm{w}}{\mathrm{d}}\right)_{\mathrm{i}}$$
(16)

By manipulation:

$$\left(\frac{\mathbf{v}_{\mathrm{F}}}{(\mathrm{F})(z_{\mathrm{F}})}\right)_{\mathrm{i}} \left(\frac{(\mathrm{F})(z_{\mathrm{F}})}{\mathrm{d}}\right)_{\mathrm{i}} + \left(\frac{\mathbf{v}_{\mathrm{f}}}{\mathrm{b}}\right)_{\mathrm{i}} \left(\frac{\mathrm{b}}{\mathrm{d}}\right)_{\mathrm{i}} = \left(\frac{\mathrm{b}_{\mathrm{f}}}{\mathrm{d}}\right)_{\mathrm{i}} + 1 + \left(\frac{\mathrm{w}}{\mathrm{d}}\right)_{\mathrm{i}}$$
(17)

Rearrangement of the overall tower material balance equation gives:

$$\left(\frac{(\mathbf{F})(\mathbf{z}_{\mathbf{F}})}{\mathbf{d}}\right)_{\mathbf{i}} = \mathbf{1} + \left(\frac{\mathbf{b}}{\mathbf{d}}\right)_{\mathbf{i}} + \left(\frac{\mathbf{w}}{\mathbf{d}}\right)_{\mathbf{i}}$$
(18)

Substituting equation (18) into equation (17) and solving for $\left(\frac{b}{d}\right)_{i}$:

$$\left(\frac{b}{d}\right)_{i} = \frac{\left(\frac{l}{d}\right)_{NF+1,i} + 1 + \left(\frac{w}{d}\right)_{i} - \left(\frac{v_{f}}{(F)(X_{F})}\right)_{i} - \left(\frac{v_{F}}{(F)(x_{F})}\right)_{i} \left(\frac{w}{d}\right)_{i}}{\left(\frac{v_{F}}{(F)(X_{F})}\right)_{i} + \left(\frac{v_{f}}{b}\right)}$$
(19)

Rearrangement of the feed balance equation gives:

$$\left(\frac{\mathbf{v}_{\mathrm{F}}}{(\mathrm{F})(\mathbf{x}_{\mathrm{F}})}\right)_{\mathbf{i}}^{\mathbf{i}} + \left(\frac{\ell_{\mathrm{F}}}{(\mathrm{F})(\mathbf{x}_{\mathrm{F}})}\right)_{\mathbf{i}}^{\mathbf{i}} = 1$$
(20)

Substituting equation (20) into (19) and simplifying results in the following equations:

$$\left(\frac{b}{d}\right)_{i} = \frac{\left(\frac{b}{d}\right)_{NF+1,i} + \left(\frac{b}{(F)(x_{F})}\right)_{i}\left(1 + \left(\frac{v}{d}\right)\right)_{i}}{\left(\frac{v_{F}}{(F)(x_{F})}\right)_{i} + \left(\frac{v}{b}\right)_{f,i}}$$
(21)

The Thiele-Geddes Method combines the restrictions of heat, equilibrium and material balance. The summation of the distillate component rates and sidestream component rates does not equal the specified distillate rate or the sidestream rate until the solution has converged. The theta convergence method is used to facilitate convergence. The theta method of convergence selects a set of d's and w's such that their sum will equal the specified distillate and sidestream races, respectively. There are two 0's required which are defined by the following equations:

$$d_{i,i} = \frac{(F)(z_{\mathrm{MF},i})}{1 + \left(\frac{b}{d}\right)_{i}} \Theta_{d} + \left(\frac{w}{d}\right)_{i} \Theta_{w}}$$
(22)

where:

NC

$$\Sigma \quad d_{i}, = D \text{ specified}$$

 $i=1$
(23)

$$\sum_{i=1}^{nc} \left(\frac{w}{d} \right)_{i}^{O} \Theta_{w} d_{i}^{I} = \sum_{i=1}^{NC} w_{i}^{I} = W \text{ specified}$$
(24)

The thetas $(\theta_d \text{ and } \theta_v)$ are determined by the Newton-Raphson Method. Equation 22 can be differentiated analytically for use in the Newton-Raphson Method.¹

The component rates of the bottoms and sidestream which are normalized to the specified summations, are now found from the following equations:

$$b_{i} = \Theta_{d} \left(\frac{b}{d} \right)_{i} d_{i}$$
(25)

$$w_{i} = \Theta_{w} \left(\frac{w}{d} \right)_{i} d_{i}$$
(26)

Round off error is minimized by using the above equations instead of differences. The solution has converged when the thetas equal unity. The compositions for each stage are determined by taking the (ℓ/d)'s or (ν/b)'s, determined from equations (4), (6), (8), (12), and (13), and multiplying them by the respective d_i ' or b_i '. The temperature profile for the next trial is determined by either dew or bubble points. The method of convergence used for bubble and dew points is the Newton Method. The liquid and vapor rates for the next trial are now determined by enthalpy balance calculated by the Constant Composition Method.¹ The enthalpy balance is calculated from the condenser down to the reboiler. The Simplified Thiele-Geddes Method is based on the Thiele-Geddes plate-to-plate method. The equations developed in the next paragraph are completely rigorous.

Equations (14) and (21) are still to be used, therefore series equations are developed to obtain $\left(\frac{w}{d}\right)_i$, $\left(\frac{\hat{k}}{d}\right)_{i+1,i}$ and $\left(\frac{w}{b}\right)_i$. Successive substitution of equations (4) and (6) results in the following equation in terms of the component absorption factors:

$$\begin{pmatrix} \underline{\ell} \\ d_{i} \end{pmatrix}_{\text{NS},i} = (R) (A_{\text{NTT},i}) \cdot \cdot \cdot (A_{\text{NS},i}) + (A_{\text{NTT},i}) \cdot \cdot \cdot \\ (A_{\text{NS},i}) + \cdot \cdot \cdot + A_{\text{NS}}$$
(27)

where:

$$R = External reflux ratio, L_{MTT + 1}/D$$

and:

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$$\left(\frac{W}{d}\right)_{i} = \left(\frac{L}{d}\right)_{NS,i} \left(\frac{W}{L_{NS}}\right)$$
(28)

With successive substitution of equation (8), and remembering the restriction of equation (10) the following equation results:

$$\begin{pmatrix} \underline{\hat{x}} \\ d \end{pmatrix}_{NF + 1, i} = \left((A_{NS-1, i}) \cdot \cdots \cdot (A_{NF + 1, i}) \right) \left(\underline{\hat{x}} \\ d \end{pmatrix}_{NS, i} - (29)$$

$$\begin{pmatrix} \underline{w} \\ d \end{pmatrix}_{i} + \left(1 + \left(\underline{w} \\ d \right)_{i} \right)^{\text{obtained from equation (27)}} \left((A_{NS - 1, i}) (A_{NS - 2, i}) \cdot \cdots \right)^{(A_{NF + 1, i}) + \cdots + A_{NF + 1, i}}$$

Successive substitution of equations (13) and (12) results in the following series equation:

$$\left(\frac{v}{b}\right)_{NF,i} = (S_{NF,i})(S_{NF-1,i}) \dots (S_1) + (S_{NF}) \dots$$

$$(S_2) + \dots + (S_{NF,i})(S_{NF-1}) + S_{NF}$$
(30)

The simplified approach to the Thiele-Ceddes Method divides the column into three sections defined by equations (27), (29), and (30). The first step in the simplification of the Rigorous Thiele-Geddes Method involves the elimination of bubble or dew point calculations for each tray. Only the solutions of the end temperatures of the three tower sections are considered. The problem then becomes one of finding the representative stripping or absorption factors for each tower section.

Five temperatures are calculated for each trial. These temperatures are assumed for the initial trial. These temperatures and their methods of determination are:

- Top tray temperature (TT) dew point of the overhead vapor (same composition as the distillate).
- Sidestream tray temperature (TS) bubble point of the sidestream product.
- 3. Bottom tray temperature (T1) bubble point of the bottoms.
- 4. Second stage temperature $(T2) T_1$, V_1 , B, and L_2 are known along with their compositions. The composition of L_2 is obtained by material balance. The bubble point of L_2 is therefore T2.

5. Feed plate temperature (TF) - this is the "slack" temperature used to converge the solution.

The reasons why these temperatures are calculated will become evident in the following paragraphs. The end temperatures for the middle tower section should be the tray temperature below the sidestream tray temperature, and the tray temperature above the feed tray. It was first attempted to estimate their values by linear interpolation between TS and TF. The increase in accuracy did not seem to justify pursuing this method further. Therefore TS and TF are used as the end temperatures for the middle section.

Constant molal overflow was used to set internal liquid and vapor flow rates. Absorption or stripping factors for the ends of each tower section are determined by combining the equilibrium constant values with the respective liquid and vapor rates. The reboiler stripping and condenser absorption factors are solved for separately, since these are quite different from the values in the adjacent tower section. The absorption factor for the total condenser is the external reflux ratio.

The core of this simplified fractionation procedure is, therefore, the calculation of only five temperatures, the assumption of constant molal overflow in calculating absorption or stripping factors, and the solution of forms of equations (27), (28), (29), and (30).

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One method for solving equations (27), (28), (29), and (30) . is to assume a linear profile of absorption or stripping factors between the calculated end values. This constitutes the stand-alone version of the calculation. With this approach the calculation procedure is as follows:

1.
$$\Lambda_{\text{NTT},i} = \frac{(L3)}{(V3)(K_{\text{Tf},i})}$$

where:

$$L3 = (R)(D)$$

V3 = (R)(D) + D

2.
$$A_{NS,i} = \frac{(L3)}{(V3)(K_{TS,i})}$$

3. Solve equation (27) for $\left(\frac{\lambda}{d}\right)_{NS,i}$ using a linear interpolation for the A's between $\Lambda_{NTT,i}$ and $\Lambda_{NS,i}$.

4.
$$\left(\frac{W}{d}\right)_{i} = \left(\frac{L}{d}\right)_{NS,i} \left(\frac{W}{L_{NS}}\right)$$

where:

$$L_{\rm NS} = (R)(D) + D$$

5.
$$A_{NS - 1,i} = \frac{L2}{(V2)(K_{TS,i})}$$

where:

$$L2 = (R)(D) - W$$

 $V2 = V3 = (R)(D) + D$

6.
$$A_{\rm NF} + 1, i = \frac{L2}{(V2)(K_{\rm TF}, i)}$$

7. Linearly interpolate for the intermediate A's for the middle tower section and solve equation (29) for $\begin{pmatrix} \underline{k} \\ d \end{pmatrix}$ NF + 1,i

8.
$$S_{1,i} = \frac{(K_{T1,j})(VI) - (F)(I - FLIQ)}{B}$$

where:

FLIQ = mole fraction of the feed that is liquid

 $V_1 = (R)(D) + D - (F)(1 - FLIQ)$

where:

L1 = V1 + B

9.
$$S_{2,i} = \frac{(K_{T2})(V1)}{L1}$$

10.
$$S_{NF, i} = \frac{(K_{NF, i})(VI)}{LI}$$

- 11. Linearly interpolate for intermediate S's and solve equation (3) for $\left(\frac{v}{b}\right)_{NF,1}$
- 12. Solve equation (21) for $\left(\frac{b}{d}\right)_i$.
- 13. Solve a modified form of equation (14) for $d_{\underline{i}}$ using $\theta_{\underline{w}}$ which is initially unity.

$$d_{i} = \frac{(F)(z_{i})}{1 + \left(\frac{b}{d}\right) + \left(\frac{w}{d}\right)_{i}} \Theta_{w}}$$
(31)

where:

 $\Theta_{_W}$ is a forcing factor which is required to have the calculated sidestream rate equal the specified sidestream rate.

14. Solve for 0

$$\Theta_{W} = \frac{\begin{array}{ccc} NC & NC \\ \Sigma & w_{1} & \Sigma & \left(\frac{w}{d}\right)_{i} \\ \frac{i=1}{W} = \frac{i=1}{W} \end{array}$$

- 15. Solve equation (31) using the calculated value of $\theta_{\rm y}$.
- 16. Determine the compositions on the four key locations by multiplying the appropriate $(l/d)_i$ by d_i or $(v/b)_i$ by b_i .
- 17. Solve for the four equilibrium temperatures T1, T2, TS, and TT, using the appropriate location compositions.
- 18. Go back to step 1 and repeat until the assumed temperatures (T1, T2, TS, and TT) equal the calculated temperatures for a given trial.
- NC 19. If $\sum_{i=1}^{NC} d_i$ from step 13 equal the calculated distillate rate i=1 i the solution has converged. If they are not equal assume a new TF and return to step 1. Standard linear interpolation procedure on distillate rate and TF is used to converge TF.

Another method of solving equations (27), (29), and (30) is to define an average absorption or stripping factor for each equation. Equation (27) becomes:

$$\left(\frac{\Omega}{d}\right)_{\text{NS,i}} = \left(\frac{\Lambda_3^{(\text{NTT-NS})} - \Lambda_3^{\text{ave,i}}}{\Lambda_3^{\text{ave,i}} - 1} + (\text{R}) \left(\Lambda_3^{(\text{NTT-NS-1})}\right) \right)$$
(32)

22

where:

A3_{eve,i} · · · "average" absorption factor of component i is the upper towar section.

Equation (29) becomes:

$$\frac{\binom{p}{d}}{NF + 1, i} = \left(\frac{\Lambda 2 \binom{(NS - NF + 1)}{ave, i}}{\binom{d}{d}_{NS, i}} - \binom{w}{d}_{1} \right) +$$
(33)
$$\frac{\left(1 + \binom{w}{d}_{1} \right) \left(\frac{\Lambda 2 \binom{(NS - NF)}{ave, i}}{-\Lambda 2 \binom{ave, i}{ave, i}} - \frac{\Lambda 2}{ave, i} \right)}{\binom{\Lambda 2}{ave, i}}$$

where:

A2_{ave,i} · · · "average" absorption factor of component i in the middle tower section.

Equation (30) becomes:

$$\left(\frac{v}{b}\right)_{\text{NI},i} = \frac{\left(\text{S1}_{\text{ave},i}^{(\text{NF})} - \text{S1}_{\text{ave},i}\right)}{\left(\text{S1}_{\text{ave},i} - 1\right)} + \left(\text{S}_{1,i}\right) \left(\text{S1}_{\text{ave},i}^{(\text{NF}-1)}\right)$$
(36)

where:

Slave, i · · · "average" stripping factor of component i in the stripping section.

Since constant molal overflow is used in the simplified calculation procedure equation (32) equates to:

$$\left(\frac{W}{d}\right)_{\text{NS},i} = \left(\frac{W}{(R)(D)}\right) \left(\frac{A_{3}^{(\text{NTT-NS})} - A_{3}^{\text{ave},i}}{A_{3}^{\text{ave},i} - 1} + (R) \left(A_{3}^{(\text{NTT-NS}-1)}\right)\right) (35)$$

and:

$$\begin{pmatrix} \underline{s} \\ \underline{d} \end{pmatrix}_{\text{NS,i}} = \begin{pmatrix} \underline{w} \\ \underline{d} \end{pmatrix}_{\text{NS,i}} \frac{(\mathbf{R})(\mathbf{D})}{(\mathbf{W})}$$
(36)

One method of finding A3_{ave,i}, A2_{ave,i}, and S1_{ave,i} would be to take the arithmetic average of the respective tower section end values of absorption or stripping factors. It has been shown in the earlier unpublished work by Dr. Cecchetti on simple towers that the accuracy obtained by using arithmetic average values for stripping or absorption factors is less than if a linear profile were assumed between the end absorption or stripping factors.

The best way to determine the "average" absorption or stripping factors is to obtain definitive "average" fractions for each component that reproduce the rigorous plate-to-plate solution exactly for a "base" case. These fractions can then be used to make parametric studies at other tower conditions. First, the fractions describing where the "average" absorption or stripping factors lie need to be defined.

Upper tower section:

$$FRAC3_{i} = \frac{\frac{A3_{ave,i}}{(L3)}}{\frac{(L3)}{(V3)(K_{TT,i})} - \frac{(L3)}{(K_{TS,i})(V3)}}$$
(37)

Middle tower section:

$$FRAC2_{i} = \frac{A2_{ave,i} - \frac{(L2)}{(K_{TF,i})(V2)}}{\frac{(L2)}{(V2)(K_{TS,i}) - \frac{(L2)}{(K_{TF,i})(V2)}}$$
(38)

Lower tower section:

$$FRAC1_{i} = \frac{S1_{ave,j} - \frac{(K_{TF,i})(V1)}{(L1)}}{\frac{(K_{TF,i})(V1)}{(L1)}}$$
(39)

The
$$\left(\frac{N}{d}\right)_{i}$$
, $\left(\frac{L}{d}\right)_{NF + 1, i}$, and $\left(\frac{N}{b}\right)_{NF, i}$ ratios from the Rigorous

Thiele-Geddes solution are inserted into the appropriate equations to solve for $\Lambda_{ave,i}^3$, $\Lambda_{ave,i}^2$, and $Sl_{ave,i}^2$. Equations (33), (34), and (35) are solved by a trial and error procedure for $\Lambda_{ave,i}^3$, $\Lambda_{ave,i}^2$, and $Sl_{ave,i}^2$, respectively. The half-interval method of convergence is used, with the rigorous absorption or stripping factors as limits for the respective tower section end values.

The fractions are next determined using equations (37), (38), and (39). These fractions usually lie between zero and unity, but they can be negative due to the fact that the end values of the absorption or stripping factors used in equations (33), (34), and (35) are based on constant molal overflow. These fractions when used in the simplified Thiele-Geddes Method reproduce the rigorous solution within any desired tolerance convergence on $\left(\frac{W}{d}\right)_{i}$, $\left(\frac{k}{d}\right)_{NF + 1, i}$, and $\left(\frac{V}{b}\right)_{NF, i}$.

The real benefit of using force-fit fractions (FRAC3_i, FRAC2_i, FRAC1_i) is that parametric cases can then be run with a high degree of accuracy. The calculation procedure for the parametric cases, obtains the A3_{ave,i}, A2_{ave,i}, and S1_{ave,i} from the following equations:

$$A3_{ave,i} = (PRAC3_{i}) \frac{(L3)}{(V3)(K_{TT,i})} - \frac{(L3)}{(V3)(K_{TS,i})} + \frac{(L3)}{(V3)(K_{TS,i})}$$
(40)

$$M_{ave,i} = (FRAC2_{i}) \frac{(L2)}{(V2)(K_{TS,i})} - \frac{(L2)}{(V2)(K_{TF,i})} + \frac{(L2)}{(V2)(K_{TF,i})}$$
(41)

$$S1_{ave,i} = (FRAC1_i) \frac{(V1)(K_{T2,i})}{(L1)} - \frac{(K_{TF,i})(V1)}{(L1)} + \frac{(K_{TF,i})(V1)}{(L1)}$$
(42)
The calculation procedure for the Force-Fit Thiele-Geddes Method is essentially the same as that for the Stand-Alone Simplified Thiele-Geddes shown on pages 20 to 23. The difference between the two methods are the equations used for the component ratios $\left(\frac{k}{d}\right)_{NF + 1,i}$, $\left(\frac{w}{d}\right)_{i}$ and $\left(\frac{v}{b}\right)_{i}$. The equations to be used for the Force-Fit Thiele-Geddes Method are (33), (34), (35), (36), (37), (38), and (39).

DISCUSSION OF RESULTS

Table 1 on the following page summarizes the cases that were investigated using three calculation methods. The three calculation methods are: (1) Rigorous Thiele-Geddes Method, (2) Stand-Alone Simplified Thiele-Geddes Method, (3) Force-Fit Thiele-Geddes Method. Computer programs were written to carry out these investigations. A total of six debutanizer column cases was studied. Case 1 was selected as the base case from which the forcefit fractions were extracted for use with the Force-Fit Thiele-Geddes Method for the other five cases.

Tables 3 through 8 tabulate the results for these six cases using the three calculation methods. The force-fit fractions which would be required to duplicate the rigorous base case solution may be found in Table 2. The accuracy of the Force-Fit Thiele-Geddes Method is considerably better than the Stand-Alone Simplified Thiele-Geddes Method, with the exception of case number three, which has a reflux ratio considerably higher than that used in the base case. It is apparent that in this instance the force-fit fractions extended into a region which is beyond the accuracy of the method.

Temperatures calculated for the distillate, bottoms, and sidestreams were within 2° or better of the rigorous solution values for the Stand-Alone Simplified Thiele-Geddes Method and within 0.5° for the Force-Fit Thiele-Geddes Method (except case 3). Compositions were within 0.3 moles for the Stand-Alone and 0.1 moles for the Force-Fit.

Table 1

Tower Case Studies

Fixed Variables

Feed, Mole %

C3	5			
iČ4	15			
nC4	25	****	Light	Key
iC5	20	-	Heavy	Key
nC ₅	35			.,

Liquid Feed at its bubble point of 181.6°F Fixed Feed Rate of 100 moles/hr. Fixed Tower Pressure (120 psia) Total Condenser Side Stream Drawoff Rate = 10 moles/hr.

Case	Parametric Variables	Reflux <u>Ratio</u>	Distillate Rate (moles/hr)	Number of <u>Stageš</u>	Feed Stage*	Side Stream Drawoff Stage*
1	Base	2.0	30	10	5	8
2	High Reflux	2.5	30	10	5	8
3	High Reflux	.3.0	30	10	5	8
4	Low Distill- ate	2.0	25	10	5	S
5	High Stages	2.0	30	11	6	9
6	Low Feed Stage	2.0	30	10	8	4

*Stage 1 is the reboiler

Table 2 Case 1

Parametric Variable:

Reflux	Rate	*					2
Distill	ate	Rate	**************************************				30
Number	of S	tages	3	Owle rate Plant Room		B	10
Feed St	ages	*					5
Side St	ream	Dray	voff	Stad	e:		8

Force Fit Fraction From Rigorous Solution

Component	Top Tower	· Middle Tower `	Bottom Tower
Number	Section	Section	Section
1	.2850	-0.4872	.1037
2	.3038	-0.3804	.1322
3	.3160	-0.3371	.1311
4	.3551	-0.2907	.0397

Table 3

<u>Case l</u>

Parametric Varialbe:

Reflu:	<pre> Rate</pre>	·			 - 2
Disti	llate 1	Rate:		ng arang ayana kindi dirah da	 -30
Number	c of Si	cages	3 2		 -10
Feed S	Stage:-				 - 5
Side S	Stream	Draw	off	Stage	 - 8

Com-

po-	Disti	llate		Bott	oms		Side St	reams		
nent	Mole	Moles/	Temp	Mole	Moles/	Temp	Mole	Moles/	Temp	Calculation
No.	Fraction	Hour	• F	Fraction	Hour	°F	Fraction	Hour	٥Ŧ	Method Used
l	.1530	4.59		.0017	.10		.0307	.31		
2	.3370	10,11	153.1	.0501	3.01	213.3	.1885	1.89	174.2	Rigoreus
3	.4254	12,76		,1436	3.61		.3623	3.62		Thiele-
4	.0485	1.46		.2777	16.67		.1880	1,88		Geddes
5	,0361	1.08		.5269	31.61		,2305	2.30		
-	1.0000	30.00		1.0000	60.00		1.0000	10.00		
1	1534	4 60		0016	. 09		0302	30		Stand-Alone
2	.3405	10.21	152 2	0478	2 87	213 9	1918	1 92	173 4	Simplified
۲ ۲	4286	12 86	يني ميڪ ڪي ڪري	1403	8 42	44000	3724	3 72	1/207	Thielo-
Δ	0451	1 35		2800	16.80		1846	1 85		Goddeg
5	0324	2,00 Q7		5303	31 82		2210	2 21		
2	$\frac{.0324}{1.0000}$	30.00		$\frac{.3333}{1.0000}$	60.00		1.0000	10.00		
1	.1530	4.59	153.1	.0017	.10	213.3	.0307	.31	174.2	Force-Fit
2	.3370	10.11		.0501	3.01		.1885	1.89		Thiele-
3	.4254	12.76		,1436	8.61		.3623	3,62		Geddes
4	.0485	1,46		.2777	16.67		.1880	1.88		
5	.0361	1.08		.5269	31.61		,2305	2.30		
	1.0000	30.00		1.0000	60,00		1.0000	10.00		

Table	4
And the second second second second	

Case 2

Parametric Variable:

۸. ت

Reflux Rate:2.5
Distillate Rate30
Number of Stages10
Feed Stage5
Side Stream Drawoff Stage8

Com- po- nent No.	Disti Mole Fraction	llate Moles/ Hour	Temp °F	Bott Mole Fraction	oms Moles/ Hour	Temp J°	Side St Mole Fraction	reams Noles/ Hour	Temp ° F	Calculation Method Used
1 2 3 4 5	.1544.3476.4358.0373.02481.0000	4.63 10.43 13.08 1.12 .74 30.00	149.9	$\begin{array}{r} .0012 \\ .0425 \\ .1320 \\ .2859 \\ \underline{.5384} \\ 1.0000 \end{array}$.07 2.55 7.92 17.15 <u>32.31</u> 60.00	215.3	.0294 .2018 .4905 .1732 .1951 1.0000	.29 2.02 4.01 1.73 <u>1.95</u> 10.00	170.3	Rigorous Thiele- Geddes
, 1 2 3 4 5	.1547.3509.4380.0340.02181.0000	$4.64 \\ 10.53 \\ 13.16 \\ 1.02 \\ .65 \\ 30.00 $	149.0	.0011 .0401 .1284 .2885 .5419 1.0000	$ \begin{array}{r} .07\\ 2.41\\ 7.70\\ 17.31\\ \underline{32.52}\\ 60.00\\ \end{array} $	215.9	.0290 .2056 .4140 .1673 .1831 1.000	.29 2.07 4.14 1.67 <u>1.83</u> 10.00	169.5	Stand-Alope Simplified Thiele- Geddes
1 2 3 4 5	.1544.3473.4349.0379.02551.0000	4.63 10.42 13.05 1.14 .76 30.00	150.1	.0012 .0420 .1330 .2853 .5376 1.0000	,07 2.57 7.98 17.12 32.26 50.00	215,2	.0296 .2012 .3975 .1741 .1975 1.0000	.30 2.01 3.97 1.74 1.98 10.00	171.0	Porce-Fit Thiale- Geddes (Based on Case 1)

نن سر Table 5

<u>Cese 3</u>

Parametric Variable:

3

Reflux Rate:	. We are the one and the set of the two the two the two the transmission of the two the two the ${\mathfrak Z}$
Distillate Rat	
Number of Stag	eo10
Reed Stage	5
Side Stream Dr	awoff Stage8

Com-										•
-0q	Disti	llate		Eoct	oms		Side St	reams		
nent	Mole	Moles/	Temp	Mole	Holes/	Temp	Mole	Moles/	Temp	Calculation
No.	Fraction	Hour	° E	Fraction	Eour	°E	Fraction	i Hour	0 <u>7</u> 7	Nethed Used
H C C & 10	.1554 .3571 .4439 .0274 .0162 1.0000	4.66 10.71 13.32 .82 .49 30.00	147.2	.0009 .0350 .1204 .2945 .5493 1.0000	.05 2.10 7.22 17.67 <u>32.96</u> 60,00	317.3	.0287 .2187 .4460 .1511 .1555 1.0000	.24 2.19 4.46 1.51 1.55 10,00	165.6	Augorous Thiclo- Gaădas
1 2 3 4 5	$\begin{array}{r} .1556 \\ .3578 \\ .4442 \\ .0267 \\ .0157 \\ \hline 1.0000 \end{array}$	$ \begin{array}{r} 4,67\\ 10.73\\ 13.33\\ .30\\ .47\\ 30.00\\ \end{array} $	147.1	.0008 .0347 .1193 .2949 .5493 1.0000	.05 2.08 7.10 17.69 <u>32.99</u> 60.00	217.5	.0232 .2136 .4432 .1507 .1543 1.0000	.28 2.19 4.43 1.51 1.54 10.00	166.6	Stand-Alone Simplified Thisla- Coides
1 2 3 4 5	.1554 .3544 .4407 .0305 .0190 1.0030	4.6610.6313.22.92.5730.00	149.1	0009 0375 1250 2913 5453 1.0000	.05 2.25 7.50 17.49 32.72 60.00	215.7	.0237 .2113 .4280 .1602 .1714 1.0000	.29 2.12 4.23 1.60 1.71 10.00	168.3	Force-Fit Whiche- Gefées (Bused on Case 1)

3

<u>Table</u> 6

Case 4

Parametric Variable:

Reflu	1x Rate:2	}
Disti	llate Pate25	;
Numbe	er of Stagesl()
Feed	Stage	>
Side	Stream Drawoff Stage8	2

Com-

po-	Disti	llate		Bott	ons		Side St	reans		
nent	Mole 1	Moles/	I'emp	Mole	Moles/	Temp	Mole	Moles/	Temp	Calculation
No.	Fraction	Hour	۰E	Fraction	Hour	۰E	Fraction	Hour	0 <u>5</u>	<u>Method Used</u>
1 2 3 4 5	.1774 .3429 .4058 .0424 .0315 1.0000	4.43 8.57 10.15 1.06 .79 25.00	150.2	.0031 .0680 .1725 .2640 .4924 1.0000	.20 4.42 11.21 17.15 32.01 55.00	208.2	.0365.2004.3645.1781.22051.0000	.37 2.00 3.65 1.78 2.20 10.00	171.7	Rigorcus Thiole- Gaddes
1 2 3 4 5	.1806 .3520 .4046 .0366 .0262 1.0000	4.51 8.30 10.11 .92 .66 25.00	148.4	$\begin{array}{r} .0018\\ .0629\\ .1706\\ .2676\\ .4971\\ 1.0000\end{array}$.12 4.05 11.09 17.39 <u>32.31</u> 35.09	209.3	.0369 .2114 .3799 .1385 .2033 1.0000	.37 2.11 3.50 1.69 2.03 10.00	169.7	Stand-Alone Simplified Thiele- Geddes
1 2 3 4 5	.1799 .3459 .3988 .0419 .0335 1.0000	4.50 8.65 9.97 1.05 .84 25.00	150,3	.0020 .0668 .1765 .2647. .4200 1.0000	.13 4.34 11.47 17.21 <u>31.85</u> 65.07	208.3	.0370 .2010 .3559 .1745 .2315 1.0000	37 2.01 3.56 1.74 2.32 10.00	172.2	Force-Fit Thiele- Seddes (Based on Case 1)

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Table 7

Case 5

Parametric Variable:

Refl	ux Rate:2.0
Dist	illate Rate30
. Numb	er of Stagesll
Feed	Stage we we consider the second of the second s
Side	Stream Drawoff Stage9

-no po	Distillate			Pottons			Side Streams					
nent <u>No.</u>	Mole Fraction	Moles/ <u>Hour</u>	Temp °E	Mole Fraction	Moles/ <u>Sour</u>	uent T	Mole Fraction	Moles/ <u>Hour</u>	Temp T	Calculation <u>Method Used</u>		
1 2 3 4 5	$ \begin{array}{r} .1543 \\ .3425 \\ .4252 \\ .0449 \\ .0330 \\ 1.0030 \\ \end{array} $	4.6310.2812.71.35.9930.00	152.1	.0010 .0461 .1421 .2807 .5301 1.0000	.06 2.77 3.53 16.84 31.81 60.00	214.1	.0314 .1958 .3716 .1810 .2202 1.0000	.31 1.26 3.72 1.81 2.20 10.00	172.8	Rigorous Thiala- Geddes		
1 2 3 4 5	.1545 .3464 .4237 .0412 .0292 1.0000	4.63 10.39 12.86 1.24 .28 30.00	151.0	. 0009 . 0434 . 1083 . 2834 . 5340 1. 0000	.06 2.60 8.10 17.00 <u>32.64</u> 50.00	214.7	.0309 .2001 .3839 .1763 .2038 1.0000	.31 2.00 3.84 1.76 2.00 10.00	171.7	Stand-Alone Simplified Thiola- Geddes		
	.1543 .3419 .4248 .0455 .0335 1.0000	4.63 10.26 12.74 1.36 <u>1.01</u> 30.00	152.2	.0010 .0465 .1427 .2303 .5235 1.0000	.05 2.00 8.56 16.01 31.77 60.00	214.0	,0313 ,1248 ,3698 ,1022 ,2219 1,0705	.31 1.95 3.70 1.02 1.02 10.00	173.0	Force-Fit Thicle- Geddes Method (Based on Case 1)		

34

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Table 8

Case 6

Parametric Variable:

Reflux	Sate-	and four place more read more drift with	, we use the set of the set of the set of the 2
Distill	late I	Rate	~~~~30
Number	of Si	tages	<u>0 1 1 </u>
Feed St	age		we are set in the set of the set of the set 3
Side St	:ream	Drawoff	Stage4

Com-	Dicti	112+0		Pott	<u>oma</u>		sido st	reams		
nent No.	Mole Fraction	Moles/	Temp °F	Mole Fraction	Moles/ Hour	Temp °F	Mole Fraction	Moles/ Hour	Temp °F	Calculation Method Used
1 2 3 4 5	.1508 .3304 .4273 .0533 .0382 1.0000	4.53 9.91 12.82 1.60 1.14 30.00	154.1	.0029 .0546 .1438 .2734 .5253 1.0000	,13 3.27 8.63 16.40 <u>31.52</u> 60.00	212,4	$\begin{array}{r} .0299\\ .1812\\ .3552\\ .1996\\ .2341\\ 1.00000\end{array}$	$ \begin{array}{r} .30 \\ 1.81 \\ 3.55 \\ 2.00 \\ \underline{2.34} \\ 10.00 \\ \end{array} $	175.5	Rigorous Thiele- Geãães
L 2 3 4 5	,1515.3346.4317.0489.03331.0000	4.54 10.04 12.95 1.47 <u>1.00</u> 30.00	152.8	.0027 .0517 .1394 .2763 .5299 1.0000	.15 3.10 8.37 16.53 31.79 60.00	213.2	$\begin{array}{r} .0295 \\ .1858 \\ .3586 \\ .1954 \\ .2207 \\ 1.0000 \end{array}$.29 1.86 3.69 1.95 <u>2.31</u> 10.00	174.2	Stand-Alone Simplified Thiele- Geddes
1 2 3 4 5	.1509 .3310 .4275 .0529 .0377 1.0000	4.53 9.93 12.83 1.58 1.13 30.00	153.9	.0029 .0542 .1435 .2737 .5257 1.0000	.17 3.25 8.61 16.43 <u>31.54</u> 60.00	212,5	.0300 .1819 .3565 .1939 .2327 1.0000	.30 1.82 3.56 1.99 <u>2.33</u> 10.00	175,3	Force-Fit Thielo- Gaddes (Pased on Case 1)

(12) (12)

CONCLUSIONS

The Simplified Thiele-Geodes Methods make possible rapid, accurate screening calculations. The Force-Fit Thiele-Geddes Method is well suited for parametric studies around a rigorous solution. The degree of accuracy that can be obtained from the Force-Fit Thiele-Geddes Method is believed to be the highest available from a short-cut procedure. Reduced costs for fractionation studies and a better engineering understanding of the effort of key tower design variables, are the principle assets of these methods.

It should be emphasized that the Force-Fit Thiele-Geddes Method is not limited by the constant molar overflow assumption used in the development of the simplified equations. The force-fit fractions take into account deviations from constant molar overflow by force fitting the rigorous solution. The force-fit also takes into consideration any composition effects which were used in the basic data for the plate-to-plate procedure.

RECOMMENDATIONS

The simplified fractionation procedure based on the Thiele-Geddes Method can be adapted for any type of tower with a two-phase system. This can be accomplished by developing modular calculation blocks for each type of tower section.

An improved convergence procedure using the theta method for complex towers could facilitate convergence. This short-cut fractionation procedure requires investigation for towers with very nonideal systems such as extraction, extractive distillation, and azeotropic distillation.

The equations used in the simplified fractionation procedure are fundamentally sound, and improvements can be made only for methods for estimating the average absorption or stripping factors. It may be possible to develop a method for adjusting force-fit fractions to give more accurate answers for parametric cases. The distribution curve of the average absorption or stripping fraction as a function of the absorption or stripping factor at the respective tower end values could provide a basis for improving the force-fit method.

Graphical methods can be developed for each type of tower section thus permitting easy hand calculations. Work using graphical methods has been done by Dr. Ralph Cecchetti an adjunct professor at Newark College of Engineering. His work has not yet been published.

NOMENCLATURE

A n,i	Absorption factor on stage n for component i
	$A_{n,i} = \frac{L_{n}}{V_{n,i}}$
A3 ave,i	"Average" absorption factor of component i in the upper tower section
A2 ave,i	"Average" absorption factor of component i in the upper tower section
В	Bottom molar flow rate
b.	Molar flow rate of component i in the bottoms
D	Molar distillate flow rate
d i	Molar flow rate of component in in the distillate
di	Molar flow rate of component in in the distillate calculated by use of the theta convergence method.
DDF	Design degrees of freedom
F	Molar feed flow rate
FLIQ	Mole fraction of the feed that is liquid
FRAC3	Fraction describing A3 ave,i
FRAC2	Fraction describing A2 ave,i
FRAC1	Fraction describing S1 ave,i
H _{t,i}	Vapor enthalpy at temperature t of component i
HC	Heavy component
h _{t,i}	Liquid enthalpy of temperature t of component i
j.	Subscript designating component i
K _{n,i}	Equilibrium constant on stage n for component i
	$K_{n,i} = \frac{Y_{n,i}}{x_{n,i}}$

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K _{t,i}	Equilibrium constant of temperatures t for component i
L n	Total molar liquid rate off stage p
LNS	Liquid molar rate off the sidestream stage before the sidestream is drawn off
Ll	Liquid molar flow rate in the lower towar section based on constant molal overflow
L2	Liquid molar flow rate in the middle tower section based on constant melal overflow
· L3	Liquid molar flow rate in the upper tower section based on constant molal overflow
² F,i	Liquid molar flow rate of component i in the feed
l _{n,i}	Liquid molar flow rate off stage n of component i
LC	Light component
NTT	Number of stages including the reboiler but not the condenser
NF.	Feed stage
NS	Sidestream drawoff stage
R	External reflux ratio (L _{NTT + 1/D})
S _{n,i}	Stripping factor on stage n for component i $S_{n,i} = \frac{V_n K_{n,i}}{L_n}$
Slave,i	"Average" stripping factor of component i in the stripping section
1 73.	Bottom (reboiler) tray temperature
Τ2	Second stage (tray above the reboiler) temperature
TF	Feed tray temperature
TS	Sidestream tray temperature
${ m TT}$	Top tray temperature
V	Total molar vapor rate off stage n

V)	Vapor moler flow rate in the lower tower section based on constant motel overflow
V2	Vapor molar flow rate in the middle tower section based on constant molal overflow
V3	Vapor molar flow rate in the upper tower section based on constant solal overflow
VF,i	Molar vapor flow rate of component i in the feed
v _n ,i	Molar vapor flow race off stage n of component i
, <u>V</u> 7	Molar sidestream flow rate
w _i	Molar flow rate of component i in the sidestream
wi'	Molar flow rate of component i in the sidestream calculated by the theta convergence method
x _{n,i}	Liquid mole fraction on stage n of component i
×F,i	Mole fraction of component i in the feed (regard- less of vapor or liquid)
^y n,i	Vapor mole fraction on stage p of component i
^z n,i	Mole fraction of component i in composite feed.

 $L_{i} \cap$

APPENDIX

- APPENDIX A Computer Program Listing
- APPENDIX B Sample Program Input for the Base Case (Case 1)

APPENDIX A

Main Program for the Rigorous Thiele-Geddes Method

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	CON	MON Ad	BOCODOE	0	if 2 fillion, look of a	at to the w			
	1	. A1	(5),81(5	1,01(5).	01(5)+E	1(5) +A2(5);82(5);	C2(5),D2(5	5) 222(5)
	AK (AA . BB .	CC,DD,EE	>TT)=AA+	TT*(88+	TT★(CC+T	1*100+11+	EE)))	
		D(2,10	0) .NC#N	TT +NS + NP					
	RE4	D(2+10	3) (A(I)	93(I)9Cl	1) • D(1)	~E([) sI=	l (NC)		
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•	100 POP	MPONEN.	7791UAS Tonimarer	(T) 1 = 4)	C. LA(1))		·	
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	104	68 01/1 x	3X****NC)TE**TRAY	(S ARE N	UMBERED	FROM THE	SOLLON MI	IH THE R
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	RE.	4D.(2,10	2) (X(1)	×XL(I)	xv(1).	1=1+NC)_			
******	R£.	4D(2+10	21 F+000	DER+S+FL	IQ.TF				
	WR	178(3+3	02) 000	StRIF_					•
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	RE	AD(2:10	2) (T(I)	= 1)				
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	A.	LINTT+1)=R*DDD						14. a st kontre lanço astritutan. 1. strava
	٧V	(NTT)=0	DD+AAL(VTT+1)					
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	DO	30 1=1	y J		,				
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		31 1=	F.J						ni, an mana a nar na na anna - anna a na a na anna a na anna A
		(1)=VV	(NTT)	1.0 · · · · · · · · · · · · · · · · · · ·		******			*
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		3) AAL(141)=AA((NTT+1)⇒S .1=01T+1			
	an an instruction of the Million of	NN=NS=1 000 32 1-2001 (and and a second south south	, , , , , , , , , , , , , , , , , , ,	a a faith an ann ann ann ann ann ann ann ann ann
		VV(I)=VV(NTF)		· ·	··· · •
		72 00 1 1=1+KC	· ·		ана. А
	una avai n'in arr - Can a can manifiant -	1 RAT(1,NTT+1)=0 NN+NTT+NS+1	ang ng gi sé sétanén san satu ang dapit ng		anan an
	50 - 1000	DO 2 JERRAN Kentter-J			
	· · ·	DO 2 1#1,NC APPAGE A(1) B(1) C(1) D(1) G(1) T	1.5.5.5		
	ala sina inangan ja pingangan kan panak ang	$\therefore 2 \text{ SAT}(1; N) = \text{AAL}(N) = (\text{RAT}(1; N \in 1) / (N)$	V(N)*AK1)		
	a succession and the second	WOD(1)=KAT((+RS)*SZAAL(NS)			· · · · · /
		4 RA1(1,NS)=RA1(1,NS)~xC)(1) 1N=NS+NF+1			
		DO B JELEN Mensel			
,	an an channa ann a na sur an Anthair ann an an	DO 3 ITISK (KTACK ALL OLIVECTIVE TO A TO A TO	1		a an
		3 RATIANT ALLAST (1) * (RATII * (1) * (0) (1)	+1.)/(VV(N)*A	<1)	· · · · ·
		DO_6_1=1,NC AK1=AK(A(J),B(I),C(I),DEI),E(1),T(1))		
· • •		6 RAT(1,1) #AK(*vV(1)/AAL()) DO 5 J#2%AF			
فر		DC 5 THISE AND THE STANDARD FOR THE		. . .	
·		5 RAT(1,J)=AK1*VV(J)*(RAT(1,J+1)*)/	AAL(J)		
•	•	DO 7. 1=1+NC	· · · · · · · · · · · · · · · · · · ·		ر ایر در این شمین بعد این ارام می در
	•	<pre>7 BOD(1)#(RAT(1)NE+1)+XL(1)/(E*X(1))</pre>	*(1.+WOD(I)))/	
		45 SUMPO: SUM1=0:			
		SUM2=0.a SUM2=0.a			· · · · · · · · · · · · · · · · · · ·
		SU34=0.	Conference and an of the and and the cost of a set of the	enen en an	naninale inizinana enary z 2007 e 2001
	i i mani an an si si an an si si an an si si an an si	50%5=0* DO 13 I=1;NC			
	W = 0.17 (0.000) (0.00	<pre>SS=F*X(1)/(1*+THETD*BOD(1)+THETW*/ SUM=SUM+SS</pre>	OD(I))		
ţ,		<pre>SUM3=55*THETW*WOD(1)+SUM3 SS= F#X(1)/(1*+(THETD**0C1)*</pre>	BOU(I)+THETW*		·····
	99	SUM1+55_SUM1+55SUM1+55SUM1+55SUM1+55SUM1+55SUM1+5	e es	· · · · ·	· · · · · · · · ·
			(THETW+.COl)*	WOD([))	· · · · ·
*		5075755*(1481848001)*W00(1)*SUM5 13.SUM2=SUM2+SS	annan a sha tana 1 - marakan kakan kakan sa sa	an a an ann anns anns an starta ann tarr a an tarr a gu	
		IF(ABS(SUM-DDD)/DDD-+00001) 49+4 49 IF(ABS(S-SUM3)/S-+00001) 47+47+49	9:48		
		48 Fix+(SUM1+SUM)/+001 FiY=(SUM2+SUM)/+001			
		F2X=(50M4+50M3)/6001 62X=(50M45-50M2)/6001			
	 An an all an above the statements as an a 	THE= (F2X+(SUM-DDD)-F1X+(SUM2	-\$))/(F2Y*F1X	-F2X*F1Y)	
	a for the provide the second			•	
	ware of a final group of group to g			na manana manana ang kanana ang ka	
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•	s.				

THETD=THETD=((SUM=DDD)+F1Y#TEE)/F1X

	and the second
	THETDSTREEDS(1)+F(Y)+F(Y)+F(Y)+F(Y)+F(Y)+F(Y)+F(Y)+F(Y
	HETTELS.CART THETOLICESUM
	10010707101070710101070710101070701000000
	969 FORMAT (6X;'THETO=';E15;B;/67;'THETW=';E15;S;/5X;'DISTILLATE='; 1 F15;B;/5X;'SIDF STREAM='; E15;8)
	67 D0 46 [=1+NC RAT(1+NT+1)=F*X(1)/(1++TEFT0 <b02(1)+teetj*w02(1))< td=""></b02(1)+teetj*w02(1))<>
•	$VOS(1) = PAT(1 \circ AF)$
	46 RAT(1,)=80D(1)*THETD*RAT(1,NTT+1)
	C CALCULATE THE MULE FRACTIONS ON EACH TRAY
,	DO 55 J=2+NTT SUM-O
	DO 51 I=1,NC
•	51 SUV=SUM + RAT(I,J)*RAT(I,NN)
	55 RAT(I;J)#RAT(I;NN)/SUM
	DO 56 I=1 (NC $RAT(1 (I (I$
	55 RAT(1+1)=RAT(I+1)/(F-DDD-S)
	NS=NTT+1
• _	DO 58 J=1.NN
×	59 BOD(1)=RAT(1,J)
i.	TF(J-NF) 78:78:86
	79 K=1
	86 K≃0
•	58 CALL BUBBA (A+B+C+D+E+BOD+ T(J)+NC+K) DO 96 J=2+NF
	58 CALL BUBBA (A+B+C+D+E+BOD+ T(J)+NC+K) DO 96 J=2+NF DO 96 J=1+NC AK1=AK(A(J)+B(J)+C(J)+E(J)+T(J))
	58 CALL BUBBA (A+B;C+D;E,BOD; T(J);NC+K) D0 96 J=2;NF D0 96 J=1;NC AK1=AK(A(I);B(I);C(I);D(I);E(I);T(J)) 96 RAT(I;J);RAT(I;J)/AK1
	58 CALL BUBBA (A+B+C+D+E+BOD+ T(J)+NC+K) D0 96 J=2+NF D0 96 I=1+NC AK1=AK(A(I)+B(I)+C(I)+E(I)+T(J)) 96 RAT(I+J)+RAT(I+J)/AK1 IF(ITH) 62+61+62 62 IF(ABS(THETD -1+)=+00001) 64+64+63
	58 CALL BUBBA (A+B;C+D;E,BOD; T(J);NC+K) D0 96 J=2;NF D0 96 J=1;NC AK1=AK(A(I);B(I);C(I);D(I);E(I);T(J)) 96 RAT(I;J);RAT(I;J)/AK1 IF(ITH) 62;61;62 62 IF(ABS(THETD -1;)=:00001) 64;64;63 63 ITH=0 60 T0 69
 	58 CALL BUBBA (A+B;C;D;E;BOD; T(J);NC;K) D0 96 J=2;NF D0 96 I=1;NC AK1=AK(A(I);B(I);C(I);D(I);E(I);T(J)) 96 RAT(I;J);RAT(I;J)/AK1 IF(ITH) 62;61;62 62 IF(ABS(THETD -1;)-:00001) 64;64;63 63 ITH=0 60 TO 69 61 IF(ABS(THETD -1;)-:00001)66;66;69 64 ITH=1
	58 CALL BUBBA (A+B;C;D;E;BOD; T(J);NC;K) D0 96 J=2;NF D0 96 I=1;NC AK1=AK(A(I);B(I);C(I);D(I);E(I);T(J)) 96 RAT(I;J);RAT(I;J)/AK1 IF(ITH) 62;61;62 62 IF(ABS(THETD -1:)=:00001) 64;64;64;63 63 ITH=0 G0 T0 69 61 IF(ABS(THETD ~1:)=:00001)66;66;69 66 ITH=1 69 CALL DATSW(10;IDSW)
	<pre>58 CALL BUBBA (A+B;C+D;E,BOD; T(J);NC+K) D0 96 J=2;NF D0 96 I=1;NC AK1=AK(A(I);B(I);C(I);D(I);E(I);T(J)) 96 RAT(I;J);RAT(I;J)/AK1 IF(ITH) 62;61;62 62 IF(ABS(THETD -1:)=*00001) 64;64;63 63 ITH=0 60 T0 69 61 IF(ABS(THETD -1:)=*00001)66;66;69 66 ITH=1 69 CALL DATSW(10;IDSW) G0 T0 (70;71); IDSW 70 CALL OUT (NTT;AAL;VV;T;D0D;F;NF;NS;NC;TF;A;B;C;D;E;RAT;X;HNF</pre>
	<pre>58 CALL BUBBA (A+B;C;D;E;BOD; T(J);NC;K) D0 96 J=2;NF D0 96 I=1;NC AK1=AK(A(I);B(I);C(I);D(I);E(I);T(J)) 96 RAT(I;J);PAT(I;J)/AK1 IF(ITH) 62;61;62 62 IF(ABS(THETD -1:)=:00001) 64;64;63 63 ITH=0 60 T0 69 61 IF(ABS(THETD -1:)=:00001)66;66;69 66 ITH=1 69 CALL DATSW(10;IDSW) G0 T0 (70;71); IDSW 70 CALL OUT (NTF;AAL;VV;T;DDD:F;NF;NS;NC;IF;A;B;C;D;E;RAT;X;HNF 1;QR;ODD;QBB;QC;HNS) 71 CALL HEAT (RAT;AAL;VV;X;NTT:NF;NS;NC;DDD; TF;T;F;KEY;HNF;QR;</pre>
	<pre>58 CALL BUBBA (A+B+C+D+E+BOD; T(J)+NC+K) D0 96 J=2+NF D0 96 J=1+NC AK1=AK(A(I)+B(I)+C(I)+E(I)+T(J)) 96 RAT(I+J)+RAT(I+J)/AK1 IF(ITH) 52+61+52 62 IF(ABS(THETD -1+)=+00001) 64+64+64 63 ITH=0 60 T0 69 61 IF(ABS(THETD -1+)=+00001)66+66+69 66 ITH=1 69 CALL DATSW(I0+IDSW) G0 T0 (70+71)+ IDSW 70 CALL CUT (NTF+AAL+VV+T+DDD+F+NS+NC+TF+A+B+C+D+E+RAT+X+HNF 1+QR+CDD+QBB+QC+HNS) 71 CALL HEAT (RAT+AAL+VV+X+NTT+NF+NS+NC+DDD+ TF+T+F+KEY+HNF+QR+ 1 QDD+QBB+QC+S+HNS) G0 T0 72</pre>
	<pre>58 CALL BUBBA (A+B+C+D+E+BOD; T(J)+NC+K) D0 96 J=2+NF D0 96 J=1+NC AK1=AK(A(I)+B(I)+C(I)+D(I)+E(I)+T(J)) </pre>
	<pre>56 CALL BUBBA (A+B;C*D;E;BOD; T(J);NC*K) D0 96 J=2;NF D0 96 I=1;NC AK1=AK(A(I);B(I);C(I);E(I);T(J)) 96 EAT(I;J);RAT(I;J)/AK1 IF(ITH) 62:61;62 62 IF(ABS(THETD -1:)=*00001) 64;66;663 63 ITH=0 60 T0 69 61 IF(ABS(THETD -1:)=*00001)66;66;69 66 ITH=1 69 CALL DATSW(10;IDSW) 69 CALL DATSW(10;IDSW) 69 CALL OUT (NTT;AAL;VV;T;DDD;F;NE;NS;NC;IF;A;B;C;D;E;RAT;X;ENF 1;0R;GDD;0BB;0CC;HNS) 71 CALL HEAT (RAT;AAL;VV;X;NTT;NF;NS;NC;IF;A;B;C;D;E;RAT;X;ENF 1;0D;0BB;0CC;HNS) 71 CALL HEAT (RAT;AAL;VV;X;NTT;NF;NS;NC;DD; TF;T;F;KEY;HNF;0R; 60 T0 77 64 WRITE(3;107) WRITE(3;969) THETD;THETW;SUM;SUM3 CALL OUT (NTT;AAL;VV;T;DD);F;NE;NC;TF;A;B;C;D;E;RAT;X;ENF 1;0D;0BB;0CC;HNS) 65 T0 77 66 WRITE(3;107) WRITE(3;969) THETD;THETW;SUM;SUM3 CALL OUT (NTT;AAL;VV;T;DD);F;NE;NC;TF;A;B;C;D;E;RAT;X;ENF 1;0D;0BB;0CC;HNS) 65 T0 77 66 WRITE(3;107) 75 CALL OUT (NTT;AAL;VV;T;DD);F;NE;NC;TF;A;B;C;D;E;RAT;X;ENF 1;0D;0D;0BB;0CC;HNS) 75 CALL OUT (NTT;AAL;VV;T;DD);F;NE;NC;TF;A;B;C;D;E;RAT;X;ENF 75 CALL OUT (NTT;AAL;VV;T;DD);F;NE;NC;TF;A;B;C;D;E;NE;NE;NE;NE;NE;NE;NE;NE;NE;NE;NE;NE;N</pre>
	<pre>58 CALL BUBBA (A+B+C+D+E+BOD; T(J)+NC+K) D0 96 J=2+NF D0 96 I=1+NC AK1=AK(A(I)+B(I)+C(I)+D(I)+E(I)+T(J)) 96 RAT(I+J)=RAT(I+J)/AK1 IF(ITH) 62+61+62 62 IF(ABS(THETD -1+)==00001) 64+64+63 63 ITH=0 60 T0 69 61 IF(ABS(THETD -1+)==00001)66+66+69 66 ITH=1 69 CALL DATSW(10+IDSW) 60 T0 (70+71)+ IDSW 70 CALL COT (NTF+AL+VV+T+DDD+F+NF+NS+NC+IF+A+B+C+D+E+RAT+X+HNF 1+OR+GDD+OBB+QCC+H+S) 71 CALL HEAT (RAT+AAL+VV+X+NT+NF+NS+NC+IF+A+B+C+D+E+RAT+X+HNF+UR+ I GD+OBB+QCC+H+S) 71 CALL HEAT (RAT+AAL+VV+X+NT+NF+NS+NC+DD+TF+T+F+KEY+HNF+UR+ G0 T0 72 64 WR ITE(3+107) WR ITE(3+969) THETD+THETW+SUM+SUM3 CALL OUT (NTT+AAL+VV+T+DD+F+NF+NS+NC+TF+A+B+C+D+E+RAT+X+HNF+ I+OR+ODD+OBB+QCC+H+S) CALL OUT (NTT+AAL+VV+T+DD+F+NF+NS+NC+TF+A+B+C+D+E+RAT+X+HNF+ I+OR+ODD+OBB+QCC+H+S) TSM1=T(NS+1) CALL OUT (NTT+AAL+VV+T+DD+F+NF+NS+NC+TF+A+B+C+D+E+RAT+X+HNF+ I+OR+ODD+OBB+QCC+H+S) TSM1=T(NS+1) CALL OUT (NTT+AAL+VV+T+DD+F+NF+NS+NC+TF+A+B+C+D+E+S+NC+D+F+S+ I+OR+ODD+OBB+QCC+H+S) TSM1=T(NS+1)</pre>
	<pre>58 CALL BUBBA (A+B;C+D;E+BOD; T(J);NC+K) D0 96 J=2+NF D0 96 J=2+NC AK1=AK(A(1);B(1);C(1);D(1);E(1)+T(J)) 96 RAT(1;J);RAT(1;J)/AK1 IF(ITH) 52+61;62 62 IF(ABS(THETD -1.)=.00001) 64+64;63 63 ITH=0 60 T0 69 61 IF(ABS(THETD -1.)=.00001)66;66;69 66 ITH=1 69 CALL DATSW(10;IDSW) 60 T0 (70;71); IDSW 70 CALL CUT (NTT;AAL;VV;T;DDD;F;NF;NS;NC;IF;A;B;C;D;E;RAT;X;HNF 1+0R;CDD;DB;DC;H4S) 71 CALL CUT (NTT;AAL;VV;T;DDD;F;NF;NS;NC;IF;A;B;C;D;E;RAT;X;HNF; 1;QD;OBB;DC;H4S) 71 CALL HEAT (RAT;AAL;VV;X;NTT;NF;NS;NC;DD; TF;T;F;KEY;HNF;OR; 60 T0 72 64 WRITE(3;969) THETD;THETW;SUM3 CALL OUT (NTT;AAL;VV;T;DD);F;NF;NS;NC;TF;A;B;C;D;E;RAT;X;HNF 1;QR;DD;OBB;DC;H4S) CALL OUT (NTT;AAL;VV;T;DD);F;NF;NS;NC;TF;A;B;C;D;E;RAT;X;HNF (CALL OUT (NTT;AAL;VV;T;DD);F;NF;NT;FL;NF;N;F;NC;TF;A;B;C;D;E;RAT;X;HNF (CALL OUT (NTT;AAL;VV;T;DD);F;NF;NT;FL;NF;N;F;NT;F,NDDD;F;NF;NT;F,NDDD;F;S] (CALL OUT (NTT;AAL;VV;T;DD);F;NF;NT;F,NDDD;F;NF;NT;F,NDDD;F;S] (CALL OUT (NTT;AAL;VV;T;DD);F;NF;NT;F,NDDD;F;NF;NT;F,NDDD;F;S] (CALL FIT(T1);T(2);T(NF);T(NF+1);TS;T' ;T(NS);T(NT);R;DDD;F;S] (ALL FIT(NS);F,NT;FL;N;F,N;F,ND;ND;F];NC;NF;NT;F,NDDD;F;S] (ALL FIT(NS);F]NT;FL;N;F]NT;F]N;F]N;F]N;F]N;F]N;F]N;F]N;F]N;F]N;F]N</pre>
	<pre>58 CALL BUBAA (A+B;C,D;E;BOD; T(J);NC;K) D0 96 J=2;NF D0 96 J=1;NC AK1=AK(A(1);B(1);C(1);D(1);E(1);T(J)) </pre>
	<pre>58 CALL BUB5A (A+8;C;D;E;BOD; T(J);NC+K) D0 96 J=2;NF D0 96 J=2;NF D0 96 J=2;NF D0 96 J=2;NF D0 96 J=2;NF D0 96 J=2;NF AKI=AK(A(I);B(I);C(I);E(I);T(J)) 96 PAT(I;J);AKI(I);J/AKI IF(ITH) 62:61;62 62 IF(ABS(THETD -1;)=:00001) 64;64;63 63 ITH=0 G0 T0 69 61 IF(ABS(THETD -1;)=:00001) 66;66;69 66 ITH=1 69 CALL DATSW(10;IDSX) G0 T0 (70;71); IDSX T0 CALL CUT (NTT;AAL;VV;T;DDD;F;NF;NS;NC;IF;A;B;C;D;E;RAT;X;PNF I;CALL HEAT (RAT;AAL;VV;T;DDD;F;NF;NS;NC;IF;A;B;C;D;E;RAT;X;PNF T1 CALL HEAT (RAT;AAL;VV;X;NTT;NF;NS;NC;IF;A;B;C;D;E;RAT;X;PNF I;CALL HEAT (RAT;AAL;VV;X;NTT;NF;NS;NC;IF;A;B;C;D;E;RAT;X;PNF I;CALL HEAT (RAT;AAL;VV;X;NTT;NF;NS;NC;IF;A;B;C;D;E;RAT;X;PNF (ALL CUT (NTT;AAL;VV;T;DD);F;NF;NS;NC;TF;A;B;C;D;E;RAT;X;PNF (ALL CUT (NTT;AAL;VV;T;DD);F;NF;NS;NC;TF;A;B;C;D;E;RAT;X;PNF (ALL CUT (NTT;AAL;VV;T;DD);F;NF;NS;NC;TF;A;B;C;D;E;RAT;X;PNF (ALL CUT (NTT;AAL;VV;T;DD);F;NF;N;T;NF;T;NF;T;NF;T;NF;T;NF;T;NF;T</pre>
	<pre>58 CALL BUBBA (AcH;C,D,E,BOD; T(J);NC+K) D0 96 J=2,NF D0 96 J=2,NF AK1=AK(A(1);B(1);C(1);D(1);E(1);T(J)) 96 RAT(1;J)=RAT(1;J)=A(1);D(1);E(1);T(J)) 96 RAT(1;J)=RAT(1;J)=A(0001) 64;64;63 63 ITH=0 64 IF(ABS(THETD =1:)=:00001) 64;64;63 66 ITH=1 69 CALL DATS/(10:IDSX) 60 T0 (70;71); IDSX 70 CALL OUT (NTT;AAL;VV;T;DDD;F;NF;NS;NC;IF;A;B;C;D;E;RAT;X;HAF 1;0(R;0DD;0BB;DC;C;HXS) 71 CALL HEAT (RAT;AAL;VV;X;NIT;NF;NS;NC;IF;A;B;C;D;E;RAT;X;HAF 1;0(B);0BB;DC;C;HXS) 71 CALL HEAT (RAT;AAL;VV;X;NIT;NF;NS;NC;DDD; TF;T;F;KEY;HNF;0N; 1;C;DD;0BB;DC;C;HXS) 71 CALL HEAT (RAT;AAL;VV;X;NIT;NF;NS;NC;DDD; TF;T;F;KEY;HNF;0N; Co TO 77 64 WRITE(3;107) WRITE(3;969) THETO;THETM;SUM;SUM3 CALL OUT (NTT;AAL;VV;T;DD);F;AF;NS;AC;TF;A;B;C;D;E;RAT;X;HAF 1;0(R;DD;0(BB;DC;HXS)) CALL FIT(T1);T(2);T(NF);T[NF+1);TSMT ;T(NS);T(NTT);R;DDD;F;S 1;NC;NS;NF;NTT;FLI;0;WOD;ALD;V0B; VV;AAL) 107 FORMAT(/6X;'***SOLUTION CONVERGED***') END</pre>
	<pre></pre>
	<pre>58 CALL BUBBA (A+B+C,D+E,BOD, T(J)+NC+K) D0 96 J=1+NC AK1=AK(A(I)+B(I)+C(I)+D(I)+E(I)+T(J)) 96 FART(I+J)+AK1(I,J)/AK1 IF(ITH) 52+61+62 62 IF(ABS(THETD -1+)-*00001) 64+64+63 63 ITH=0 60 T0 69 64 IF(ABS(THETD -1+)-*00001)66+66+69 65 ITH=1 69 CALL DATSX(I0+IDSX) 60 T0 (70+71)+ IDSX 70 CALL CUT (NTT+AAL+VV+T+BDD+F+NF+NS+NC+TF+A+B+C+D+E+RAT+X+HNF 1+0R+CDD+DBH+2CC+HAS) 71 CALL HEAT (RAT+AAL+VV+X+NTT+NF+NS+NC+TF+A+B+C+D+E+RAT+X+HNF 1+0R+CDD+DBH+2CC+HAS) 60 T0 72 64 WRITE(3+107) WRITE(3+107) WRITE(3+07) CALL CUT (NTT+AAL+VV+X+NTT+NF+NS+NC+TF+A+B+C+D+E+RAT+X+HNF 1+0R+DD+OBB+0CC+HAS) CALL CUT (NTT+AAL+VV+X+NTT+NF+NS+NC+TF+A+B+C+D+E+RAT+X+HNF 1+0R+DD+OBB+0CC+HAS) CALL CUT (NTT+AAL+VV+T+DD+F+NS+NC+TF+A+B+C+D+E+RAT+X+HNF 1+0R+DD+OBB+0CC+HAS) CALL CUT (NTT+AAL+VV+T+DD+F+NT++T+NF+C+D+F+S) 15N1=T(NS+NF+NTT+FLIA+SDU+F+NS+NC+TF+A+B+C+D+E+S) 15N1=T(NS+NF+NTT+FLIA+SDU+AD+A+D+AAL) 107 FORMAT(/6X+***SDLUTION CONVERGED***1) STOP END</pre>
	<pre></pre>

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	•	· · · · · · · · · · · · · · · · · · ·
		Enthalpy Subroutine Using the Constant Composition Method
	•	
	\$ `````	
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	· · · · · · · · · · · · · · · · · · ·	SUBROUTINE HEAT (XX;AL;V·X;NTT:NF;NS;NC;DDD;TF:T;F:KEY;HNF;QR;QDD
	C	1+088+000+5+HAS) ENTHALOY BALANCE USING THE CONSTANT+COMPOSITION METHOD
		DIMENSION A1(5),A2(5),B1(5),B2(5),C1(5),C2(5),D1(5),D2(5),E1(5),E2
	and an	1(5) *XX(5+16) *AL(16) *V(16) *X(5) *1(16) *X2(5) COMMON A(5) *B3(5) *C(5) *D3(5) *E(5) *A1*B1*C1*D1*E1*A2*B2*C2*D2*E2
	• C**	18*READ IN ENTOALPY DATA
		IF(KEY)_12+11+12
•		11 KEYal READ(2.101)(A1(1)-R1(1)-(1(1)-0)(1)
•		-READ(2:101)(A2(1):B2(10:C2(1):D2(1) +E2(1):I=1:NC)
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	مېرىمىنى بەر يەرمىيە بىرىمىرىمىر مەر	
		K=(1)
	•	20 XD(1)=XX(1*NTT+1)
		DB#DDD
	•	DO 1 1=1,NC
		QDV=ODV+XX(1,NT1+1)*(A2(1)+((N(1)*(B2(1)+((N(1)*(C2(1)+((N(1)*(D2(11)+T(NTT)*F2(1)))))
	a a sa a san ana an sa	1 OD=OD+XX(I;NTT+1)*(A1(1)+T(NFT+1)*(B1(I)+T(NTT+1)*(C1(I)+T(NTT+1)*
		(D1(I)+T(NTT+1)*E1(I))))
		OD=ODV*V(NTT)-AL(NTT+1)*QD
		QCC=(QD~QDD_)**0001 N=NTT
.*		Z N=1
{		una IF(N=NT) 394∉4 a su sua summa meneral a su
	, 	HNV≈0c
		$He^{L\approx 0}$
· _	÷	Q = (A2(1)+T(N)*(B2(1)+T(N)*(C2(1)+T(N)*(D2(1)+T(N)*
		HNVD=HNVD+XD(I)*0
	1	HNV=HNV+O*XX(1,N+1)
		つ 円目に本田ビビヤスス(1924年2)マイルエイエナナ(104年2)マイレンド(104年2)マイレンド(104年2)マイレンド(104年2)マイレンド(104年2)マイレンド(104年2)マイレンド(104年2)マイレンド(104年2)マイレンド・コーン・コーン・コーン・コーン・コーン・コーン・コーン・コーン・コーン・コーン
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	1 - 1949 - 1949 - 1949 - 1949 - 1949 - 1949 - 1949 - 1949 - 1949 - 1949 - 1949 - 1949 - 1949 - 1949 - 1949 - 194	
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	2. N	
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	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	$A((N \rightarrow 1) = (QD \rightarrow DQ \in H \land V D) / (H \land V \rightarrow D D)$
•		V(N) = AL(N+1) + BC
		GO TO 2
· -	17	NTENE DB×DDD+S
		K=0
	an an ann an a' ann anns an anns ann an	DO 16 1=1,4C
x	16	xU(1)=1XA(1)=N11+11=UUU+S*XA(1=00)1700 . HNF=HNF+XX(1=05)*(A1(1)+T(NS)*(B1(1)+T(NS)*(C1(1)+T(NS)*(U1(1)+
· · ·		1T(NS)*E1(I)))))
		N=N+1
	23	GO TO 2 3 NT=1
		DB=DB=F K=1
	1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 -	HNF=0.
•		XO(I) = (XX(I) NTT+1) * D = F * X(I) + S * XX(1 + NS)) / DB
	6	> 円気を中国の日本X(1)*(A1(1)*TE*(61(1)*TE*(C1(1)*TE*(01(1)*TE*(1(1))))) ■ 国家日本国家日本
Train		QD=_0D=_HNF
-	- 1	/ UBB=040 AL2=0e0
4	•	V1=C+0 D0 69 1=1+NC
		QBE=QBB+XX(1,1)*(A1(1)+T(1)*(B1(1)+T(1)*(C1(1)+T(1)*(D1(1)+T(1)*E1
		AL2=AL2+XX(1;2)*(A1(1)+T(2)*(B1(1)+T(2)*(C1(1)+T(2)*(D1(1)+T(2)*E1
. •		AK = A(I) + T(I) * (B3(I) + T(I) * (C(I) + T(I) * (D3(I) + T(I) * E(I)))
		9_V1=V1=XX(I+1)*AK*(A2(1)+T(1)*(B2(1)+T(1)*(C2(I)+T(1)*(D2(I)+T(1)*E
		HNS=HNS*•001
· · ·	1	HNF=HNF*3.001
	·····	QBB=QBB*(001*(F~000=5) QR=(V1*V(1)=AL2*AL(2))*0+001+Q85
		RETURN END
· ·		
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Output Subroutine for the Rigorous Thiele-Geddes Program

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. SUBR	OUTINE OUT (NTTOALOVOT	TEDDDAFANE	NSONCOTE	A. ROFADIESY	VAYAUNGA	
108.0	DD:085.GCC.HM	(S)		a - c - (g - 1 F) - (g - 5 - 5 - 5	er en antimener anna 1967 anna 1978 anna 1988. Anna 1988 anna 1988 a	O RAPALITAL A	
DIME	NSION ALLIAL	VUGIATTIN	61061610BC	51.0(51.0	15125151.VV/	だっちんりょうて	
15)			of noterior.	×11512170	erenere estret.	382011A8	
WRIT	E(3,100)						
100 FORM	ATTINICAX. ITC	WER PROFIL	FI/SY / CTA	SE NO.	TENDEDSTIN	e 1. to	
1010	RATE VAPO	R RATELZOT	XATIDEG EL	6.64.1401	ECHECTORIO ECZODII.LV.		
26815	3	in initia fianti	NP COLOTE	JONE THUS	ALEZINGI TOAS	* MULLEX	
101 FORM	AT(6X.13.0X.F	9.4.6X.FG.	4.68.50.41				
105 FORM	AT(10X+'STAGE	NO ₂ F	all 15Xall		E ERAC. L. OV.	t itennia	
101.5	FRACE()		YEDDEDAY IN	Lecto Mon	1 FOM5010340	. AVLOK U	
106 FORM	AT(BX.F10.8.6	XAE10.81	·	· · · · · · · · · · · · · · ·			
107 FORM	ATIAX DISTIL	1 4751,107.	FEEDE / / A	Yangoie ei			
1	and the second second second	ing it has the property of the	I bushelor propries	AF HOLE H	VACE BARAS A	ALL FIRE	
108 FORM	AT (RX + F10+ R+ A	X.FIO.BI					
DO 1	1=1.477		an an an marrie guarding again at ag			· •	
1 WRIT	F(3.)0)) T.TT	(I) ab! ITt.	1111				
Q= AL	(NTT+1)+DDD	1 # 1 I I I I I I A I Z	****				
	DDD						
WRIT	E(3+102) TTIN	7741) . G. OD	D • R		• • • • • •		
102 FORM	AT(5X, CONDEN	ISER /	vF9.6.66X.F	R. 6/21X . 11	STATITZT	£,50.	
14/21	X+ REFLUX	= tsF9e4	1)	estenders, s	of 6 and 6 the hand a time of a		* ** *** **
WRIT	E(3+103) NF+T	F					
103 FORM	AT (2X + STAGE	1 IS THE R	EBOILER 1.3.	X. (FEED ST	FARE ISL. 12.	197.1555	
1D TE	MP4 (DEGF) 15	1 +F8+2+///	/)	the the target the	NOW IN INST	I do to be I have to	
* WRIT	E13,104)						
104_FORM	AT(4X, MATERI	AL BALANCE	E 3				
DO 5	J=1:NTT		••••••••••••••••••	t branche in a consiste any or a c	n i shaalaa ay ah ah ah ah ah		· · · · · · · · · · · ·
WRIT	E(3+105) J						
DO 2	1=1+NC			÷ .			
AK=A	(I) *TT(J) *(B(1+(L)TT+(1	C(1)+TT(J)-	€(D(I)+TT)	(J)*E(1))))		
5 Y=XX	(1+J)*AK						
WRIT	E(3+106) XX(1	aller .					
2 CONT	INUE					. The characteristic and a second secon	•
WRIT	E(3:107)		, •				
DO 3]=] • NC				• • • • • •		· · ·
3_WRIT	E(30108) XX(1	*NTT+1) *X([]		-		
QIN=	HNF+QR						
QOUT	=0D0+G88+GCC+	HNS					
WRIT	E(3:109) HNF,	QDD # QR # QBB	, QCC , HKS, Q	INCOUT		· · · · · · · · · · · · · · · · · · ·	1964 Ballet - 1966 Aug 2
TOTAL 109 FORM	AT(// 5X0 HEA	T BALANCE!	/21X + (MM)	STUZHR) * #;	L6X+*(MM_BTU	/HR) 1/5X	
10'FE	ED ENTHALPY =	*sF5a3	+5X+101571	LATE =	* > F6 0 3 / 5 % >		
2 *R	EBOILER	= 19760	3+5X+160TT	DMS ≂	* 0F6 03/35	X # I CONDE	
3NSER	≈ ° • F6 • 3	/35X: \$1DE	STEAM =	* *F6+3			
		/13X JTOTA	L_=*•F0	5 e 3 + 1 0 × e 1 *	TOTAL *	oF6 03/11	£
RETU	KN.						
END	100 I I			•			
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	1.01.0	C L L	Threfe.	-Geddes	Method			
			na sena ana ana ana ana ana ana ana ana ana	ninganig oʻyu - iya - iya anin mon agang daga kalariyi a daga -	name o desentario por portar segundo a partecesario de	n hann, sa 200 hann ann ann an Ann	997 Fördens varin sen ärnar mit	
								$a_{0}=0$
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SUI 1FL	ROUTINE F	TT(T1,T2 ,VOB,	UV;AAL)	TSM1, TS, T	Ne (+DDD+P	s S s NC sub	eit ^{ti} eitti e	. .
D11	AENSION WO	D(5),ALC	(5), VOB(5	,	VV(16) + AA	L(16)		
CO:	MON A(5),	3(5) «C(5	5),D(5),E(5)			··· ·•	
VL: WD	*DDD+R*DD0 115(3+201))						
WR	LIE(3,1972) TF+TS	S#TEP1+TSP	11 . AAL (NE+	1);AAL(NS	-))		
1 e V'	(NS-1),VV	(<u>NF+1</u>)						
. IS/ TF	41=15 21=TE							
WR	ITE(3,1972	2) TF+TS	S.TFP1.TS	1. AAL (NE)	1) AAL (AS	-1)		
1,V	/(NS-1),V\	/(NE+1)						
101 FU: 1MR	<salc18143 4 1</salc18143 	SX 9 1 FURCE	n Fil ERAG	10NS / /	75X+*10P	SECTION	OF INE CU	_U
AL	V1=R*ODD/N	/L	len,		و مس المدسا مروز ورواها		a anna a fhonain annaichteachadh	
	=NTT-VS+1				· · · · ·			
DU AM	$1 = 1 = 1 \le NC$		(A(T)+T)	(*(B(T)+T)	* (C(1)+TN	*1.)[[]+1	0#F(1))))	3
AM	A=AAL(NTT.)/(VV())T	T)*AMA)					• • • • • • • • •
٣A	A) = I	(I)+TS*()	B(1)+TS*(C())+TS*(i	.(1)+JS*E(1))));		
- AM WP	$I \approx (AAL(NS))$))/(VV) AMA.AM	(NS)*AVI) 1		-			
103 FO	RMAT(6X)	MAX. AB	SORPTION	ACTOR= ++	15.8.576X	MIN. AB	SURPTION	ĒĀ.
1CT	OR=1,E15.9	3)						· •
AM	1=AMA*AUVI 2=AMI#AUVI	L∻VV(NŤŤ L×VV(NŠŤ)/AAL(NTT	>				
A(M WR	ZEAH1 <u>MALV</u> . ITE(3×104	L ~ V V (NS) } AM1 • AM	2 2					
104 F0	RMAT (3X+	ABSORPT	ION FACTO	RS BASED (. CONSTAN	T MOLAL	OVERFLOAT	5
1/6	Хэ*МАХа=*	•E15.8•/	6X ; 'MIN='	•E15,•8)				
ΔA 01	≓(AMA+AMI) ≂AA	1800					· •• · · · ·	· · · · · · · · ·
AA	- ^ ^ ≈(∧ ∧ * *(内白・	+ <u>1</u>)-AA)/	(AA-1.)+R	*AA**NN				
AA	=/A*S/(R*)	000)						·
WR	ITE(3,101) AA,WOD	(I)			•		• • • • • •
101 FO 16	RMATUZ(6X {ARS(AA~w	9615e877 00(1)174	400001	1 2.2.3				
3 IF	(AA-WOD(I)) 4,4,5	~ • • • • • • • • • • • • • • •					
4 AM	IEA1				antat, and a catalog at provide an		ana 211 miningar 211 - 221 - 220	
GO	10 10		- - -					
AM <u>د.</u>	NFA1 TO 10						• • ••	· · · ·
	AC = (A1 - AM)	2)/(AM1-	AM2)					
1.4 D	ITE(3+102) 1. FR	AC + Al					
YV IN								e .
102_F0	RMAT(776X	ARCOMP +	NO.=1+15+		· · · · · · · · · · · · · · · · · · ·	/lox:/FF	AC=!#E15+	8

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	1	WRITE(3+)972) IF+TS+TFP1+TSM1+AAL(NF+1)+AAL(NS-1)
	1	«VV((\(S-1)) /VV()(E+1).
	C SEC	DAD TOWER SECTION
		ALV)=(R∢ODD−S)/VL
		KN=AS+AF
		DO 21 J=1+NC The second se
		AM1= AAL(NF+1)/(VV(NF+1)*
	1	(A(I)+TFP1*(B(I)+TFP1*(C(I)+TFP1*(DJ))+TFP1*E(J))))))
		AMA=AAL(NS=1)/(VV(NS=1)*
`.		(A(1)+TSM1*(B(1)+TSM1*(C(1)+TSM1*(D(1)+TSM1*t(1))))))
		WRITE(3,1972) TF+TS,TFP1+TSM1,AAL(NE+1)+AAL(NE+1)
	· · · · · · · · · · · · · · · · · · ·	;VV(NS=1);VV(NF+1)
	1972	FORMAT(CX+E15+A)
• •	and the second	WRITE (3,103) ANASAKI
		AM22AM17ALV18VV(14PH1)/AAL(NPF1)
		AN FAMAWAAV **VV(AG*1)/AAU(AG*1)
	20	
	20	
		$A_1 - A_1 + A_2 + A_2 + A_1 + A_2 $
• •		+ (1.++20)(1))*((AA**NM-AA)/(AA*1.))
	2.	WRITE(3:101) AA;ALD(1)
	• • •	1F(ABS(AA+ALD(1))/AA+.00001) 22,22,23
	. 23	IF(A4-ALD(1))_24;24;25
	- 24	AM1=A1
	المتعادين والمعالي والمراجع	60 10 30
·	25	АМА=А2
	-	GC TO 30
×	2.2	FRAC=(A1-AM2)/(AM1-AM2)
	، ۱۰۰۰ - ۲۰۰۰ میں میں اور	W47TE(3,102) [* FRAC,A)
	21	COMTINUE
	and a construction of the second s	WRITE(3:200)
	200	FORMATCIMI,6X, BOLLOW SECTION OF COLOMNY
		VL=VL=F*(), -FL1Q)
	مديد مد∙دو	VL=VL-F*()FL1Q) ALV1=VL/(R*DDD+F*FLIQ=S)
	e	VL=VL=F*(1,-FL1Q) AtV1=VL/(R*DDD+F*FL1Q=S) DO 41 1=1+NC AMA=(A(1)+T2*(B(1)+T2*(D(1)+T2*(L(1))))
	• • • • • • • • • • • • • • • • • • •	VL=VL=F*(],=FLIQ) A(V]=VL/(R*DDD+F*FLIQ=S) DO 4] I=1+NC AMA=(A(I)+T2*(B(I)+T2*(C(I)+T2*E(I))))
	,, ,, , , , , , , , , , , , , , , , ,	$VL=VL=F*(]_{e}=FL1Q)$ At V1=VL/(R*DDD+F*FL1Q=S) D0 41 1=1+NC AMA=(A(1)+T2*(B(1)+T2*(C(1)+T2*E(1))))) 1 $kVV(2)/AAL(2)$ AM1=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1)))))
	• • • • • • • • • • • • • • • • • • •	<pre>VL=VL=F*(]_e=FLIQ) At V1=VL/(R*DDD+F*FLIQ=S) D0 41 1=1+NC AMA=(A(1)+T2*(B(1)+T2*(C(1)+T2*E(1))))) 1EVV(2)/AAL(2) AM1=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1))))) 1*VV(F)/AAL(NF)</pre>
	· · · · · · · · · · · · · · · · · · ·	<pre>VL=VL=F*(];=FLIQ) At V1=VL/(R*DDD+F*FLIQ=S) D0 41 1=1+NC AMA=(A(1)+T2*(B(1)+T2*(C(1)+T2*E(1))))) 1EVV(2)/AAL(2) AM1=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1))))) 1*VV(NF)/AAL(NF) WRITE(3+105) AMA;AMI</pre>
	105	<pre>VL=VL=F*(].=FLIQ) At V1=VL/(R*DDD+F*FLIQ=S) D0 41 1=1.NC AMA=(A(1)+T2*(B(1)+T2*(C(1)+T2*E(1)))) 1%VV(2)/AAL(2) AM1=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1))))) 1%VV(NF)/AAL(NF) WRITE(3:105) AMA;AMI FORMAT(6X;'MAX. S)RIPPING FACTOR=::E15.8;/6X;'MIN. STRIPPING FACTO</pre>
		<pre>VL=VL=F*(1,==FLIQ) At V1=VL/(R*DDD+F*FLIQ=S) D0 41 1=1+NC AMA=(A(1)+T2*(B(1)+T2*(C(1)+T2*E(1)))) 1%VV(2)/AAL(2) AM1=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1))))) 1%VV(NF)/AAL(NF) WRITE(3+105) AMA,AMI FORMAT(6X+'MAX& S)RIPPING FACTOR=**E15*8*/6X*'MIN* STRIPPING FACTO 1R='*E15*8)</pre>
		<pre>VL=VL=F*(1, -FLIQ) At V1=VL/(R*DDD+F*FLIQ=S) D0 41 1=1.NC AMA=(A(1)+T2*(B(1)+T2*(C(1)+T2*E(1)))) 1%VV(2)/AAL(2) AM1=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1))))) 1%VV(NF)/AAL(NF) WRITE(3,105) AMA,AMI FORMAT(GX,'MAX& S)RIPPING FACTOR='>E15.8*/6X*'MIN& STRIPPING FACTO 1R=',F15.8) AM1=AMA*AAL(2)*ALV1/VV(2)</pre>
		<pre>VL=VL=F*(1, -FLIQ) At V1=VL/(R*DDD+F*FLIQ=S) D0 41 1=1.NC AMA=(A(1)+T2*(B(1)+T2*(C(1)+T2*E(1)))) 1%VV(2)/AAL(2) AM1=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1))))) 1*VV(NF)/AAL(NF) WRITE(3,105) AMA,AMI FORMAT(GX,'MAX.S)RIPPING FACTOR=',E15.8*/6X;'MIN. STRIPPING FACTO 1R=',F15.8) AM1=AMA*AAL(2)*ALV1/VV(2) AM2=AM1*AAL(NF)*ALV1/VV(NF)</pre>
		<pre>VL=VL=F*(1,*=FLIQ) At V1=VL/(R*DDD+F*FLIQ=S) D0 41 1=1*NC AMA=(A(1)+T2*(B(1)+T2*(C(1)+T2*E(1)))) 1%VV(2)/AAL(2) AM1=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1))))) 1*VV(NF)/AAL(NF) WRITE(3:105) AMA;AMI FORMAT(6X;'MAX; S)RIPPING FACTOR=';E15*B;/6X;'MIN* STRIPPING FACTO 1R=';E15*B) AM1=AMA*AAL(2)*ALV1/VV(2) AM2=AM1*AAL(NF)*ALV1/VV(NF) WRITE(3:106) AM1;AM2</pre>
	105	<pre>VL=VL=F*(1, -FLIQ) AI V1=VL/(R*DDD+F*FLIQ=S) D0 41 1=1.NC AMA=(A(1)+T2*(B(1)+T2*(C(1)+T2*E(1)))) 1%VV(2)/AAL(2) AM1=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1))))) 1%VV(NF)/AAL(NF) WRITE(3,105) AMA,AMI FORMAT(6x,'MAX.S)RIPPING FACTOR=',E15.8+/6X;'MIN. STRIPPING FACTO 1R=',E15.8) AM1=AMA*AAL(2)*ALV1/VV(2) AM2=AM1*AAL(NF)*ALV1/VV(2) AM2=AM1*AAL(NF)*ALV1/VV(NF) WRITE(3,106) AM1.AM2 FORMAT(3X,'STRIPPING FACTORS BASED ON CONSTANT MOLAL OVERFLOW'.</pre>
	105	<pre>VL=VL=F*(1, -FLIQ) AI V1=VL/(R*DDD+F*FLIQ=S) D0 41 1=1.NC AMA=(A(1)+T2*(B(1)+T2*(C(1)+T2*E(1)))) 1%VV(2)/AAL(2) AM1=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1))))) 1*VV(NF)/AAL(NF) WRITE(3,105) AMA,AMI FORMAT(6x,'MAX.S)RIPPING FACTOR=',E15.8,/6X,'MIN. STRIPPING FACTO 1R=',E15.8) AM1=AMA*AAL(2)*ALV1/VV(2) AM2=AM1*AAL(NF)*ALV1/VV(2) AM2=AM1*AAL(NF)*ALV1/VV(NF) WRITE(3,106) AM1,AM2 FORMAT(3X,'STRIPPING FACTORS BASED ON CONSTANT MOLAL OVERFLOW', 1/6X,'MAX.=',E15.8./6X,'MIN.=',E15.8].</pre>
	105	<pre>VL=VL=F*(1, -FLIQ) AI V1=VL/(R*DDD+F*FLIQ=S) D0 41 1=1 *NC AMA=(A(1)+T2*(B(1)+T2*(C(1)+T2*E(1)))) 1%VV(2)/AAL(2) AM1=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1))))) 1*VV(NF)/AAL(NF) WRITE(3:105) AMA;AMI FORMAT(6x, 'MAX, S)RIPPING FACTOR=';E15*B*/6X;'MIN* STRIPPING FACTO 1R=';F15*B) AM1=AMA*AAL(2)*ALV1/VV(2) AM2=AM1*AAL(NF)*ALV1/VV(2) AM2=AM1*AAL(NF)*ALV1/VV(NF) WRITE(3:106) AM1;AM2 FORMAT(3X;'STRIPPING FACTORS BASED ON CONSTANT MOLAL OVERFLOW'; 1/6X;'MAX*=';E15*B*/6X;'MIN*=';E15*B).</pre>
•	105	<pre>VL=VL=F*(1,e=FL1Q) At V1=VL/(R*DDD+F*FL1Q=S) D0 41 1=1*NC AMA=(A(1)+T2*(B(1)+T2*(C(1)+T2*E(1)))) 1%VV(2)/AAL(2) AM1=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1))))) 1*VV(NF)/AAL(NF) WRITE(3:105) AMA;AMI FORMAT(6x,'MAX; STRIPPING FACTOR=';E15*B;/6X;'MIN* STRIPPING FACTO 1R=';E15*B) AM1=AMA*AAL(2)*ALV1/VV(2) AM2=AM1*AAL(NF)*ALV1/VV(2) AM2=AM1*AAL(NF)*ALV1/VV(NF) WRITE(3:106) AM1;AM2 FORMAT(3X;'STRIPPING FACTORS BASED ON CONSTANT MOLAL OVERFLOW'; 1/6X;'MAX*=';E15*B*/6X;'MIN*=';E15*B) AA=(AMA+AMI)**5 A1=AA</pre>
•	105	<pre>VL=VL=F*(1,e=FL1Q) At V1=VL/(R*DDD+F*FL1Q=S) D0 41 1=1*NC AMA=(A(1)+T2*(B(1)+T2*(C(1)+T2*E(1))))) 1%VV(2)/AAL(2) AM1=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1))))) 1*VV(NF)/AAL(NF) WRITE(3:105) AMA;AMI FORMAT(6x,'MAX; S)RIPPING FACTOR=';E15*B;/6X;'MIN* STRIPPING FACTO 1R=';E15*B) AM1=AMA*AAL(2)*ALV1/VV(2) AM2=AM1*AAL(NF)*ALV1/VV(2) AM2=AM1*AAL(NF)*ALV1/VV(NF) WRITE(3:106) AM1;AM2 FORMAT(3X;'STRIPPING FACTORS BASED ON CONSTANT MOLAL OVERFLOW'; 1/6X;'MAX*=';E15*B*/6X;'MIN*=';E15*B) AA=(AA**NF-AA)/(AA-1*)+AA**(NF-1)*(A(1)+T1*(B(1)+T1*(C(1)+T1*(D(1)))))</pre>
	105	<pre>VL=VL=F*(],=FLIQ) At V1=VL/(R*DDD+F*FLIQ=S) D0 41 1=1 *NC AMA=(A(1)+T2*(B(1)+T2*(C(1)+T2*E(1)))) 1*VV(2)/AAL(2) AM1=(A11)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1))))) 1*VV(NF)/AAL(NF) WRITE(3:105) AMA;AMI FORMAT(GX;'MAX;S)RIPPING FACTOR=';E15*B*/GX;'MIN*STRIPPING FACTO 1R=';F15*8) AM1=AMA*AAL(2)*ALV1/VV(2) AM2=AM1*AAL(NF)*ALV1/VV(NF) WRITE(3:106) AM1*AM2 FORMAT(3X;'STRIPPING FACTORS BASED ON CONSTANT MOLAL OVERFLOW'; 1/6X;'MAX;'*E15*8*/6X;'MIN*='*E15*8}. AA=(AA**NF=AA)/(AA=1*)+AA**(NF=1)*(A(1)+T1*(B(1)+T1*(C(1)+T1*(U(1))))*VL/(F=DCD=5)) WF 11*E(1))))*VL/(F=DCD=5)</pre>
	•105 106 50	<pre>VL=VL=F*(],=FLIQ) AI V1=VL/(R*DDD+F*FLIG=S) D0 41 1=1.NC AMA=(A(1)+T2*(B(1)+T2*(C(1)+T2*E(1)))) 1%VV(2)/AAL(2) AM1=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1)))) 1*VV(NF)/AAL(NF) WRITE(3,105) AMA,AMI FORMAT(6X,*MAX&S)RIPPING FACTOR=*2E15*8*/6X;*MIN* STRIPPING FACTO 1R='*E15*8) AM1=AMA*AAL(2)*ALV1/VV(2) AM2=AM1*AAL(NF)*ALV1/VV(NF) WRITE(3:106) AM1*AM2 FORMAT(3X,*STRIPPING FACTORS BASED ON CONSTANT MOLAL OVERFLUX** 1/6X,*MAX**'*E15*8*/6X,*MIN****E15*8) AA=(AA**NF=AA)/(AA=1*)+AA**(NF=1)*(A(1)+T1*(B(1)+T1*(C(1)+T1*(U(1) 1+T1*E(1))))*VL/(F=DDD=S) WRITE(3:101) AA*VOB(1) 1F(AB5(AA=VOB(1))/AA**OD011/42*42*43</pre>
•	105	<pre>VL=VL=F*(1, -FLIQ) At V1=VL/(R*DDD+F*FLIQ=S) DO 41 1=1*NC AMA=(A(1)+T2*(B(1)+T2*(C(1)+T2*(D(1)+T2*E(1))))) AW1=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1))))) AW1=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1))))) AW1=AMA*AAL(NF) WRITE(3;105) AMA; AMI FORMAT(GX,'MAX, S)RIPPING FACTOR='>E15*8*/6X*'MIN* STRIPPING FACTO IR=';F15*8) AM1=AMA*AAL(2)*ALV1/VV(2) AM2=AM1*AAL(NF)*ALV1/VV(2) AM2=AM1*AAL(NF)*ALV1/VV(NF) WRITE(3;106) AM1*AM2 FORMAT(3X*'STRIPPING FACTORS BASED ON CONSTANT MOLAL OVERFLUX'* 1/6X*'MAX=';F15*8*/6X*'MIN*='*E15*8) AA=(AA**NF=AA)/(AA=1*)+AA**(NF=1)*(A(1)+T1*(B(1)+T1*(C(1)+T1*(U(1)))) 1+T1*E(1))))*VL/(F=DDD=S) WRITE(3;101) AA*VOB(1) 1+F(ABS(AA=VOB(1))/AA=*OD001)42;42;42;43 LIE(AA=VOB(1))/AA=*00001)42;42;42;43</pre>
	105 106 50	<pre>VL=VL=F*(), -FLIQ) At V1=VL/(R*DDD+F*FLIQ=S) DO 41 1=1+NC AMA=(A(1)+T2*(B(1)+T2*(C(1)+T2*(D(1)+T2*E(1)))) 1*VV(2)/AAL(2) AM1=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1)))) 1*VV(NF)/AAL(NF) WRITE(3:105) AMA;AMI FORMAT(GX;'MAX; S)RIPPING FACTOR=';E15*8;/6X;'MIN* STRIPPING FACTO 1R=';F15*8) AM1=AMA*AAL(2)*ALV1/VV(2) AM2=AM1*AAL(NF)*ALV1/VV(NF) WRITE(3:106) AM1*AM2 FORMAT(3X;'STRIPPING FACTORS BASED ON CONSTANT MOLAL OVERFLUX'; 1/6X;'MAX=';E15*8*/6X;'MIN*=';E15*8]. AA=(AA**NF=AA)/(AA=1*)+AA**(NF=1)*(A(1)+T1*(B(1)+T1*(C(1)+T1*(D(1)))) 1+T1*E(1))))*VL/(F=DDD=S) WRITE(3:101) AA*VOB(1) 1+F(ABS(AA=VOB(1))/AA=*00001)42:42:42:43 3 IF(AA=VOB(1))/AA=*00001)42:42:43</pre>
	105 106 50	<pre>VL=VL=F*(]*=FLIQ AL V1=VL/(R*DDD+F*FLIQ=S) DO 41 1=1*NC AMA=(A(1)+T2*(B(1)+T2*(C(1)+T2*(D(1)+TF*E(1))))) L%VV(2)/AAL(2) AM1=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1))))) NWRTE(3:105) AMA;AM1 FORMAT(6X;'MAX.s)R1PPING FACTOR=';E15.8*/6X;'MIN.STR1PPING FACTO IR=';E15.83 AM1=AMA*AAL(2)*ALV1/VV(2) AM2=AM1*AAL(NF)*ALV1/VV(NF) WRITE(3:106) AM1;AM2 FORMAT(3X;'STR1PPING FACTORS BASED ON CONSTANT MOLAL OVERFLOW'; 1/6X;'MAX.s';FISPING FACTORS BASED ON CONSTANT MOLAL OVERFLOW'; 1/6X;'MAX.s';FISPING;FISPING FACTORS BASED ON CONSTANT MOLAL OVERFLOW'; 1/6X;'MAX.s';FISPING;FISPIN</pre>
	105 106 50 43 44 43 43	VL=VL=F(),=FLIQ) AI V1=VL/(R*DDD+F*FLIQ=S) DO 41 1=1+NC AMA=(A(1)+T2*(B(1)+T2*(C(1)+T2*(D(1)+T2*((1))))) 1%VV(2)/AAL(2) AM1=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1))))) 1%VV(NF)/AAL(NF) WRITE(3:105) AVA,AMI FORMAT(6X,'MAX.S)RIPPING FACTOR='2E15*8*/6X;'MIN*STRIPPING FACTO 1R='sF15*8) AM1=AMA*AAL(2)*ALV1/VV(2) AM2=AM1*AAL(NF)*ALV1/VV(NF) WRITE(3:106) AM1;AM2 FORMAT(3X,'STRIPPING FACTORS BASED ON CONSTANT MOLAL OVERFLOW', 1/6X,'MAX='sF15*8*/6X,'MIN*F';E15*8) AA=(AA**NF-AA)/(AA-1*)+AA**(NF-1)*(A(1)+T1*(B(1)+T1*(C(1)+T1*(U(1))))) +T1*E(1))))*VL/(F-00D-5) WRITE(3:101) AA*OB(1) 1F(ABS(AA+VOB(1))/AA*=00001)42;42;43 1F(AA+VOB(1)) 44;44;45 AM1=A1 ACTORS AND
	105 105 106 50 42 42 44	<pre>VL=VL=F()*=FLIQ Af VI=VL/(R*DDD+F*FLIG=S) D0 41 1=1*NC AMA=(A(1)+T2*(B(1)+T2*(C(1)+T2*(D(1)+T2*E(1))))) L*VV(2)/AAL(2) AMI=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1))))) L*VV(NF)/AAL(AF) WRITE(3;105) AMA;AMI FORMAT(6X;'NAX*S)RIPPING FACTOR='>E15*8*/6X;'MIN*STRIPPING FACTO IR=';F15*8) AM1=AMA*AAL(2)*ALV1/VV(2) AM2=AM1*AAL(NF)*ALV1/VV(NF) WRITE(3;106) AM1;AM2 FORMAT(3X;'STRIPPING FACTORS BASED ON CONSTANT MOLAL OVERFLOW'; I/6X;'MAX*=';E15*8*/6X;'MIN*='*E15*8).' AA=(AMA+AMI)**5 A1=AA AA=(AA**NF=AA)/(AA=1*)+AA**(NF=1)*(A(1)+T1*(B(1)+T1*(C(1)+T1*(U(1) 1+T1*E(1))))*VL/(F=0ED=S) WRITE(3;101) AA*v03(1) IF(ABS(AA=v0B(1))/AA=*00001)*2*42*43 IF(AA=v0B(1)) 44*44*45 AM=A1 GO TO 50 *</pre>
	105 105 106 50 42 42 44 44 44	<pre>VL=VL=F(1, =FL12) Af VI=VL/(R*DDD+F*FLIQ=S) D0 41 1=1*NC AMA=(A(1)+T2*(B(1)+T2*(C(1)+T2*(D(1)+T2*E(1))))) L*VV(2)/AAL(2) AM1=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1))))) L*VV(NF)/AAL(NF) WRITE(3,105) AMA,AMI FORMAT(GX,'MAX* S)RIPPING FACTOR='2E15*B*/6X*'MIN* STRIPPING FACTO IR='+F15*B) AM1=AMA*AAL(2)*ALV1/VV(2) AM2=AM1*AAL(NF)*ALV1/VV(NF) WRITE(3,106) AM1*AM2 FORMAT(3X*'STRIPPING FACTORS BASED ON CONSTANT WOLAL OVERFLOW'* I/6X*'MAX*='*E15*B*/6X*'MIN*='*E15*B' AA=(AA**NF=AA)/(AA=1*)+AA**(NF=1)*(A(1)+T1*(B(1)+T1*(C(1)+T1*(D(1)))) AA=(AA**NF=AA)/(AA=1*)+AA**(NF=1)*(A(1)+T1*(B(1)+T1*(C(1)+T1*(D(1))))) IF(AA=VOB(1))/AA=*ODOC1)42*42*43 IF(AA=VOB(1)) 44*44*45 AM=AA GO TO 50 * AM1=AA GO TO 50 * FRAC=(A1=AM2)/(AM1=AM2)</pre>
	105 106 50 42 42 42 42	<pre>VL=VL=F*(1, ==FL12) Af VI=VL/(R*DDD+F*FLI0=5) D0 41 1=1+NC AM4=(A(1)+T2*(B(1)+TF*(C(1)+T2*(D(1)+T2*E(1))))) 1*VV(2)/AAL(2) AM1=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1))))) 1*VV(NF)/AAL(NF) WRITE(3,105) AM4,AM1 FORMAT(6X,*MAX.s)RIPPING FACTOR=*2E15*8*/6X,*MIN*STRIPPING FACTO IR=*,*f15*8) AM1=AM4*AAL(2)*ALV1/VV(2) AM2=AM4*AAL(2)*ALV1/VV(2) AM2=AM1*AAL(NF)*ALV1/VV(NF) WRITE(3+106) AM1*AM2 FORMAT(3X,*STRIPPING FACTORS BASED ON CONSTANT MOLAL OVERFLOW*, I/6X,*MAX.=*,*E15*8*/6X,*MIN*=**E15*8) AA=(AM4+AM1)**5 A1=AA AA=(AM4*NF=AA)/(AA=1.)+AA**(NF=1)*(A(1)+T1*(B(1)+T1*(C(1)+T1*(U(1)))) I+T1*E(1)))*VL/(F=DDD=5) WRITE(3+101) AA*VOB(1) IF(AB*VDB(1))/AA=*00001)42*42*43 IF(AA=VOB(I))/AA=*00001)42*42*43 IF(AA=VOB(I))/AA=*00001)42*42*43 FRAC=(A1=AM2)/(AM1=AM2) WRITE(3*102) 1* FRAC*A1</pre>
	105 106 50 43 45 44 44 42 44	<pre>VL=VL=F*(1,=FL13) Af VI=VL/(R*DD)+F*FLIG=5) D0 41 F1=NC AMA=(A(1)+T2*(B(1)+T2*(C(1)+T2*(C(1)+T2*E(1))))) N=VV(2)/AAL(2) AM1=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1))))) WRITE(3,105) AM4,AM1 FORMAT(6x,*MAX, SIRIPPING FACTOR=*,E15*8;/6x,*MIN* STRIPPING FACTO IR=',F15*8) AM1=AMA*AAL(2)*ALV1/VV(2) AM2=AM1*AAL(NF)*ALV1/VV(NF) WRITE(3;106) AM1*AM2 FORMAT(3x,*STRIPPING FACTORS BASED ON CONSTANT MOLAL OVERFLUX'* I/6X,*MAX=*+E15*8*/6X,*MIN*=**E15*8) AA=(AM4+AM1)**5 A1*AA A4=(AA**NF=AA)/(AA=1*)+AA**(NF=1)*(A(1)+T1*(B(1)+T1*(C(1)+T1*(U(1)))) I+T1*E(1))))*VL/(F=ODD=5) WRITE(3;101; AA*OOD(1)42;42;43 IF(AA=VOB(1))/AA=00001)42;42;43 IF(AA=VOB(1)) 44;44*45 AM4=A1 GO T0 50 FRAC=(A1=AM2)/(AM1=AM2) WRITE(3;102) 1; FRAC;A1 CONTINUE</pre>
	105 106 50 43 42 44 44 42 44	<pre>VL=VL=/F*(1,=FE1F3) ALVI=VL/(R*DDD+F*FLIG=S) D0 41 F1*NC AMA=(A(1)+T2*(B(1)+T2*(C(1)+T2*(C(1)+T2*E(1)))) L*VV(2)/AAL(2) AM1=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1)))) L*VV(NF)/AAL(NF) WRITE(3:105) AVA,AM1 FORMAT(6X,'MAX.s S)RIPPING FACTOR=';E15*8*/6X;'MIN* STRIPPING FACTO R*';F15*3) AM1=AMA*AAL(2)*ALV1/VV(2) AM2=AM1*AAL(NF)*ALV1/VV(NF) WRITE(3:106) AM1*AM2 FORMAT(3X,'STRIPPING FACTORS BASED ON CONSTANT MOLAL OVERFLOW', I/6X;'MAX.=';E15*8*/6X,'MIN*F'*E15*8] AA=(AM4+AM1)**5 A1*AA AA=(AA**NF=AA)/(AA=1*)+*AA**(NF=1)*(A(1)+T1*(B(1)+T1*(C(1)+T1*(U(1) 1+T1*E(1))))*UL/(F=ODD=S) WRITE(3:101) AA*VOB(1) IF(AA=VOB(1)) 44*4*45 S(MA=A1 GO TO 50 * FAC=(A1=AM2)/(AM1=AM2) WRITE(3:102) 1; FRAC*A1 CONTINUE RETURN</pre>
	105 106 50 43 45 42 42 42 42	<pre>VL=VL=/F*().=FE(13) AL VI=VL/(R*DDD+F*FLIG=S) D0 41 1=1*NC AMA=(A(1)+T2*(B(1)+T2*(C(1)+T2*(D(1)+T2*E(1)))) NMVV(2)/AAL(AF) WRITE(3105) AMA,AMI FORMAT(6X,'MAX*S)R1PPING FACTOR='>E15*8*/6X;'MIN*STRIPPING FACTO IR='*E15*83 AM1=AMA*AAL(2)*ALV1/VV(2) AM2=AM1*AAL(NF)*ALV1/VV(NF) WRITE(3:106) AM1*AM2 FORMAT(3X,'STRIPPING FACTORS BASED ON CONSTANT MOLAL OVERFLUX'* I/6X*'MAX*='*E15*8*/6X*'MIN*='*E15*8) AA*(AMA*AM1)**5 A1*AA AA*(AMA*AM1)**5 A1*AA AA*(AA*NF=AA)/(AA=1*)+AA**(NF=1)*(A(1)+T1*(B(1)+T1*(C(1)+T1*(U(1)))) IF(ABS(AA+VOB(1))/AA+*00001)*2*42*43 IF(AA+VOB(1)) 44*44*45 AM*AA1 GO TO 50 FRAC*(A1=AM2)/(AM1=AM2) WRITE(3:102) 1; FRAC*A1 CONTINUE RETURN END</pre>
	105 106 50 43 45 42 42 41	<pre>VL=VL=F#(1,=FL13) At V1=VL/(R*DDD+F*FLIG=5) D0 41 1=1.NC AMA=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1)))) PXVV(2)/AAL(2) AM1=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1)))) aVU(NF)/AAL(NF) WRITE(3:105) AM4;AMI FORMAT(6X;MAX;SIRIPPING FACTOR=';E15*8;/6X;'MIN*STRIPPING FACTO R=';F15*8] AM1=AMA*AAL(2)*ALV1/VV(2) AM2=AM1*AAL(NF)*ALV1/VV(NF) WRITE(3:106) AM1*AM2 FORMAT(3X;'STRIPPING FACTORS BASED ON CONSTANT WOLAL OVERFLOW'; I/6X;'MAX*=';F15*8;/6X;'MIN**';F15*8] AA=(AA#*NF=AA)/(AA=1*)+AA**(NF=1)*(A(1)+T1*(B(1)+T1*(C(1)+T1*(U(1))))) I+T1*E(1);)))*VL/(F=DDD=5) WRITE(3:101) AA;VO3(1) I+T1*E(1);))*VL/(F=DDD=5) WRITE(3:101) AA;VO3(1) I+T4*E(1);))*VL/(F=DDD=5) WRITE(3:101) AA;VO3(1) I=(ABS(AA=VO8(1))/AA=*0001)A2;42;42;43 I=(AA=AA) GO TO 50 PRAC=(A1=AM2)/(AM1=AM2) WRITE(3:102)]; FRAC;AA1 CONTINUE RETURN END</pre>
	*105 106 50 42 42 42 42	<pre>VL=vL=f#(1,-FL13) At v1=vL (R=DDD)+F*FLIG=5) D0 41 l=1*NC AMA=(A(1)+T2*(B(1)+T2*(C(1)+T2*(D(1)+T2*E(1)))) NV(V(2)/AAL(2) AM1=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1)))) NV(NF)/AAL(1F) WRITE(3,105) AM4;AM1 FORMAT(6X,'MAX: SIRIPPING FACTOR=';E15*B;/6X;'MIN* STRIPPING FACTO IR*';F15*B) AM1=AM4*AAL(1F)*ALV1/VV(2) AM2=AM1*AAL(1F)*ALV1/VV(2) HRITE(3:106) AM1;AM2 FORMAT(3X,'STRIPPING FACTORS BASED ON CONSTANT MOLAL OVERFLOW'* I/AX;'MAX=';*E15*B*,6X;'MIN**';E15*B) AA*(AM4+AM1)**5 A1=AA AA*(AM4+AM1)**5 A1=AA AA*(AA**NF=AA)/(AA=1*)+AA**(NF=1)*(A(1)+T1*(B(1)+T1*(C(1)+T1*(U(1)))) I+T1*E(1))))*VL/(F=DDD=5) WRITE(3:101) AA*(OB(1)) I+T(AB*(AA=V0B(1))/AA=*00001)42:42;42;43 IF(CA=V0B(1))/AA=*00001)42:42;43 IF(CA=V0B(1))/AA*=00001)42:42;43 IF(CA=V0B(1))/AA=*00001)42:42;44;45 IF(CA=V0B(1))/AA=*00001)42:42;44;45 IF(CA=V0B(1))/AA=*00001)42:42;44;45 IF(CA=V0B(1))/AA=*00001)42:42;45 IF(CA=V0B(1))/AA=*00001)42:42;45;45 IF(CA=V0B(1))/AA=*000001)42:42;45;45 IF(CA=V0B(1))/AA=*000001)42:42;45;45 IF(CA=V0B(1))/AA=*000001)42:42;45;45 IF(CA=V0B(1))/AA=*000001)42:42;45;45 IF(CA=V0B(1))/AA=*000001)42:42;45;45 IF(CA=V0B(1))/AA=*000001)42:42;45;45 IF(CA=V0B(1))/AA=*000001)42:42;45;45 IF(CA=V0B(1))/AA=*000001)42:42;45;45 IF(CA=V0B(1))/AA=*000001)42:42;45 IF(CA=V0B(1))/AA=*0000001)42:42;45 IF(CA=V0B(1))/AA=*00000000000000000000000</pre>
	*105 106 50 42 42 42 42 42	<pre>VL=VL=F#(1,-FL10) At V1=VL/(R*DDD+F*FLIG=5) D0 41 1=1.NC AAA=(A(1)+T2*(B(1)+T2*(C(1)+T2*(D(1)+T2*E(1)))) NVV(2)/AAL(2) AM1=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1)))) NVV(RF)/AAL(RF) WRITE(3,105) AM4,AM1 FORMAT(CX,'MXX.SIRIPPING FACTOR=',E15*8,/6A;'MIN* STRIPPING FACTO IR=',F15*8) AM1=AM4*AAL(AF)*ALV1/VV(2) AM1=AM4*AAL(AF)*ALV1/VV(2) WRITE(3,106) AM1*AM2 FORMAT(3X,'STRIPPING FACTORS BASED ON CONSTANT MOLAL OVERFLOW', I/6X,'MAX=',*E15*8*/6X,'MIN*F',E15*2) AA=(AM4*AFF=AA)/(AA=1.)*AA**(NF=1)*(A(1)+T1*(B(1)+T1*(C(1)+T1*(U(1)) 1+T1*E(1))))*VL/(F=ODD=5) WRITE(3,101) AA*V03(1) IF(AB*(AA=V0B(1))/AA*=00001142;42;43 IF(AA=V0B(1)) 44;44:45 AA=(A1=A0 G0 T0 50 FRAC=(A1=AM2)/(AM1=AM2) WRITE(3:102) I; FRAC;A1 CONTINUE RETURN END</pre>
	*105 106 50 42 42 42 42 42	<pre>VL=VL=F±(1,=FL13) At V1=VL/(R*DD0+F*FLIG=5) D0 41 t=1+AC AMA=(A(1)+T2*(B(1)+T2*(C(1)+T2*(D(1)+T2*E(1))))) t=VV(2)/AAL(2) AM1=(A1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1)))) wRITE(3,105) AM4,AM1 FORMAT(GX,*MAX&S)R1PPING FACTOR=*,E15*B*/GX**MIN* STRIPPING FACTO IR*',F15*8) AM1=AM4AAL(2)*ALV1/VV(2) AN2=AM1*AAL(NF)*ALV1/VV(NF) WRITE(3,106) AM1*AM2 FORMAT(3X*'STRIPPING FACTORS BASED ON CONSTANT MOUAL OVERFLUX'* 1/6X*'MAX=*'+E15*8*/GX*'MIN*F**(E15*8) AA=(AA*AAL(2)*ALV1/VV(NF) WRITE(3,106) AM1*AM2 FORMAT(3X*'STRIPPING FACTORS BASED ON CONSTANT MOUAL OVERFLUX'* 1/6X*'MAX=*'+E15*8*/GX*'MIN*F**(E15*8) AA=(AA**NF=AA)/(AA=1*+FAA**(NF=1)*(A(1)+T1*(B(1)+T1*(C(1)+T1*(U(1)))*VL/(F=D0D=5)) WRITE(3,101) AA*(A0(1)+1)*AA**(NF=1)*(A(1)+T1*(B(1)+T1*(C(1)+T1*(U(1)))*VL/(F=D0D=5)) WRITE(3,101) AA*(A4*(5)) IF(AA=V0B(1))/AA==00001142*42*43 IF(AA=V0B(1))/AA=000014*40*43 IF(AA=V0B(1))/AA=0000000*44*44*43 IF(AA=V0B(1))/AA=00000*44*44*44*43 IF(AA=V0B(1))/AA=000*44*44*44*44*</pre>
	*105 106 50 43 45 42 42 42	<pre>VL=VL=F±(1,=FL13) At vi=vL/(R*DD0+F*FLIG=5) D0 41 1=1.xC AMA=(A(1)+T2*(B(1)+T2*(C(1)+T2*(D(1)+T2*E(1))))) AW1=(A(1)+TF*(B(1)+TF*(C(1)+TF*(D(1)+TF*E(1))))) wRiTE(3,105) AM4,AM1 FORMAT(6X,'MAX.S)RIPPING FACTOR=';E15.8;/6X,'MIN.STRIPPING FACTO IR=',F15.3) AM1=AM4AAA(1XF)*ALV1/VV(Z) AM2=AM4*AAA(1XF)*ALV1/VV(XF) WRITE(3,106) AM1,AM2 FORMAT(3X,'STRIPPING FACTORS BASED ON CONSTANT MOLAL OVERFLUX'. AA*(AA*AM1)*.5 AA=(AA*AMF=AA)/(AA=1.++AA*(NF=1)*(A(1)+T1*(B(1)+T1*(C(1)+T1*(U(1))))) IF(1A85(AA=V0B(1))/AA=.00001)42;42;43 IF(AA=V0B(1)) 44;44:45 AM=AA G0 T0 50 FRAC=(A1=AM2)/(AM1=AM2) WRITE(3:102) 1; FRAC,A1 CONTINUE RETURN END</pre>

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	SUBROUTINE BUGBA TAME	500000000000000000000000000000000000000	1947	· .	
	DIMENSION A(5), B(5) + C	(5),D(5),E(5	s) \$X(5)	•	
• 9	.SUN=0.	an anna ann ann ann ann an an an an an a	ter som stadt average og at at anders som anders average og at	ner e la lage de la companya de la c	
	SUM1=0.				
	_DO 6 1=1+N		and a second	ta anno 11 an anna 11 anna 11	
	AKC=A(1)+B(1)*T+C(1)*	*T*T*O(1)*T*	[并]+仨(])为[为]为[?]		
	_AKPC=B(])+2**C(])*1+:	2≈⊁₽ℓ┇♪᠅∓҂テ≁┙	+ • ★E(1) *T *T *T	and the second	
	IF(2) 1.2:1	μ.			
2	SUM= X(1) *AKC ·	+SUN	د سهد به دیرمند د عمدمد ب چر چرد امته و در مسر در	المائية محاجم المحاجم المراجع والمراجع والمراجع المراجع والمحاجم والمحاجم والمحاج والمحاج والمحاج والمحاج والم	
	SUMD = X(I)*AKPC	+50111			
	30 70 3		C CONTRACTOR CONTRACTOR OF A CONTRACTOR	and a second	
1	SUM=SUM+X(1)/AKC				
	_SUM1=SUM1-X(I)*AKPC/	AKC**Z		and a second	
3	CONTINUE				
	CONTINUE		a many as a set of the start and the set of	بالمنتقافية المستعانية الالتبانية المستم	
	IF(ABS(SUM-1.)0000	01) 8:7:7			
. 7	T =T -(SUM-le)/SUML		and a set of the set of		
	IF(T-101.) 21.21.9				
	T=101.«		$(1,1,2,\dots,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,$	a ser a ser e e	
	GO TO 9				
	CONTINUE	alariana a manazara na kanina na		المحاجبات الحاديات ليواصين والسجاعين الموجعين	•

RETURN

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Program for Both the Stand-Alone Simplified Thiele-Geddes Method and the Porce-Fit Thiele-Geddes Method SIMPLIFIED THIELE GEODLS PROCEDURE __DIMENSION_A(E),B(5),C(5),C(5),E(5),X(6),X((5),X7(5),US(5),BS(5), 1WS(5);ALD(5) ;VOE(5); FRAC1(5);FRAC2(5);FRAC3(5) AK (AA, EB, CC, DD, EE, TT) =AA+TT*(BB+TT *(CC+TT*(DD+TT*EE))) 76 READ(2,100) NC, ATT, NS, NF, IFF READ(2,101) (A(1),1=1,NC) READ(2:101) (B(1):1=1:NC) _READ(2:101) (C(1):1=1:NC) READ(2+101) (D(1)+I=1+NC) READ(2,101) (E(1), 1=1,NC) , ImlaNC) READ(2:102) (X(1) READ(2:102) F:DDD:R:S:FLIG:TN:TS:T1:TF:T2 WRITE(3,205) WRITE(3,300) NC+NTT+NS+PF ATF=0. . <u>276</u> VL=DDD+R*DDD. ALV1=R*000/VL ALV2=(R*D0D-S)/VL VL=VL-F*(1.-FLID) AVL3=VL/(R*DDD+E*FL12+S) 69 ANN= NS-NF menonence in the convertient and provide and provide and addresses in the respect to the convertient of the respective

GO TO 31 39 DO 1 I=1,MC AK1=AK(A(I),B(I),C(I),D(I),E(I), TN) AK2=AK(A(I),B(I),C(I),D(I),E(I), TS) PROD=ALV1/AK2

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W00111=PR00 ANN=AUVIANS(1+/AK1=2*/AK2) AK1=AUVIAS2 D2 J=1:A AS2=AUVIAS2 D3 PR0D1+REACATINATE AS3=J PR0D1+REACTATINATE AS3=J PR0D1+REACTATINATE AS3=J PR0D1+REACTATINATE AS3=J PR0D1+REACTATINATE AS3=J PR0D1+REACTATINATE AS3=J PR0D1+REACTATINATE C CALCULATE J FALSE D D D D AND FALSE ADD + FALSE AND FALSE ADD + FALSE D D ADD + FALSE AD + FALSE <										
w00t1) = PR00								• •		
w00r(1) = PR00 AINEXALV1/ANE(1+/AK1=1*/AK2). AK2=ALV1/ANE(1+/AK1=1*/AK2). AK2=ALV1/ANE(1+/AK2 D0 2 J=1*N AINEX AINEX PRODERDOP(AC24AINPAN) 2 WOB11*RUD(1)+PR00 1 WOB11*RUD(1)+PR00 1 WOB11*RUD(1)+PR00 4 WOB11*RUD(1)+PR00 1 WOB11*RUD(1) 2 WOB1*RUD(1) 2 WOB1*RUD(1) 2 WOB1*RUD(1) 2 WOB1*RUD(1) 3 WOB(1)*RUD(1) 3 WOB(1)*RUD(1) 4 WID(1)*RUD(1)*RUD(1)*RUD(1)*RUD(1)*RUD(1) 4 WID(1)*RUD(1)*RUD(1)*RUD(1)*RUD(1)*RUD(1) 4 WID(1)*RUD(1)*RUD(1)*RUD(1)*RUD(1)*RUD(1)*RUD(1) 4 WID(1)*RUD(1)*RUD(1)*RUD(1)*RUD(1)*RUD(1)*RUD(1)*RUD(1)*RUD(1)*RUD(1)*RUD(1)*RUD(1)*RUD(1)*RUD(1)*RUD(1)										
WODD11 = PROD ATX+ALVI/AXWE (1-7AK2) = 1.47AK2). AK2+ALVI/AXE CALCULT1=KX00(1)+PROD 1 AK2+ALVI/AXE CALVI/AXE AK2+ALVI/AXE			• t						•	
wG0111+PH00 AK2+ALV1/AK2 AK2+ALV2/AK2 ALD(11++20011+PRD3P4(-)) AK2+ALV2/AK2 AK2+ALV2/AK2 AK2+ALV2/AK2 ALD(11+PRD3PLAK2/AK2) ALD(1			· · ·	• •	•					
ATA ATA ATA MAX MAX MAX MAX MAX		41	WOD(1) = PROD							
ACC+ALNYAKE			ATNO ALVIZANDAZ	1. / 67 1. 3. /	5273			· · ·		4
$\begin{array}{c} M(2^{-1}, M(2^{-1},$		and the constant conservation of the later	- MEN- VER Y / VIVINA	Lernisk ser:	NGTERN P. C. C. C					
$ \begin{array}{c} \text{Loc} \lambda \ J = 1 \text{ A} \text{ A} \text{ (i)} \\ \text{PROD-PROOF (A < 2 + A \text{ (i)} \text{ (i)}$			ARZEALVIZARZ							
Ared PROD-PRODe(A<2AAINEAN) 2 WOD(I)=WOD(I)+PRODeR C CALCULATE (L/D) F-2 IF(5) 15-306(1)+PRODER C CALCULATE (L/D) F-2 IF(5) 15-306(1) 16 00 12 1=1+RC ALD(I)=WOD(I) 14 WOD(I)=0- C 00 70 77. 15 NR+K5=NE=2 ANN=NA D0 3 1×1+NC ANN=NA D0 3 1×1+NC ANN=NA D0 3 1×1+NC ANN=NA D0 3 1×1+NC ALD(I)=PRODE(AC+1)+AC(I)+D(I)+E(I)+TEP1) PRODE/RCD=(AC+1)+AC(I)+D(I)+E(I)+TEP1) ANN=J PRODE/RCD=(AC+1)+AC(I)+AC(DO Z JELENN							•
PR00+FR00+(A(2,4+1) MEAR) 1 WOD(1) + WOD(1) + PR00+M C CACCULATE (1/2) F*1 16 D0 14 [=1, HAC ALD(1) + Z00+1] 14 WOD(1) + D0 60 TO 15 D0 17 16 D0 17 17 NNA+SNN 00 3 TalsNC ANASHN D0 3 00 3 TalsNC ANASHN D0 4 00 4 D1 + D(1) + C(1) + D(1) + E(1) + TFP1) ARD-ARCH ALV2/AR2 D0 4 D0 4 JE + NN ARCD-PR00+A(X2+ALN+AAN) A ARCD-PR00+A(X2+ALN+AAN) A ARCD-PR00+A(X2+ALN+AAN) A ARCD-PR00+A(X2+ALN+AAN) A ARCD-PR00+A(X2+ALN+AAN) A ARCD-PR00+A(X2+ALN+AAN) A A			ANTJ							
2 WORT1+PROD(1+PRODMA, 1 WORT1+PRODMA, C CALCULATE (L/D) FAI 16 D0 14 1=1,900 A LD 14 ye0013 14 WORT1+PO. 00 17 . 15 KNENSENFE-2 ANREW, D0 3 1=1,NC A K1=AKCA(1)+B(1)+C(1)+D(1)+E(1)+TF1) A K1=AKCA(1)+B(1)+C(1)+D(1)+E(1)+TF1) PROD=FLV2/AKZ A LD 11=PROD A LD 11=PROD A LD 11=PROD A LD 11=PROD A LD 11+PROD (1)+PROD A LD 11+PROD A LD 11+			PROD=PROD# (VKS	(平方:內華八內)						
<pre>1 WGD1(1+ROU(1)+PRODMA C CALCULATE (L/D) FF1 JF15) 15+16+15 ACD(11+WGD) 14 WGD(11+GC) ACD(11+WGD) 15 WN=AS=MF=2 ANR=RM DO 3 L=1+NC ACD(11+BGD) ACD(11+CD) ACD=ACD(11+BGD) ACD(11+BCD)</pre>		2	WOD(I) = WOD(I)	-PROD						
C CALCULATE (L/D) F+1 F(5) 15+15+15 16 0D 16 F=1+0C ALD(1)=+00D(1) 14 WDC(1)=0. D 3 F=1+NC D 3 F=1+NC MARENN AREAN-NF=2 ARRENN MARENN AREAN-NF=2 ALD(1)=PROD ALD(1	WGD([])=XOD(])+	-PROD#R		دى مەمەرىسىتى ب		an a		
IF(S) 15+16+15 16 D0 16 F=1+NC ALD(1) = x004(1) 18 W05(1)=0.		C CA	LCULATE (LZD) P	-1						
<pre>16 DD 14 F1+KC ADD 11+ #OD413 14 WD0413=0.</pre>	×.		IF(S) 15,16,15	5						
ALDTIP #0041) 14 WOD(1)=0. G0 (10)7. 15 NN=NS-NT=2 ANN=NA D0 3 1=1;NC ANN=NA D0 4 1=1;NC ANN=NA ANN=NA D0 4 11;B(1);C(1);D(1);E(1);TFP1) PROD=LV2/AAC2 ALD1;PROD ALD1;PROD ALD1;PROD AN=J PROD=PROD*(AAC2A) AN=A AN=A AN=A D0 5 1=1;K AN=A AN=A AN=A AN=A AN=		16	DO 14 1=1.NC							
14 WOO(1)=0. GO YO Y7 15 KN=AS=NF=2 ANN=NN DO S T=1=xC AX1=AK(A(1)+B(1)+C(1)+D(1)+E(1)+TSM1) AX2=AK(A(1)+B(1)+C(1)+D(1)+E(1)+TSM1) AX2=AX(A(1)+B(1)+C(1)+D(1)+E(1)+TSM1) AX2=AX(A(1)+B(1)+C(1)+AX2) ALD(1)=PROD ALD(1)=PROD AX2=AX(A(2) AX2=AX(A(2) AX2=AX(A(2) AX2=AX(A(2) AX2=AX(A(2) AX2=AX(V2/AK2 DO A_J=1, NN AN#=3 PROD=PROD*(AX2+A1N*AN) 4 ALP(1)=ALD(1)+PROD AN#=3 PROD=PROD*(AX2+A1N*AN) 4 ALP(1)=ALD(1)+PROD AN*=3 WOD(1)==x00(1) = -A1N ALD(1)==PROD*(MO)(1) = A1N) + (1 + +A1N) *ALD(1) 3 WOD(1)==AN C CALCULATE (V/B)F TA NN*E=X ANN=A DO 5 1=1,NC AN=AC(1)+B(1)+C(1)+D(1)+E(1)+T1) AX1=AX(A(1)+B(1)+C(1)+D(1)+E(1)+T1) AX1=AX(A(1)+B(1)+C(1)+D(1)+E(1)+T3) AX1=AX(A(1)+B(1)+C(1)+D(1)+E(1)+T3) AX1=AX(A(1)+B(1)+C(1)+D(1)+E(1)+T3) AX1=AX(A(1)+B(1)+C(1)+D(1)+E(1)+T3)	•		ALD(1)===00(1)							
GO TO 17 15 KN=KS=NF=2 ANN=NN DO 3 I=1sNC AKX=AK(A(1)+B(1)+C(1)+D(1)+E(1)+TSM1) AK2=AK(A(1)+B(1)+C(1)+D(1)+E(1)+TFP1) PROD=f_LV2/AK2 ALD(1)=PROD ALN=AVC ANN=AN OD 5 I=1;%C ANN=AN D0 5 I=1;%C ANN=AN D0 5 J=1;%C ALD(1)=PROD ALN=AVC(A(1)+B(1)+C(1)+D(1)+E(1)+T1) AK1=AVL AN=A ALD(1)=PROD ALD(1)=PROD ALD(1)=PRO	~	1	W00(1)=0-							
15 NN=KS=NF=2 ANN=NN DO 3 1=1=NC AX1=AK(A(1)+B(1)+C(1)+D(1)+E(1)+TSP1) AX2=A(1A(1)+B(1)+C(1)+D(1)+E(1)+TSP1) PROD=/LV2/AK2 ALD(1)+PROD ALD(1)+PROD AX2=ALV2/AK2 DO 4 AN=3 NN AN=4 X2A(1A(1)+B(1)+C(1)+A(X)) AK2=ALV2/AK2 AX2=ALV2/AK2 DO 4 AN=3 PROD=PROD#(AK2+A1N#AN) 4 ALP(1)=ALD(1)+PROD MN=3 PROD=PROD#(AK2+A1N#AN) 4 ALP(1)=S10*D WOD(1)=ALD(1)+PROD ALD(1)=PROD#(MOD(1)+ALN)+(3+ALN)#ALD(1) WOD(1)=PROD#(WOD(1)+ALN)+(3+ALN)#ALD(1) X=WOD(1)=PROD#(WOD(1)+ALN)+(3+ALN)#ALD(1) X=WOD(1)=PROD#(WOD(1)+C(1)+C(1)+TF) AK1=KX(A(1)+B(1)+C(1)+C(1)+FF) AK1=KX(A(1)+B(1)+C(1)+C(1)+FF) AK1=AK1A(A(1)+B(1)+C(1)+C(1)+FF) AK1=AK1A(A(1)+B(1)+C(1)+C(1)+FF) AK1=AK1A(A(1)+B(1)+C(1)+C(1)+FF) AK1=AK1A(A(1)+S(1)+C(1)+FF) AK1=AK1A(A(1)+FF) AK1=AK1A(A(1)+FF) AK1=AK1A(A(1)+FF) AK1=AK1A(A(1)+FF) AK1=AK1A(A(1)+FF) <		2. ⁻ 1	CO TO 17							
ANNAHN D0 3 [#1;NC ANNAHN D0 3 [#1;NC AK1=AK(A(1);B(1);C(1);D(1);E(1);TFP1) PROD#/LV2/AK2 ALD(1)=PROD ALD(1)=ALD(1)+PROD ALD(1)=PROD ALD(1)=PROP			- LOV - FO -							
DO 3 [=1+NC AX1=AK(A(1),B(1),C(1),D(1),E(1),TSM1) AX2=AX(A(1),B(1),C(1),D(1),E(1),TFP1) PROD=FLV2/AX2 ALD(1)=PROD AIN=ALV2/AXR8(1*/AK1=1, /AK2) AX2=ALV2/AK2 DO 4 J=1 NN AX2=ALV2/AK2 AX2=ALV2/AK2 DO 4 J=1 NN AX=J PROD=PROD*(AX2+A1N*AN) 4 ALD(1)=ALD(1)+PROD AN=ALO(1)=PROD*(MO2(1)-AIN)+(1,+AIN)*ALD(1) 3 WO(1)=ROD*(WO2(1)-AIN)+(1,+AIN)*ALD(1) C CALCULATE (V/B)F 17 NN=MF-2 ANN=AN DO 5 I=1:KC AX1=AX(A(1)+B(1)+C(1)+D(1)+E(1)+TF) AX2=AX(A(1)+B(1)+C(1)+D(1)+E(1)+T1) C OVA(1)=PROD AIN=ANA AN=J PROD=PROD*(AY1+AN*AIN) C OVA(1)=PROD AIN=ANAU 3*(AC2-AX1)/ANN AX1=AVL3*(A(1)+B(1)+C(1)+D(1)+E(1)+T1) C OVA(1)=PROD AIN=ANU 3*(AC2-AX1)/ANN AX1=AVL3*(A(1)+PROD AIN=ANU 3*(AC2-AX1)/ANN AX1=AVL3*(A(1)+PROD AIN=ANU 4*(AI)+PROD AIN=ANU 5*(AI)+PROD AIN=ANU 5*(AI)+PROD AIN=AU(1)+PROD AIN=AU(10	Markey Dentry Come							
DO 3 1*1*AC AK2=AK(A(1),B(1),C(1),D(1),E(1),TSM1) AK2=AK(A(1),B(1),C(1),D(1),E(1),TFP1) PROD=fxC2/AK2 DO 4, J=1, NN AN=J PROD=PRCD#(AK2+A1N#AN) 4 ALP(1)=ALD(1)=PROD AIN=xCC(1)=SA(20,D) WOD(1)=WOD(1)=AIN ALD(1)=PROD#(WOD(1)=AIN)+(1,=AIN)#ALD(1) 3 WOD(1)=RCO#(WOD(1)=AIN)+(1,=AIN)#ALD(1) C CALCULATE (V/D)F 17 NN=XF=2 ANN=AN DO 5 I=1,NC AK1=AK(A(1),B(1),C(1),D(1),E(1),FF) AK2=AK(A(1),B(1),C(1),D(1),E(1),F7) AK1=AK(A(1),B(1),C(1),D(1),E(1),F7) AK1=AK(A(1),B(1),C(1),D(1),E(1),F7) AK1=AK(A(1),B(1),C(1),D(1),E(1),F7) AK1=AK(A(1),B(1),C(1),D(1),E(1),F7) AK1=AK(A(1),B(1),C(1),D(1),E(1),F7) AK1=AK(A(1),B(1),C(1),D(1),E(1),F7) AK1=AK(A(1),B(1),C(1),D(1),E(1),F7) AK1=AK(A(1),B(1),C(1),D(1),E(1),F7) AK1=AK(A(1),B(1),C(1),D(1),E(1),F7) AK1=AK(A(1),B(1),C(1),D(1),E(1),F7) AK1=AK(A(1),B(1),C(1),D(1),E(1),T7) AK1=AK(A(1),B(1),C(1),D(1),E(1),T7) AK1=AK(A(1),B(1),C(1),D(1),E(1),T7) AK1=AK(A(1),B(1),C(1),D(1),E(1),T7) AK1=AK(A(1),B(1),C(1),D(1),E(1),T5)			ANNERS .		·····					
AK1=AK(A(1),B(1),C(1),D(1),E(1),TFP1) PR00=2LV2/AX2 ALM=ALV2/AXN*(1,*/AK1=1,*/4K2) AK2=AK(A(1),B(1),*/AK1=1,*/4K2) AK2=AK(A(1),B(1),*/AK1=1,*/4K2) AK2=AK(A(1),B(1),*/AK1=1,*/4K2) AK2=AK(A(1),B(1),*/AK1=1,*/4K2) AK2=AK(A(1),B(1),*/AK1=1,*/4K2) AK2=AK(A(1),B(1),*/AK1=1,*/4K2) AK=J PR00=PROB*(AK2+AIN*AN) AK=J PR00=PROB*(AK2+AIN*AN) AK=J=1, NN ALD(1)=PROB*(WOD(1)=AIN)+(1,*AIN)*ALD(1) SWOB(1)=ANN ALD(1)=PROB*(WOD(1)=AIN)+(1,*AIN)*ALD(1) SWOB(1)=PROB*(WOD(1)=AIN)+(1,*AIN)*ALD(1) ANN=NN DO 5 J=1,NN AK1=AK(I)=B(1)*C(1)*D(1)*E(1)*FF) AK1=AK(I)*B(1)*C(1)*D(1)*E(1)*FF) AK1=AK(I)*B(1)*C(1)*D(1)*E(1)*FF) AK1=AK(I)*B(I)*C(I)*D(1)*E(1)*FF) AK1=AK(I)*S(I)*AX1 AK1=AK(I)*S(I)*C(I)*D(I)*E(I)*FF) AK1=AK(I)*S(I)*PR0D AK1=AK(A(I)*S(I)*PR0D AK1=AK(A(I)*S(I)*C(I)*D(I)*E(I)*TN) AK1=AK(A(I)*S(I)*C(I)*D(I)*E(I)*TN) AK1=AK(A(I)*B(I)*C(I)*D(I)*E(I)*TN) AK1=AK(A(I)*B(I)*C(I)*D(I)*E(I)*TN) AK2=AK(A(I)*B(I)*C(I)*D(I)*E(I)*TN) <			DO 3 1=15NC		· • • • • • • • • • •	23.3.3				
AK2=AX(A(1)+B(1)+C(1)+C(1)+F(1)+F(1) AK2=AX(A(1)+B(1)+C(1)+C(1)+F(1)+F(1) AK2=AX(A(1)+B(1)+C(1)+C(1)+F(1)+F(1) AK2=AX(A(1)+B(1)+C(1)+C(1)+F(1)+F(1) AK1=AX(A(1)+B(1)+C(1)+F(1)+F(1)+F(1) AK1=AX(A(1)+B(1)+C(1)+F(1)+F(1)+F(1)+F(1)+F(1)+F(1)+F(1)+F			AK1=AK(A(1),B	(1) ((1))(11, E(1), 15	(SET)				
<pre></pre>			AK2=AK(A(1))B	$(1)_{9}C(1)_{9}D($	1152111917	F(1)				
ALD(1)=PROD AN=LV2/A(N)#(1*/AK1=1*/4K2) AK2=ALV2/A(X) D0 4 J=1* NN AN=J PROD=PROD#(AK2+A1N*AN) 4 ALD(1)=ALD(1)+PROD AN=J 4 ALD(1)=ALD(1)+PROD AN=KJ MOD(1)=KOD(1)=ALN MOD(1)=KOD(1)=ALN ALD(1)=PROD*(WOD(1)=ALN)*(1*+ALN)*ALD(1) 3 WOD(1)=KOD(1)=ALN MOD(1)=KOD(1)=ALN ALD(1)=PROD*(WOD(1)=ALN)*(1*+ALN)*ALD(1) 3 WOD(1)=KOD(1)=ALN ALD(1)=PROD*(WOD(1)=ALN)*(1*+ALN)*ALD(1) 3 WOD(1)=KOD(1)=ALN ALT=AK(A(1)+B(1)+C(1)+D(1)+E(1)+TF) ALT=AK(A(1)+B(1)+C(1)+D(1)+E(1)+TF) ALT=AK(A(1)+B(1)+C(1)+D(1)+E(1)+TT) ALT=AVL3*AK1 D0 5 J=1+NC AN=AN AN=AN AN=AN AN=AN ALT=AVL3*AK1 AN=AN AN=AN AN=AN AN= PROD=PROD*(A(X)+AN*AIN) AN= PROD=PROD*(A(X)+AN*AIN) AN= PROD=PROD*(A(X)+AN*AIN) 6 VOB((1)=VOB(1)+PROD AK1=AK(A(٤	PROD=ALV27AK2						water and when the	
A + A × Z / A × Z × Z / A × Z × Z / A × Z × Z / A × Z × Z / A × Z × Z / A × Z × Z / A × Z × Z / A × Z ×			ALD(1)=PROD							
AK2=ALV2/AK2 DO 4 J=1; NN AN=J PROD=PRCD#(A(2+AIN*AN) 4 ALD(I)=ALD(I)+PROD AlverCC(I)>\$/(PCDJD) WDO(I)=×DOI(I)=AIN ALD(I)=PRCD#(WOD(I)=AIN)+(I)*ALD(I) 3 WOO(I)=AIN C CALCULATE (V/B)F I7 NN=NF=2 ANN=NN DO 5 I=1;NC AK1=AK(A(I);B(I);C(I);D(I)*E(I);F) AK2=AK(A(I);B(I);C(I);D(I)*E(I);T2) PROD=AVL3*AC1 OO 5 J=1;NN AN=J PROD=PRCD*(A(1+AN*AIN)) C OB(I)=PRCD AIN=AVL3*AC1 DO 5 J=1;NN AK1=AK(A(I);B(I);C(I);D(I)*E(I);T1) AK1=AK(A(I);B(I);C(I);D(I)*E(I);T1) 5 VOB(I)=VOB(I)+PRCD AK1=AK(A(I);B(I);C(I);D(I)*E(I);T1) 5 VOB(I)=VOB(I)+PRCD *AK1*VL/(F=DDD=5) CO IC 38 C FORCE FII DO 33 I=1;NC AK1=AK(A(I);B(I);C(I);D(I)*E(I);T5)			AIN=ALV2/ANN*	(10/AK1-10/	4421					
DO 4 J=1; NN AN=J PROD=PROD*(AK2+AIN*AN) 4 ALD(J)=ALD(I)+PROD Alberty and an analysis and an an an analysis and an	a .a.a. ett a		AK2=ALV2/AK2							
AN#J PROD=PROD*(AK2+AIN*AN) 4 ALD(J)=ALD(I)+PROD AN#J ALD(J)=WOD(I) = AIN ALD(J)=PROD*(WOD(I)=AIN)+(J,+AIN)*ALD(I) 3 WOD(J)=XON ALD(J)=PROD*(WOD(I)=AIN)+(J,+AIN)*ALD(I) 3 WOD(J)=AIN C CALCULATE (V/B)F 17 NN=NF-2 ANN=NN D0 5 I=1;NC AK1=AK(A(I);B(I);C(I);D(I);E(I);IF) AK1=AK(A(I);B(I);C(I);D(I);E(I);IF) AK1=AK(A(I);B(I);C(I);D(I);E(I);IF) AK1=AVL3*(AK2=AK1)/AAN AK1=AVL3*(AK2=AK1)/AAN AK1=AVL3*(AK2=AK1)/AAN AK1=AVL3*(AK2=AK1)/AAN AK1=AVL3*(A(I)=S(I)+C(I);D(I);E(I)+TI) 5 VOB(I)=VOB(I)+PROD AK1=AK(A(I);S(I)+C(I);D(I);E(I)+TI) 5 VOB(I)=VOB(I)+PROD AK1=AK(A(I)+B(I)+C(I);D(I)+E(I)+TN) AK1=AK(A(I)+B(I)+C(I)+D(I)+E(I)+TN) AK1=AK(A(I)+B(I)+C(I)+D(I)+E(I)+TN) AK1=AK(A(I)+B(I)+C(I)+D(I)+E(I)+TN)			DO 4 J=1 NN							
PROD=PROD#(AK2+AIN#AN) 4 ALN=(C(1)+ALD(1)+PROD ALN=(C(1))=ALD(1)+PROD MOD(1)=NOD(1) = ALD WOD(1)=NOD(1) = ALD WOD(1)=RDO#(MOD(1)+ALD(1)+(1)+ALD(1) 3 WOD(1)=NOD(1)+ALD(1)+(1)+ALD(1) 3 WOD(1)=RDO#(MOD(1)+ALD(1)+(1)+ALD(1) 3 WOD(1)=ROD*(MOD(1)+ALD(1)+(1)+F) AKD=AK(A(1))+B(1)+C(1)+D(1)+E(1)+TF) AK1=AK(A(1))+B(1)+C(1)+D(1)+E(1)+TF) AK1=AK(A(1))+B(1)+C(1)+D(1)+E(1)+T1) AK1=AK(A(1))+B(1)+C(1)+D(1)+E(1)+T1) AK1=AK(A(1))+B(1)+C(1)+D(1)+E(1)+TN) AK1=AK(A(1))+B(1)+C(1)+D(1)+E(1)+TN) AK1=AK(A(1))+B(1)+C(1)+D(1)+E(1)+TN) AK1=AK(A(1))+B(1)+C(1)+D(1)+E(1)+TN) AK1=AK(A(1))+B(1)+C(1)+D(1)+E(1)+TN) AK1=AK(A(1))+B(1)+C(1)+D(1)+E(1)+TN) AK1=AK(A(1))+B(1)+C(1)+D(1)+E(1)+TN) AK1=AK(A(1))+B(1)+C(1)+D(1)+E(1)+TN) AK1=AK(A(1))+B(1)+C(1)+D(1)+E(1)+TN)			ANEL							
4 ALDE(1) = ALD(1) + PROD ALMNACD(1) = X(Q*D)D) WOD(1) = WOD(1) - ALM ALD(1) = PROD*(WOD(1) + ALM) + (1 * + ALM) * ALD(1) 3 WOD(1) = ALM C CALCULATE (V/B)F 17 NN*#NF=2 ANN#AN DO 5 1= 1; NC AK1=AK(1); B(1); C(1); D(1); E(1); TF) AK1=AK(1); B(1); C(1); D(1); E(1); TZ) PROD=AVL3*AK1 VOB(1)=PROD AK1=AVL3*(A(2=AK1)/ANN AK1=AVL3*(A(2=AK1)/ANN AK1=AVL3*(A(2=AK1)/ANN AK1=AVL3*(A(1); B(1); C(1); D(1); E(1); T1) 6 VOB(1)=PROD AK1=AKLA(1); B(1); C(1); D(1); E(1); T1) 5 VOB(1)=VOB(1)+PROD AK1=AK(A(1); B(1); C(1); D(1); E(1); T1) 5 VOB(1)=VOB(1)+PROD AK1=AK(A(1); B(1); C(1); D(1); E(1); T1) 5 VOB(1)=VOB(1)+PROD AK1=AK(A(1); B(1); C(1); D(1); E(1); TN)			- PRA-0 - PSAS-02004144	04ATN#AN1						
<pre>A Let (1) + S/ (2+0.2) A Live ACC (1) + S/ (2+0.2) WOD (1) = WOD (1) - AIN A LD (1) = PROD* (WOD (1) - AIN) + (1 + AIN) * ALD (1) 3 WOD (1) = AIN A WOT AIN C C CALCULATE (V/B)F 17 NN=NF-2 DO 5 I=1+NC AK1=AK(A(1) + B(1) + C(1) + D(1) + E(1) + TF) AK2=AK(A(1) + B(1) + C(1) + D(1) + E(1) + T2) PROD=AVL3 * AK1 VOB (1) = PRCD AIN=AVL3 * (AK2=AK1)/ANN AIN=AVL3 * (AK2=AK1)/ANN AK1=AVL3 * AK1 DO 6 J=1+NN AN=J PROD=PROD* (AK1+AN*AIN) 6 VOB (1) = VOB (1) + PROD AK1=AK(AT1) + B(1) + C(1) + D(1) + E(1) + T1) 5 VOB (1) = VOB (1) + PROD AK1=AK(AT1) + B(1) + C(1) + D(1) + E(1) + TN) AK1=AK(AT1) + B(1) + C(1) + D(1) + E(1) + TN) AK1=AK(AT1) + B(1) + C(1) + D(1) + E(1) + TN) AK1=AK(AT1) + B(1) + C(1) + D(1) + E(1) + TN) AK1=AK(AT1) + B(1) + C(1) + D(1) + E(1) + TN) AK1=AK(AT1) + B(1) + C(1) + D(1) + E(1) + TN) AK1=AK(AT1) + B(1) + C(1) + D(1) + E(1) + TS) </pre>	******			10000 10000	Color factor is an orally seen of a	the second second second second second				
<pre>MOD(1)=WOO(1) =AIN ALD(I)=PRGD*(WOD(I)=AIN)+(1,+AIN)*ALD(I) 3 WOD(I)=AIN C_CALCULATE.(V/B)F 17 NN=MF=2 ANN=NN DO 5 I=1+NC AK1=AK(A(I),B(I)+C(I)+D(I)+E(I)+TF) AK2=AK(A(I),B(I),C(I)+D(I)+E(I)+T2) PROD=AVL3*AK1 VOB(I)=PRCD AIN=AVL3*(AK2=AK1)/ANN AN=J PROD=PROD*(AK1+AN*AIN) 6 VOB(I)=VOB(I)+PRCD AK1=AK(A(I)+S(I)+C(I)+D(I)+E(I)+T1) 5 VOB(I)=VOB(I)+PRCD *AK1*VL/(F=DDD=5) GO IC 38 C_FORCE FIT 31 NN=NIT=N5±1 DO 33 I=1+NC AK1=AK(A(I)+B(I)+C(I)+D(I)+E(I)+TS)</pre>		·	• Audit () (= Audit 1) • At Numerical () () () () () () () () () (1080203		•				
MOD(1) = AGD(1) → ALL ALD(1) = PROD*(WOD(1) → ALN) + (1 * + ALN) * ALD(1) 3 WOD(1) = ALN C CALCULATE (V/B)F 17 NN=NF-2 ANN=NN D0 5 I=1+KC AK1=AK(A(1) * B(1) * C(1) * D(1) * E(1) * TF) AK2=AK(A(1) * B(1) * C(1) * D(1) * E(1) * T2) PROD=AVL3 * AK1 VOB(1) = PROD AK1=AVL3 * AK2 MN=J PROD=PROD*(AK1+AN*AIN) 6 VOB(1) = VOB(1) + PROD AK1=AK(A(1) + B(1) + C(1) + D(1) + E(1) + T1) 5 VOB(1) = VOB(1) + PROD AK1=AK(A(1) + B(1) + C(1) + D(1) + E(1) + T1) 5 VOB(1) = VOB(1) + PROD AK1=AK(A(1) + B(1) + C(1) + D(1) + E(1) + T1) 5 VOB(1) = VOB(1) + PROD AK1=AK(A(1) + B(1) + C(1) + D(1) + E(1) + TN) AK2=AK(A(1) + B(1) + C(1) + D(1) + E(1) + TN) AK2=AK(A(1) + B(1) + C(1) + D(1) + E(1) + TS)	•• •••		_ ALM-MCULIA3/	3 75 1 21 21 21 21 21 21 21 21 21 21 21 21 2				· · · ·	, in the second s	
ALD())=PROD*(WOS())=AIN(+()**AIN)*AED() 3 WOD())=AIN C CALCULATE (V/B)F 17 NN=NF=2 ANN=NN DO 5 I=1;NC AK1=AK(A(I);B(I);C(I);D(1);E(I);IF) AK2=AK(A(I);B(I);C(I);D(1);E(I);I2) PROD=AVL3*AK1 VOB(I)=PROD AIN=AVL3*AK1 VOB(I)=PROD*(AK1*AN*AIN) AK1=AVL3*AK1 DO 6 J=1;NN AN=J PROD=PROD*(AK1*AN*AIN) 6 VOB(I)=VOB(I)+PROD AK1=AK(A(I);B(I);C(I);D(I);E(I);I1) 5 VOB(I)=VOB(I)+PROD *AK1*VL/(F=DDD=S) GO IC 38 C FORCE FIT 31 NN=NIT=NS+1 DO 33 I=1;NC AK1=AK(A(I);B(I);C(I);D(I);E(I);TN) AK2=AK(A(I);B(I);C(I);D(I);E(I);TN) AK2=AK(A(I);B(I);C(I);D(I);E(I);TS)			WOD(1)=WOD(1)		115 101014	CALLY TY				
3 WOD(1)=A1N C CALCULATE (V/B)F 17 NN=NF=2 ANN=NN D0 5 I=1;NC AK1=AK(A(1);B(1);C(1);D(1);E(1);TF) AK2=AK(A(1);B(1);C(1);D(1);E(1);T2) PROD=AVL3*AX1 VOB(1)=PRCD AIN=AVL3*(AX2=AK1)/ANN AK1=AVL3*AX1 D0 6 J=1;NN AN=J PROD=PROD*(AK1+AN*AIN) 6 VOB(1)=VOB(1)+PROD AK1=AK(A(1);B(1);C(1);D(1);E(1);T1) 5 VOB(1)=VOB(1)+PROD *AK1*VL/(F=DDD=5) G0 1C 38 C FORCE FIT 31 NN=N1T=NS±1 D0 33 I=1;NC AK1=AK(A(1);B(1);C(1);D(1);E(1);TN) CK2=AK(A(1);B(1);C(1);D(1);E(1);TN)			AUDIT) = PROD*(WODTIT#AINI	TIJ678181)					• • • • •
C CALCULATE (V/B)F 17 NN=NF=2 ANN=NN D0 5 I=1;NC AK1=AK(A(I);B(I);C(I);D(I);E(I);TF) AK2=AK(A(I);B(I);C(I);D(I);E(I);T2) PROD=AVL3*AK1 VOB(I)=PRCD AIN=AVL3*(A(2=AK1)/ANN AK1=AVL3*AK1 D0 6 J=1;NN AN=J PROD=PROD*(AK1+AN*AIN) 6 VOB(I)=VOB(I)+PROD AK1=AK(A(I);E(I);C(I);D(I);E(I);T1) 5 VOB(I)=VOB(I)+PROD *AK1*VL/(F=DDD=S) G0 TC 38 C FORCE FIT 31 NN=NIT=NS+1 D0 33 I=1;NC AK2=AK(A(I);E(I);C(I);D(I);E(I);TS)		2	3 WOD(I)=AIN							
17 NN=NF-2 ANN=NN DO 5 I=1,%C AK1=AK(A(I),B(I),C(I),D(I),E(I),TF) AK2=AK(A(I),B(I),C(I),D(I),E(I),T2) PROD=AVL3*AK1 VOB(I)=PROD AIN=AVL3*(AK2=AK1)/ANN AK1=AVL3*AK1 DO 6 J=1,NN AN=J PROD=PROD*(AK1=AN*AIN) 6 VOB(I)=VOB(I)+PROD AK1=AK(A(I),B(I),C(I),D(I),E(I),T1) 5 VOB(I)=VOB(I)+PROD *AK1*VL/(F=DDD=S) GO IC 36 C FORCE FIT 31 NN=NIT=NS+1 DO 3 I=1,NC AK1=AK(A(I),B(I),C(I),D(I),E(I),TN) AK2=AK(A(I),B(I),C(I),D(I)+E(I),TN) AK2=AK(A(I),B(I),C(I),D(I)+E(I),TS)	1000 10 × 1	<u> </u>	ALCULATE (V/B)F							
ANN=AN DO 5 I=1+NC AK1=AK(A(I)+B(I)+C(I)+D(I)+E(I)+TF) AK2=AK(A(I)+B(I)+C(I)+D(I)+E(I)+T2) PROD=AVL3*AK1 VOB(I)=PROD AIN=AVL3*(AK2+AK1)/ANN AK1=AVL3*AK1 DO 6 J=1+NN AN=J PROD=PROD*(AK1+AN*AIN) 6 VOB(I)=VOB(I)+PROD AK1=AK(A(I)+B(I)+C(I)+D(I)+E(I)+T1) 5 VOB(I)=VOB(I)+PROD *AK1*VL/(F+DDD+S) GO TC 38 C FORCE FIT 31 NN=NIT=NS+1 DO 33 I=1+NC AK1=AK(A(I)+B(I)+C(I)+D(I)+E(I)+TN) AK2=AK(A(I)+B(I)+C(I)+D(I)+E(I)+TS)		17	7 NN=NF-2							
DO 5 I=1;NC AK1=AK(A(I);B(I);C(I);D(I);E(I);TF) AK2=AK(A(I);B(I);C(I);D(I);E(I);T2) PROD=AVL3*AK1 VOB(I)=PROD AIN=AVL3*(AK2=AK1)/ANN AK1=AVL3*AK1 DO 6 J=1;NN AN=J PROD=PROD*(AK1+AN*AIN) 6 VOB(I)=VOB(I)+PROD AK1=AK(A(I);B(I);C(I);E(I);T1) 5 VOB(I)=VOB(I)+PROD *AK1*VL/(F=DDD=S) GO 1C 38 C; C FORCE FIT DO 33 I=1;NC AK1=AK(A(I);B(I);C(I);E(I);TN) AK2=AK(A(I);B(I);C(I);D(I);E(I);TS)	· ·		ANN=NN							
AK1=AK(A(1),B(1),C(1),D(1),E(1),TF) AK2=AK(A(1),B(1),C(1),D(1),E(1),T2) PROD=AVL3*AK1 VOB(1)=PRCD AIN=AVL3*AK1 DO 6 J=1,NN AN=J PROD=PROD*(AK1+AN*AIN) 6 VOB(1)=VOB(1)+PROD AK1=AK(A(1),B(1)+C(1),D(1),E(1),T1) 5 VOB(1)=VOB(1)+PROD *AK1*VL/(F+DDD+S) GO TO 38 C FORCE FIT 31 NN=NIT=NS+1 DO 33 I=1+NC AK1=AK(A(1),B(1),C(1),D(1),E(1),TN) AK2=AK(A(1),B(1),C(1),D(1),E(1),TN) AK2=AK(A(1),B(1),C(1),D(1),E(1),TS)			DO 5 1=1+NC							
AK2=AK(A(I),B(I),C(I),D(I),E(I),T2) PROD=AVL3*AK1 VOB(I)=PROD AIN=AVL3*(AK2~AK1)/ANN AK1=AVL3*AK1 DO 6 J=1,NN AN=J PROD=PROD*(AK1+AN*AIN) 6 VOB(I)=VOB(I)+PROD AK1=AK(A(I),S(I)+C(I),D(I),E(I),T1) 5 VOB(I)=VOB(I)+PROD *AK1*VL/(F~DDD~S) GO IC 38 C FORCE FIT 			AKI = AK(A(I))	B(I) + C(I) + ()(1);E(1);	TE)				
PROD=AVL3*AK1 VOB(I)=PROD AIN=AVL3*(AK2=AK1)/ANN AK1=AVL3*AK1 DO 6 J=1,NN AN=J PROD=PROD*(AK1+AN*AIN) 6 VOB(I)=VOB(I)+PROD AK1=AK(A(I);B(I)+C(I);D(I);E(I);T1) 5 VOB(I)=VOB(I)+PROD *AK1*VL/(F=DDD=5) GO TC 38 C FORCE FIT 	•• •		AK2=AK(A(I).	B(1) . C(1) .)(I) • E(I) • '	12)				
VOB(I)=PRCD AIN=AVL3*(AK2=AK1)/ANN AKI=AVL3*AK1 DO 6 J=1,NN AN=J PROD=PROD*(AK1+AN*AIN) 6 VOB(I)=VOB(I)+PROD AK1=AK(A(I);5(I)+C(I);5(I);F(I);T1) 5 VOB(I)=VOB(I)+PROD *AK1*VL/(F=DDD=5) GO IC 38 C FORCE FIT 			PRODEAVE 3 HAK 1							
AIN=AVL3*(AK2=AK1)/ANN AK1=AVL3*AK1 D0 6 J=1;NN AN=J PROD=PROD*(AK1+AN*AIN) 6 VOB(1)=VOB(1)+PROD AK1=AK(A(1);B(1)+C(1);D(1)+E(1);T1) 5 VOB(1)=VOB(1)+PROD *AK1*VL/(F+DDD+S) G0 TC 38 C; C FORCE FIT 31 NN=NIT=NS±1 D0 33 I=1;NC AK1=AK(A(1);B(1)+C(1);D(1)+E(1);TN) AK2=AK(A(1);B(1)+C(1);D(1)+E(1);TS)	*					annesis a su ana serie a ne n'i				
A IN=AVL 3* AX2 = AK177AKN AK1=AVL 3* AX1 DO 6 J=1;NN AN=J PROD=PROD*(AK1+AN*AIN) 6 VOB(1)=VOB(1)+PROD AK1=AK(A(1);B(1)+C(1);D(1);E(1);T1) 5 VOD(1)=VOB(1)+PROD *AK1*VL7(F+DDD+S) GO TO 38 C FORCE FIT 31 NN=NIT=NS±1 DO 33 I=1;NC AK1=AK(A(1);B(1)+C(1);D(1)+E(1);TN) AK2=AK(A(1);B(1)+C(1);D(1)+E(1)+TS)				MAKEN A CAME						
AK1=AVL3*AK1 DO 6 J=1;NN AN=J PROD=PROD*(AK1+AN*AIN) 6 VOB(I)=VOB(I)+PROD AK1=AK(A(I);S(I)+C(I);D(I);E(I);T1) 5 VOB(I)=VOB(I)+PROD *AK1*VL/(F+DDD+S) GO IC 38 C FORCE FIT 		a ara ara ara Anarana ar	L AINEAVLOYIAKZ	TAKLIZANN	4 · · · ·		1 14 BUT 75			÷ .
DO 6 J=1,NN AN=J PROD=PROD*(AX1+AN*AIN) 6 VOB(I)=VOB(I)+PROD AK1=AK(A(I);B(I)+C(I);D(I);E(I),T1) 5 VOB(I)=VOB(I)+PROD *AK1*VL/(F-DDD-5) GO IC 38 C FORCE FIT 	•		AK1=AVL3*AK1							
AN=J PROD=PROD*(AK1+AN*AIN) 6 VOB(I)=VOB(I)+PROD AK1=AK(A(I);B(I)+C(I);D(I);E(I)+T1) 5 VOB(I)=VOB(I)+PROD *AK1*VL/(F+DDD+S) GO IG 38 C FORCE FIT 31 NN=NIT=NS+1 DO 33 I=1;NC AK1=AK(A(I);B(I);C(I);D(I);E(I);TN) AK2=AK(A(I);B(I);C(I);D(I);E(I);TS)			DO 6 J=1.NN							
<pre> PROD=PROD*(AK1+AN*AIN) 6 VOB(I)=VOB(I)+PROD AK1=AK(A(1);B(I)+C(I);D(1);E(I);T1) 5 VOB(I)=VOB(I)+PROD *AK1*VL/(F+DDD+5) 60 T0 38 7; C FORCE FIT 31 NN#NTT=NS±1 D0 33 I=1;NC AK1=AK(A(I);B(I);C(I);D(I);E(I);TN) ;K2=AK(A(I);B(I);C(I);D(I);E(I);TS) </pre>			AN=J							•
6 VOB(1)=VOB(1)+PROD AK1=AK(A(1),B(1)+C(1),D(1),E(1)+T1) 5 VOB(1)=VOB(1)+PROD *AK1*VL/(F+DDD+S) GO TO 38 C FORCE FIT 31 NN=NTT=NS+1 DO 33 I=1+NC AK1=AK(A(1),B(1)+C(1)+D(1)+E(1)+TN) AK2=AK(A(1)+B(1)+C(1)+D(1)+E(1)+TS)	÷		PROD=PROD* (A*	(I+AN#AIN).						• • •••••
AK1=AK(A(1);B(1);C(1);D(1);E(1);T1) 5 VOB(1)=VOB(1)+PROD *AK1*VL/(F+DDD+S) GO TO 38 			6 VOB(1)=VOB(1)	4PROD						
5 VOB(1)=VOB(1)+PROD *AK1*VL/(F+DOD+5) GO TO 38 				3(I) *C(I) *D	(1),E(1),T	1)	•			
GO TC 38 .C FORCE FIT 			5 VOR(I)=VOR(I)	+PROD *AK1	*VL/(F-DDD	S)				
C FORCE FIT 31 NN#NIT=NS+1 DO 33 I=1+NC AKJ=AK(A(I)+B(I)+C(I)+D(I)+E(I)+TN) AKZ=AK(A(I)+B(I)+C(I)+D(I)+E(I)+TS)			60 TC 38	, i constante de la constante d						
$\frac{31}{D0.33} = 1 + NC$ $= AK 1 = AK (A(1) + B(1) + C(1) + D(1) + E(1) + TN)$ $= AK 2 = AK (A(1) + B(1) + C(1) + D(1) + E(1) + TS)$		с г	000 10 JU	· · · · · ·						
DO 33 I=1;NC AK1=AK(A(I);B(I);C(I);D(I);E(I);TN) AK2=AK(A(I);B(I);C(I);D(I);E(I);T5)	·	-C. f*								
- DU 33 I=I #NC AK]=AK(A(I) *B(I) *C(I) *D(I) *E(I) *TN) AK2=AK(A(I) *E(I) *C(I) *D(I) *E(I) *TS)		F	L RISEN LLEBOALL						,	
AKI = AK(A(1) * B(1) * C(1) * D(1) * E(1) * IN) $ AK2 = AK(A(1) * B(1) * C(1) * D(1) * E(1) * IS)$	•		JN # 1 = 1 & 6 & 00			NI Y				
ふK2☆AK(A(I)*E(I)*C(I)*C(I)*E(I)*E(I)*(S)			AKI=AK(A(1))	31110(1110)	11/02/1/01	AND CONTRACTORS OF A				
a construction of the state of the			AK2=AK(A(I)))	HIII CIII D	111+2111+1	51				

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AK1=ALV1/AK2+FRAC1(I)*ALV1*(1./AK1-1./AK2) WOD(I)=(AK1**(NN+1)-AK1)/(AK1-1.)+R*AK1**NN 33_WOD(1)=WOD(1)*S/(R*DDD) DO 34_I=1+NC _AK1=AK(A(I) +B(I) +C(I) +D(I) +E(I) +TS) -

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AK2mAK(A(1)+5(1)+C(1)+D(1)+E(1)+TF) 34 ALD(1)=AK14*(NS-NF-1) *(300(1)*R*000/S-#00(1)) *(1,+WOD(1))*((AK1**(NS-NF)-AK1)/(AK1-1.)) NN=MP-1 DO 35 1=1+MC AK1=AK(A(I),B(I),C(1),D(1),E(1),T1) AK1=AK1+VL/(F-ODD-S) AK2#AK(A(1)*B(1)*C(1)*D(1)*E(1)*T2) AK3=AK(A(I),5(I),C(I),D(I),E(I),TF) AK2=AK3+AVL3+AVL3+FRAC3(1)*(AK2+AK3) 35 NOB(1)=(AK2*=NF-AK2)/(AK2-1.)+AK1*AK2**NN C FORCE FRACTION END _____36_IJK=0_____ THETWEL. والمحاوية المحمولة والمحمولة والمحم 49 DCAL=0. WCAL=0. BCAL=Ce DO 7 1=1,NC _B00+(ALD(11+XL(1)/1F*X(1))*(1.+WOD11)))_ /(VOB(I)+XV(I)/(E*X(1))) 5 DS(1)=F*X(1)/(1.+BOD+WOD(1)) WS(1)=WOD(1)*DS(1) *1HETW BS(I)=F*X(1)→DS(I)-VS(4) DCAL=DS(1)+DCAL BCAL=BS(1)+BCAL ... 7 WCAL=WS(I)+WCAL 1F(1JK) 41:42:41 42 1F(S) 43,41,43 43 THETW=S/WCAL [JK=1 GO_TO 49 41 DO 8 1=1.NC WS(I)=WS(I)/WCAL BS(1)=BS(1)/BCAL S DS(I)=DS(I)/DCAL J=1 WRITE(3,203) DCAL, BCAL, WCAL. TNATIN T1A=T1 TSA=TS T2A=12 ł TXT=TN CALL BUBBA(A, B, C, D, E, DS, TN , NC, J). J = 0CALL BUBBA(A, B, C, D, E, BS, T1, NC, J) CALCULATE TS, TZ, TN ____ IF(S) 18+19:18 18. CALL BUBBA (A, B, C, D, E, WS, TS, NC, J) GET L2 AND CALCULATE T2 С 19 AL22=BCAL+VL DO 10 1=1,NC AK1=AK(A(1),B(1),C(1),D(1),E(1),T1) 10 WOD(I)=(AK1*BS(I)*VL~BCAL*BS(I))/AL22 CALL BUBBA (A, B, C, D, E, WOD, T2, NC; J) IF(ABS(TNA-TN)/TN-+0005) 71+71+69 71 IF(ABS(T1A-T1)/T1-,0005). 72:72:69

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72 IF(ABS(ISA-TS)/TS=,0005) 73:72:69 73 1F(ABS(T2A+T2)/T2+.0005 174,74,69 74 IF(ASS(DOD=DCAL)/DCAL= -0005) 68,68,22 68 WRITE(3:204) WRITE(3,669) THETW WRITE(3+201) DO 9 1=1+NC 2 WRITE(3:202) 1:55(1):05(1):W5(1) GO TO 76 22 [F(ATE) 26+25+26 25 IF(DDD-DCAL) 81,82:82 82 ATF=TF ADD=DCAL TF=TF-2. GO TO 69 81 ATF=TF ADD=DCAL TF=TF+2. GO TO 69 26 ANN=TE TF=(ATF-TF)/(ADD-DCAL)*(DDD-DCAL)+TF ATECAN ADD=DCAL GD TO 69 100 FORMAT(415) 101 FORMAT(SE15.9) 102 FORMAT(8F10.0) 103 FORMAT(3F10+0) 201 FORMAT(3X, 'BOTTOMS COMPOSITION', 6X'DISTILLATE COMPOSITION', 6X, 'SI 1DE STREAM COMPOSITIONT) 203 FORMAT(/6X, 'DISTILLATE=', F10,4,/6X, 'BOTTOMS=', F1C.4, 1/6X; *SIDE STREAM=**Fl0e4)
202 FORMAT(20X; I3; E14.7; IX; IX; E14.7; IX 204 FORMAT(/ ****FIN1SHED****!) 205 FORMAT(1H1+6X+***MODIFIED THIELE GEDDED PROGRAM***/+///) 206 FORMAT (GX, !***FRACTION INFUT METHOD BEING USED***!, 1 ///*8X**FOLLOWING FRACTIONS HAVE BEEN INPUTED**/2X*3(6X*E15*8)) 300 FORMAT(___ 12x; 'INPUT SPECIFICATIONS';/3X; '***NOTE TRAY 1 IS THE R 1EBOILER******/ / 6X . INUMBER OF COMPONENTS= 1 . 10X . I3 . / 6X . INUMBER OF TR 2AYS (INCLUDING THE REBOILER)=',2X,13,76X, SIDE STREAM PLATE NUMBER 3=1+8X +13+/GX+FEED TRAY NUMBER=++8X+13) 700 FORMAT(6X; 'T1=*;E15+8;/6X; 'T2=';E15+8;/6X; 'TF=*;E15+8;/6X; 1*TFP1=***E15*8*/6X**TSM1=**E15*8*/6X**TS=**E15*8*/6X**TN=**E15*8* 669 FORMATIOX, 'THETW= '* E15*81_____ END

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APPENDIX B

Input for the Base Case (Case 1) using the Rigorous Thiele-Goddes Program

Equilibrium and entholpy data are fitted to a polynomial of the following form:

K _{t,i} =	$A_i + B_i t + C_i t^2 + D_i t^3 + E_i t^4$
H _{t,i} =	$A_i + B_i t + C_i t^2 + D_i t^3 + E_i t^4$
h _{t,i} =	$A_{i} + B_{i}t + C_{i}t^{2} + D_{i}t^{3} + E_{i}t^{4}$
where:	A, B, C, D, E, are inputed coefficients for component i and t is the temperature in degrees fahrenheit
	H _{t,i} = vapor enthalpy at temperature t for component i
	<pre>h_{t,i} = liquid enthalpy at temperature t for component i</pre>
	K _{t,i} = equilibrium constant at temperature t for component i
Card #1	
Columns	Inserted Value
1 - 5	Number of Components 5
6 - 10	Total Number of stages 10 including the reboiler

5

11 - 15 *Number of Sidestream draw-8 off stage

*Number of feed stage

16 - 20

*Stage 1 is the reboiler

Card #2	Coefficient equilibrium number one	constant	for	component
<u>Columns</u>	Inserted Value			
l - 1 5	0.28531998F 00			
16 - 30	0.82878992E-02			
31 - 45	0.37 041988E-04			
46 - 60	-0.63860000E-04			
61 - 75	0.71090994E-10			
Card #3				
Columns	Inserted Value	1 		
1 - 15	0.278049955 0C	2		
16 - 30	-0.11902999E-02	1		
31 45	0.62290987E-04			
46 - 60	-0.12023997E-06			
61 - 75	0,10241999E-09)		
Card #4				
Columns	Inserted Value	2		
1 - 15	0.22200996E 00)		
16 - 30	-0.18502998E-02	2		
31 - 45	0.54022996E-04	δ. 1.		
46 - 60	-0.81239989E-0	7		
61 - 75	0.53332991E-10	0		
Card #5				
Columns	Inserted Value	<u>9</u>		
1 - 15	0.15309995E 0	0		
16 - 30	-0.22649998E-0	2		

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Columns	Inserted Value
31 - 45	0.21813989E-04
46 - 60	-0.20709997E-07
61 - 75	~0.40599999E-12
Card #6	
Columns	Inserted Value
· 1 - 15	0.16042995E 00
16 - 30	-0.26387000E-02
31 - 45	0.28703987E-04
46 - 60	-0.88699998E-08
61 - 75	-0.14969997E-10
There would	d be additional cards for additional components.
Card #7	
Columns	Valu Valu
1 - 10	Mole fraction of component 1 in the feed .05
ll - 20	Mole fraction of component 2 in the feed .15

.15 Mole fraction of component 3 in the feed 21 - 30.25 31 - 40 Mole fraction of component 4 in the feed .20 41 - 50 Mole fraction of component 5 in the feed .35 There would be additional numbers for more components.

Card #8							
Card ro	•						Inserted
Columns							Value
1 10	Initial	assumed	temperatures	for	stage	1	220.
11 - 20	Initial	assumed	temperatures	for	stage	2	210.

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Inserted Value

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~: 1	Inserted
Columns	Value
21 - 30	Initial assumed temperatures for stage 3 200.
31 - 40	Initial assumed temperatures for stage 4 190.
41 - 50	Initial assumed temperatures for stage 5 180.
51 - 60	Initial assumed temperatures for stage 6 170.
61 - 70	Initial assumed temperatures for stage 7 160.
71 - 80	Initial assumed temperatures for stage 8 150.
Card #9	
Columns	Inserted Value
1 - 10	Initial assumed temperatures for stage 9 145.
11 - 20	Initial assumed temperatures for stage 10 140.
There would	d be additional numbers for more stages.
Card #1.0	Coefficient for liquid enthalpy for component number one
Columns	Inserted Value
1 - 15	0.44835997E 01
16 - 30	0.2688299E-01
31 - 45	0.64745000E-05
46 - 60	0.32505998E-07
61 - 76	-0.52879992E-10
Card #11	Coefficient for liquid enthalpy for component number two
Columns	Inserted Value
1 - 15	0.52091999E 01
16 - 30	0.40495999E-01

	Bear Sec.	5		6 F. F.	
Columns	lnser	rter	2 1	VELL	-U Ü
the second se	BRANCHARD AND A DESCRIPTION AND A DESCRIPTION			and the state of the	1.14.1

- **31 45 -0.57040988E-04**
- **46 60 0.25799994**18-06
- **61 75** -0.326449081000
- <u>Card #12</u> Coefficient for liquid enthalpy for component number three
- Columns Inserted Value
- 1 15 0.644429970 01
- 16 30 0.14100999E-01
- **31 45 0.16052999E-03**
- **46 60 -0.49556996E-06**
- 61 75 0.61558980E-09
- Card #13 Coefficient for liquid enthalpy for component number four
- Columns Inserted Value
- 1 15 0.67343998E 01
- 16 30 0.43812998E-01
- **31 45 -0.2259**5996E-04
- **46 60 0.13574999**B-06
- **61 75 -0.16938999**E-09

Card #14 Coefficient for liquid enthalpy for component number five

<u>Colum</u>	ms	Inserted Value
1 -	15	0.83587999E 01
16 -	30	0.80696978E-02
31 -	45	0.26773987E-03
Columns	Inserted Value	
---------	-----------------	--
46 - G0	-0.26588000B-06	
61 - 75	0.10789998E-08	

There would be additional cards for additional components.

- Card #15 Coefficients for vapor enthalpy for component number one
- Columns Inserted Value
- 1 15 0.13575000E 02
- 15 30 -0.27656998E-01
- 31 45 0.37013995E-03
- 46 60 -0.12388991E-05
- 61 75 0.15431998E-08
- Card #16 Coefficients for vapor enthalpy for component number two

Columns Inserted Value

- 1 15 0.15278999E 02
- 16 30 -0.60739964E-02
- **31** 45 **0.23645999E-03**
- 46 60 0.75789995E 06
- 61 75 0.94283981E-09
- <u>Card #17</u> Coefficients for vapor enthalpy for component number three
- Columns
 Inserted Value

 1 15
 0.13910999E 02

 16 30
 0.46811998E-01

 31 45
 -0.19588000E-03

 46 60
 0.74338999E-06

 61 75
 -0.92781982E-09

Card #18 Coefficients for vapor enthalpy for component number four

- ColumnsInserted Value1 150.19401998E 0216 30-0.93661994E-0231 450.30484982E-0346 60-0.97820975E-0661 750.12168999E-08
- Card #19 Coefficients for vapor enthalpy for component number five

Columns		nns	Inserted Value	
1	64**	15	0.21092987E 02	
16	100	30	-0.35334997E-01	
31	e nte-	45	0.52449-92E-03	
46	P14	60	-0.17495995E-05	
61	-	75	0.21789999E-08	

There would be additional cards for additional components.

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- 2. Thiele, E. W. and R. L. Geddes, "Computation of Distillation Apparatus for Hydrocarbon Mixtures," Ind. Eng. Chem., 25, 289 (1933).
- Tomme, W. J., "A Convergence Method for Distillation Systems," Ph. D. dissertation, A. and M. College of Texas, College Station, Texas, 1963.