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A SIMULATION MODEL CAPABLE OF PERFORMING THE CALCULATIONS INVOLVED IN DEFINING A CRUDE PREHEAT TRAIN

by

ROBERT G. PARKER

A Thesis

Presented in Partial Fulfillment of the

Requirements for the Degree

of

Master of Science in Chemical Engineering

at

Newark College of Engineering

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Newark, New Jersey

ABSTRACT

A simulation model has been developed for a system of exchangers to preheat the feed to a crude distillation unit. In conjunction, a Fortran program for the performance of the model calculations by digital computer was written. Two types of preheat system were simulated, a single train system and a split (or parallel) train system. A number of features were included in the program for flexibility and versatility. A particular effort was made to have the model represent as economical a preheat system as possible.

The model program was used to obtain computer-calculated results for both single-train and split-train preheat systems. Computer runs were made to show the effect of using different temperature approach values. The computer output data as printed for several sample problems is presented. Results have been analyzed with regard both to type of preheat system and to temperature approach value.

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APPROVAL OF THESIS

A SIMULATION MODEL CAPABLE OF PERFORMING

THE CALCULATIONS INVOLVED IN DEFINING A

CRUDE PREHEAT TRAIN

ΒY

ROBERT G. PARKER

FOR

DEPARTMENT OF CHEMICAL ENGINEERING

NEWARK COLLEGE OF ENGINEERING

BY

FACULTY COMMITTEE

APPROVED:_____

NEWARK, NEW JERSEY

JUNE, 1971

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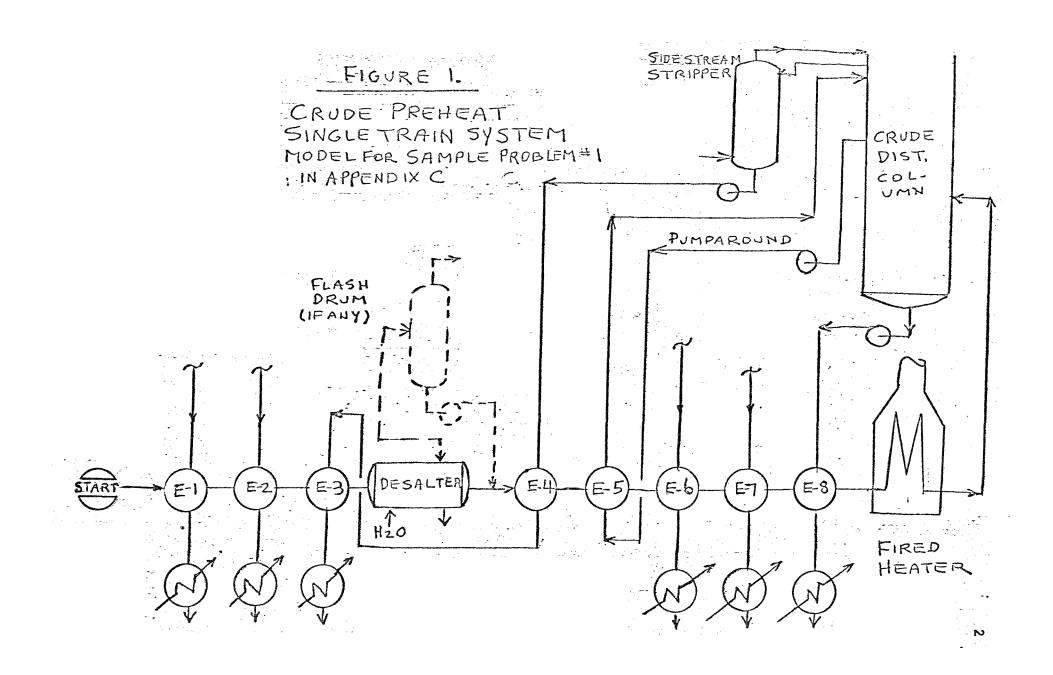
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CHAPTER I

INTRODUCTION

The purpose of this thesis project was the development of a simulation model to perform the calculations required for preheating the feed to a crude oil distillation unit. Economic considerations as well as heat transfer principles are involved in the preheat problem itself, and in the model that has been developed. The model program is entitled "Preheat."

The problem of feed preheat is encountered whenever a new crude distillation unit is designed for the petroleum industry. The feed to a crude unit must be heated sufficiently to effect the required amount of vaporization at the inlet of a distillation tower operating at essentially atmospheric pressure, and a system of equipment to accomplish this must be selected. Such a system is shown in Figure 1. The principal components of the system are heat exchangers, coolers, and a fired heater or furnace. Liquid sidestreams are withdrawn from the atmospheric distillation tower at elevated temperatures and must be cooled before leaving unit limits. These streams may be routed through heat exchangers to preheat the feed by indirect heat transfer, before flowing through coolers (air or water) to be brought to required battery limits temperatures. That portion of the required heat not supplied by the heat exchangers must be supplied by the fired heater, using gas and/or oil as fuel. The problem is to determine how many heat exchangers to employ, how much heat



should be provided by each, and consequently how much must be supplied in the fired heater. A great deal of engineering effort is involved in establishing a suitable system of equipment. The necessary calculations include many, many heat balances, and numerous studies involving the various economic factors that are applicable. Since the amount of heat involved is usually large, fuel costs and equipment investment costs will be correspondingly high. Careful and detailed studies are required in order to minimize these costs. A great deal of time can be consumed if the above calculations are carried out "by hand", i.e. with pencil, slide rule and/or desk calculator. Use of a computer to perform the calculations is indicated and desirable. Not only can engineering time be saved, but the resulting design should more nearly approach the optimum from an economic standpoint. The model developed here is intended primarily as a time saving tool and has been kept as simple as feasible. However, its use should result in economical designs since it provides the capability of comparing results obtained when significant parameters are varied.

A number of articles have been published dealing with the economics of heat exchangers, both with regard to relatively simple systems involving but one exchanger and cooler, and with more complex systems involving banks of exchangers and their associated coolers. The articles stress the importance of employing optimum cold-end temperature approaches for the exchangers. This concept of optimum cold-end approach has been used in the development of the simulation model.

Figure | shows a vessel marked "desalter"as being included

in the preheat system. The purpose of the desalter is the removal from the crude of salt which would otherwise be deposited in the tubes of the high temperature heat exchangers and the furnace. The desalter is usually electrical, an imposed voltage promoting coalescence of brine droplets which are formed on pre-mixing a small amount of water with the crude. The desalting temperature is usually 260-270°F. and this temperature requirement must be met in order to establish a satisfactory preheat system.

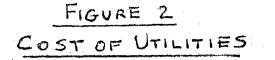
A preflash drum is also shown in Figure 1, represented with dotted lines to indicate its inclusion is less common than that of a desalter. The flash that occurs is defined by the input data to the model program.

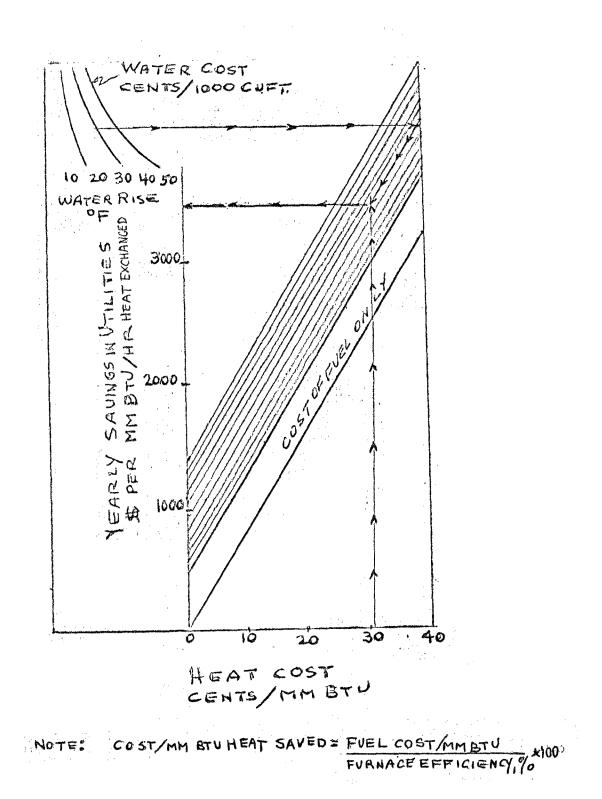
CHAPTER 2

ECONOMIC CONSIDERATIONS AND COSTS

The heat exchangers included in the preheat train of a crude distillation unit serve the dual purpose of removing heat from streams that must be cooled and of supplying the crude with the heat required for fractional distillation. The streams to be cooled are product streams and pump around streams. Pump around streams, which are sometimes called circulating reflux streams, are used to remove heat from the distillation column at temperature levels suitable for heating crude. A great deal of heat must be supplied to the crude to comply with the conditions required at the "flash zone" of the distillation column. Much of this heat must be supplied in a fired heater by burning fuel. Generally substantial savings of money can be effected by using exchangers to recover as much heat as possible from the product and pump around streams, thus reducing the amount of fired heat required. This not only reduces the amount of fired heat, but also the extent of cooling with water and/or air. Besides the savings in fuel and water costs which result, the investment cost of the furnace and cooling equipment are both reduced.

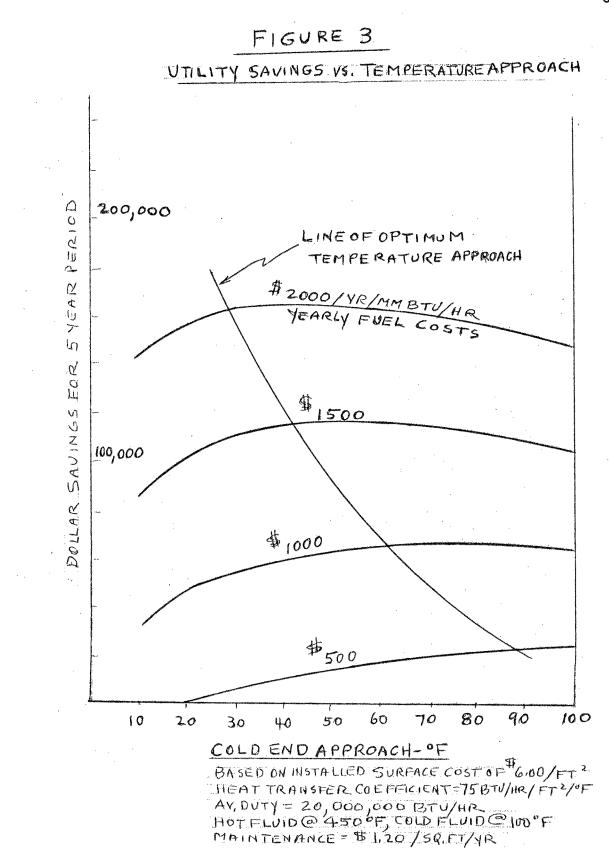
As previously indicated, reductions in utility costs effected by heat exchange are regarded as "savings". Figure 2 gives yearly savings in utility costs per million BTU/hr. of heat exchanged. Both fuel costs and cooling water costs are included in these savings. Figure 2 is based on a similar chart





presented in an article by Whistler (3). To attain these savings, equipment costs must be incurred. Equipment costs include capital charges, or investment costs, which must cover not only the purchase price of the exchangers themselves, but the cost of associated piping, foundations, insulation, etc., as well as installation costs. Equipment maintenance expenses are also involved. These include cleaning costs as well as the cost of replacement parts, such as new exchanger tubes. After yearly gross savings and the investment costs have been calculated, the yearly net savings can be calculated by subtracting a fixed percentage of the investment cost, e.g., 20%, from the yearly gross savings. These are "before tax" savings. The "payout time" can be calculated by dividing equipment cost by savings. A payout time of from 2 to 3 years on a "before tax" basis is usually considered satisfactory. Thereafter, the net savings that result for the rest of the life of the equipment may be considered as "profit". Another way of evaluating the desirability of the exchanger installation in question is to divide the yearly savings by the investment cost, giving yearly return on investment as "per cent return". A return of 30% or better before taxes is usually considered satisfactory.

In determining how much heat from a hot stream should be exchanged with the crude stream entering an exchanger, a number of outlet temperature values can be assumed for the hot stream and the per cent return calculated for each case. The temperature difference between the hot stream leaving an exchanger and the cold stream (crude) entering it is called the "cold end" temperature approach. Savings can be plotted against cold end approach



to give curves showing maximum savings at an optimum approach. Whistler (3) presents several such sets of curves, Figure 3 illustrating a typical set. Fuel costs, incremental exchanger costs, and the exchanger heat transfer coefficient all affect the value of the optimum temperature approach. High annual fuel costs result in "closer" approaches if incremental exchanger costs and the heat transfer coefficient stay the same. Higher exchanger costs and/or a lower heat transfer coefficient result in a larger optimum temperature approach value for cases where the fuel cost remains the same.

Typical yearly fuel cost values in \$/year/MMBTU/Hr range from about 2000 to 4000. Gulf Coast fuel costs are usually relatively low since natural gas is often available at low cost. East Coast fuel costs are generally at the higher end of the range. A typical value for the cost of water is \$.02/1000 gallons which includes the cost of required equipment, including cooling tower and piping, as well as the cost of the power for pumping. Installed cost of exchanger surface, \$/sq. ft., will usually vary from as low as \$6 to as high as \$20. Heat transfer coefficients may vary from 30 - 75 BTU/hr/sq.ft./°F for the exchangers in a crude train.

Average values of \$10/sq.ft. for exchanger surface and 50 BTU/hr/sq.ft./°F for the heat transfer coefficient can usually be used quite satisfactorily in determining the optimum temperature approach for all the exchangers in a crude preheat train. This is true because the hotter exchangers, which tend to have the higher heat transfer coefficients, and also tend to cost more

because they require more expensive materials. Higher fouling factors at hotter temperatures also tend to keep the heat transfer coefficient values from varying excessively. The "return" versus approach curves are relatively flat at approach values above the optimum, as is shown by Figure 3. Below the optimum approach the decline in yearly savings is quite abrupt, so it is better to use approaches slightly above, rather than below, the optimum. Inspection of the above curves seems to indicate that the optimum approach will usually fall between 35 and 75.

Happel (1) suggests "as a rule of thumb" starting with a value of 30°F when making calculations to determine an optimum exchange approach. While this may be all right as a starting point, it appears from Whistler's work that such a close approach would only be justified when fuel is quite expensive (about \$.45/MMBTU/Hr heat absorbed or when exchanger surface is unusually cheap, in the order of \$6/sq.ft. installed).

In summary it appears from Whistler's article that an approach value of 40°F could safely be used if the cost of fuel is fairly high relative to the cost of exchanger surface, while a value of 50°F could be used when the cost of fuel is, again relatively, somewhat low. However, a more precise method of determining optimum approach is detailed in Chapter 3. Whether or not its use is justified will be determined by experience.

CHAPTER 3

OPTIMUM TEMPERATURE APPROACH

Establishing the most economical preheat system for a crude unit is a matter of establishing the order in which the available streams should exchange their heat with the crude and of determining to what extent the streams (other than fixed-duty streams) should be cooled by the crude before undergoing further cooling in air or water coolers.

Considering a system with only one heating stream, the inlet temperatures of the hot and cold streams will be constants. with the outlet temperatures as variables (of course fixing either outlet temperature fixes the other). There will be an optimum outlet temperature for the hot stream which will result in the most profitable exchanger-cooler system from the standpoint of utility savings realized. This problem is dealt with in considerable detail by Happel (1) in his text book. He shows calculations for a number of base cases and presents results in tabular form. The most significant case is for "East Coast" utilities and for 1-2 multipass exchangers. Results for this case are given in Table 1. Optimum approach temperature is the dependent variable with R and D (see nomenclature) as the independent variables. The temperature approach values given are "hot end" approaches. This is somewhat inconvenient since approach is generally considered to refer to "cold end" approach. This is the "approach" used by Whistler and by Happel himself in another chapter in his book

TABLE I

* OPTIMUM APPROACH (HOT END) = $t_1 - T_2$, °F

EAST COST UTILITIES 1-2 MULTI PASS EXCHANGER

	R =	- W& = WC	APPROX	(IMA TE	RATIO	OF HOT	FLUID	T0 C	RUDE
$D=t_1-T_1$				R					
D	<u>. </u>	.25	.50	<u>.75</u>	1.0	2.0	4.0	6.0	10.0
50	46	40	33	28	24	17	12	10	8
100	91	79	64	53	45	28	18	13	.11
200	182	158	126	104	86	52	30	22	17
300	272	235	188	153	127	75	42	30	21
400	363	313	250	203	169	98	56	40	28

TABLE II

* OPTIMUM APPROACH (COLD END) = $t_2 - T_1$, °F

EAST COAST UTILITIES 1-2 MULTI PASS EXCHANGER

 $R = \frac{WC}{WC}$ = APPROXIMATE RATIO OF HOT FLUID TO CRUDE

		normer to matterige and		R		Managaran sa		-	
$D = t_{j} - T_{j}$.1	.25	.50	<u>.75</u>	1.0	2.0	4.0	6.0	10.0
50	10	10	16	21	24	34	41	43	46
100	10	16	28	37	45	64	80	86	91
200	20	32	52	72	86	126	58	170	182
300	20	40	76	104	127	187	235	255	272
400	30	52	100	137	169	249	314	340	363

 $* "COLD" APPROACH = \frac{RD-D + "HOT" APPROACH}{R}$

(See Nomenclature for Definition of Symbols)

entitled, "Practical Rules of Thumb". There it says that as a first trial a 30°F difference between incoming hot stream and leaving cold stream may be employed. Table || has been prepared and included here for convenience. The results in Table || are the same as in Table | except that "cold end" approaches have been substituted for "hot end" approaches.

Where there is a bank or train of exchangers, the problem of optimization is more complicated because the possible savings for each exchanger are affected by the exchangers which "follow it" in the train to further heat the crude. This problem is dealt with by Ten Broeck (2) who gives detailed calculations for the optimum outlet temperatures for each exchanger in a "bank" of three. A sample problem is solved in Appendix C to illustrate Ten Broeck's method. Reference to this problem indicates that only the exchangers which follow affect the savings for a particular exchanger. Both Ten Broeck and Happel use nomographs developed by Ten Broeck in calculating optimum temperatures. Refer to Figures 9 and 10 in Appendix C for nomographs to be used for multi-pass (1-2) exchangers and multi-pass (2-4) exchangers respectively.

In view of the above, one way to employ the model program for accurate results is to use Ten Broeck's method of obtaining optimum outlet temperatures for each exchanger in a train, using known utility and equipment costs. The calculated "cold-end" approach for each exchanger should then be entered with the other input data, and will be used in the heat transfer calculations. This appears to be the best way to approach true optimization

without unduly complicating the mathematical model.

The simulation program itself could have been written to include an optimization procedure, but, in view of the large number of variables involved, and the complexity of their relationships, much simplification and approximation would have been necessary. The results obtained from such an over-simplified procedure could hardly have been considered optimum from a theoretical standpoint.

If the Ten Broeck method of determining optimum temperatures is found to be too laborious, a "trial and error" method of attack can be employed. Several cases would be investigated, each with a separate set of estimated approach temperatures. Then, since the model gives values for the amount and cost of both exchanger and cooler surfaces, the case giving the best results in terms of per cent return on incremental investment would be selected as the design case.

This trial and error approach should prove reasonably practical since, as shown in Figure 3, relatively little variation in savings occurs over a rather wide range of temperature approach values, as long as the approach value employed is above, rather than below, the "exact" optimum. Chapter 6, "Conclusions", gives results of a sample problem where three sets of approach values were used, with the same approach used throughout each set for each variable-duty exchanger in the preheat train.

CHAPTER 4

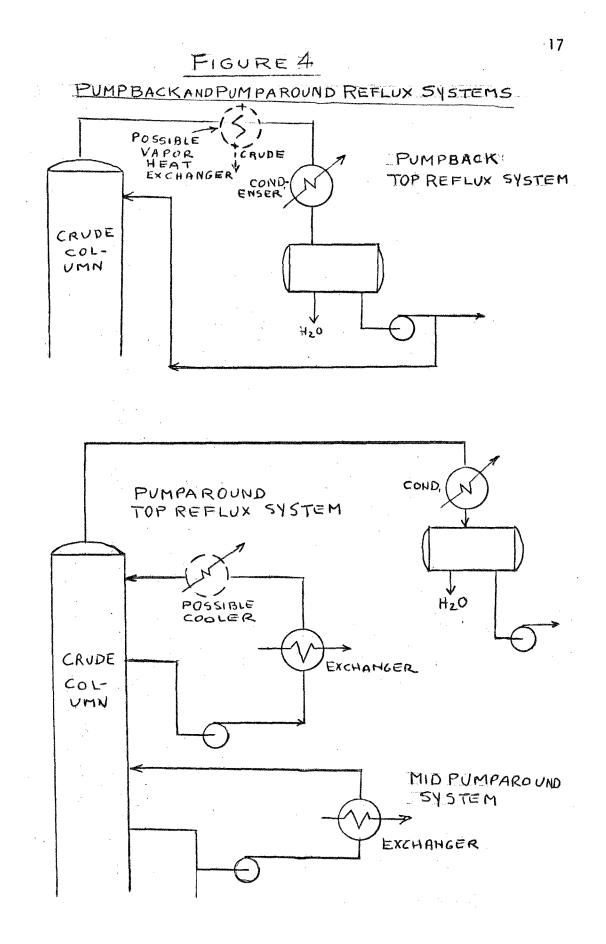
FIXED DUTY STREAMS

A great deal of the material in Chapter 3 referred primarily to variable-duty streams, such as the product streams from a distillation tower, which must be cooled to relatively low temperatures before leaving the distillation unit area. Heat not transferred to crude by an exchanger must be removed in an air or water cooler. The temperature of the hot stream leaving the exchanger depends on the optimum approach which in turn depends on utility and equipment costs. Besides these variable-duty streams, fixed-duty streams also supply heat to crude. Pumparound streams (or circulating reflux streams) are important examples of this Both the amount of heat to be removed and the temperatures type. of the pumparound stream entering and leaving the heat exchanger are supplied as input data to the program. Sometimes, instead of the entire pumparound duty being transferred to crude, a trim cooler is incorporated in the pumparound circuit. The amount of trim cooling is a process rather than an economic consideration however, and the amount of pumparound heat to crude is still predetermined, even though it may not be 100% of the heat removed by circulating reflux.

As to the nature of pumparound streams, they are used to remove heat from a crude distillation column. A certain amount of the heat entering the column with the partially vaporized feed must be removed at the top of the tower to satisfy fractionation requirements. This heat may be removed by pumping back condensed overhead as reflux, or by circulating an externally cooled pumparound stream over several of the tower trays to generate internal reflux. Figure 4 shows these two systems. Usually one or more additional pumparound systems are located farther down the column for the balance of the heat removal.

The use of pumparound systems has two advantages. First, heat is made available at sufficiently high temperature levels to be advantageous for economically preheating crude. Second, the diameter of the tower need not be as large, if mid-pumparound heat removal is employed instead of letting all the heat flow up the tower to be removed by top reflux.

A pumparound system usually is comprised of several heat transfer trays located immediately below a sidestream product drawoff tray, a pump for circulating liquid, and associated exchangersand/or coolers. While the primary function of these trays is the generation of internal reflux by direct heat transfer, they also afford a limited amount of fractionation. When a crude tower is being designed, the lower pumparound duties are established on the basis of removing as much heat as possible at as high a temperature level as possible, while still allowing enough heat to pass up the tower to result in adequate fractionation between the product streams above. The amount of pumparound and the drawoff and return temperatures are selected to correspond to an integral number of pumparound trays within the column, usually two, three or four. As to temperatures, the pumparound stream should usually be withdrawn at a temperature approximately 30°F below the

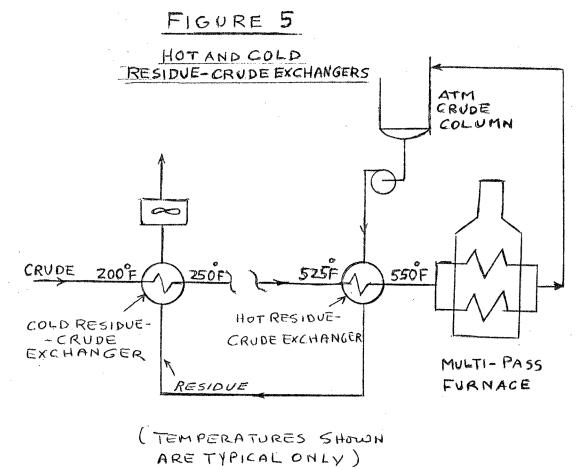


temperature of the ascending vapor at the withdrawal point. The return temperature should be such as to give a good mean temperature difference for transferring heat to crude while at the same time satisfying the internal heat removal requirements. The system selected should result in minimum cost for heat transfer trays, external heat transfer surface and pump, with capitalized pumping costs included.

If a top pumparound system is employed, it may well turn out to be the first preheat stream and to flow through the first exchanger in the train because of its relatively low temperature level. When a top pumparound system is not employed, the overhead condensing duty of the tower may be large. In such a case it may prove economical to employ a vapor heat exchanger to recover part of this heat by preheating crude. When using the model program, the duty for a vapor heat exchanger should be pre-established by the user. This is because the program relationships apply only to liquids, not to condensing vapors.

Another type of stream that may sometimes require special treatment is a "residue" or tower bottoms stream. The temperature of such a stream leaving a tower is invariably high and if the quantity is fairly large, the amount of associated heat available for preheating the crude may be large. Because of the high temperature, such a stream will usually flow through the last exchanger in a preheat train. Frequently, the residual stream leaving this last exchanger will still contain too much high temperature level heat to be "thrown" to water. In using "preheat" in such a situation, the procedure would be to calculate a duty

for the last exchanger based on a reasonably good estimate of the final preheat temperature to be achieved. This hot stream should then be treated as a pumparound or fixed duty stream when supplying the necessary input data to "Preheat". The residue at the exit temperature from the "hot residue exchanger" should be entered as a separate variable duty stream. This stream will then transfer heat to the crude at a point in the train corresponding to the "Pseudo T" value calculated by the program. The program will also carry out all the necessary calculations including the calculation of cooler surface, etc. Figure 5 shows a train with "hot" and "cold" residue exchangers. The figure also shows the crude from the "hot" residue exchanger flowing to a multi-pass heater. Most heaters, except small ones, are multi-Because of this, the crude should not be heated above its pass, bubble point at the heater inlet pressure, since instrumentation problems make it impractical to split a two-phase stream.



CHAPTER 5

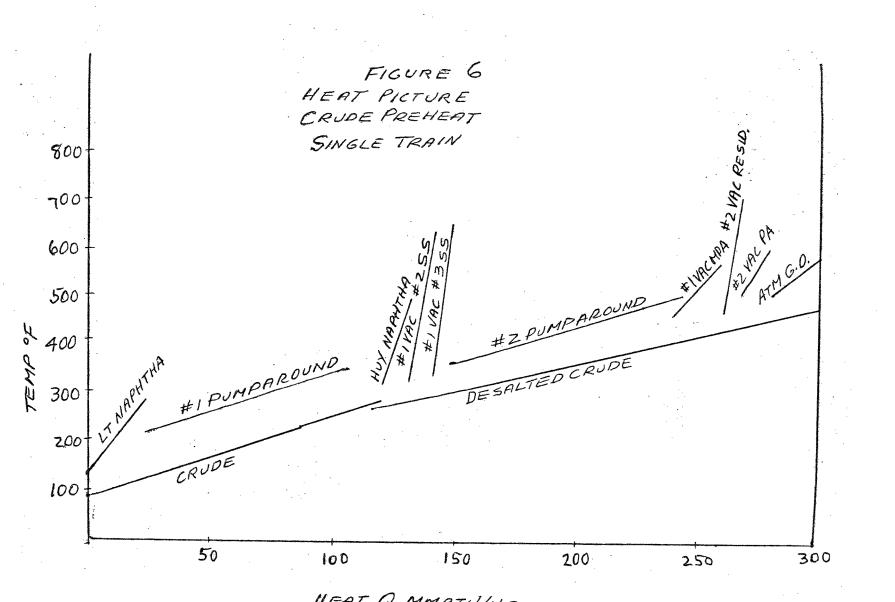
MODEL PROGRAM DESCRIPTION

The model program, entitled "Preheat", simulates a system of heat exchangers preheating the feed to a crude distillation unit. Two types of system are simulated. The first of these, designated "single train", is represented physically in Figure 1 of Chapter 1. Figure 6 gives a "heat picture", or thermal representation, of such a single train system.

The second type of system simulated is the split, or parallel, train. This is represented by the heat picture in Figure 7. The split occurs after the crude flows from the desalter. The crude is divided into two equal parallel streams, each of which is then heated by an individual set of heating streams. The program selects the heating streams for each set in such a way that the two parallel streams receive approximately equal amounts of heat. The parallel trains are called the "A Train" and the "B Train" respectively. The heat loads for the "A" and "B" trains are represented in Figure 7.

The crude stream is not usually split upstream of the desalter, primarily because much of the heat absorbed up to that point is generally supplied by a low temperature, high heat capacity stream, for example an atmospheric top pumparound stream or an atmospheric tower overhead vapor stream. Such a stream can exchange heat efficiently with the whole crude stream.

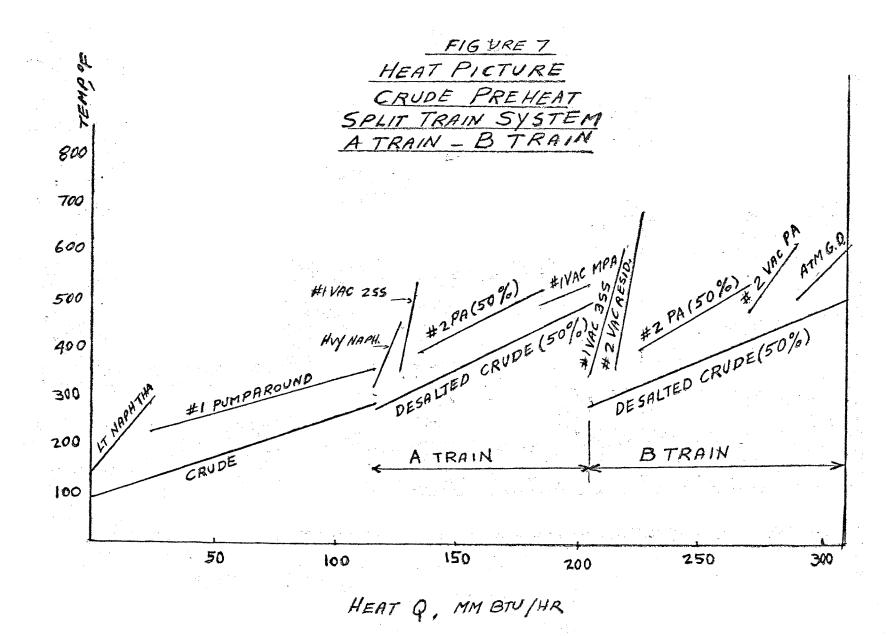
The heat pictures show how each variable-duty heat stream



HEAT Q MMBTU/HR

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exchanges heat with the crude until the specified temperature approach is reached. The pictures also show that more heat can be transferred from the heating streams to the crude as the heattemperature lines representing the heating streams tend to parallel the heat-temperature line (or curve) of the crude. This is not only true for individual exchangers, but applies to the relative arrangement of exchangers in a train as well.

The model program may be considered to represent heat exchanger trains mathematically in much the same way that heat pictures, such as Figures 6 and 7, represent them graphically. The order in which the individual exchanger calculations are to be performed is determined by the program. This corresponds to determining the order in which the exchangers should be arranged physically. Then the calculations corresponding to the transfer of heat are carried out, with the temperature rise of the crude being determined in each exchanger. In the case of the variableduty heating streams, the duty corresponding to the specified temperature approach (to crude) must be calculated, wThis is not required for fixed-duty heating streams.

Detailed information relative to preheat is given in Appendices A, B and C. Appendix A describes the program's features, defines its variables and gives detailed instructions for its use. Appendix B contains the statement list for the program and gives results for three sample problems. Appendix C covers the selection of economic temperature approach values by Ten Broeck's method.

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CHAPTER 6

CONCLUSIONS

Some conclusions based on results obtained using "Preheat" are discussed in this chapter. More definite conclusions as to practical selection of economic temperature approach values and the type of preheat system to be employed, whether single or split train, can better be made after further use of the program.

As to evaluation of an optimum temperature approach, computer runs were made for a sample problem, corresponding to a single train system, using the same temperature approach value for each "variable duty" exchanger in each run. The data for this sample problem were essentially the same as for sample problems #1 and #2 in Appendix B. Three runs were made with the approach (or temperature difference) having values of 30, 40 and 50°F. Comparative heat duties as well as fuel and equipment costs are shown in Table 3. The "total equivalent incremental equipment cost" listed in the table equals the incremental equipment costs plus the incremental utility costs for a "payout" period of three years (before taxes). Incremental costs for the three cases were plotted versus temperature approach. The curve plotted in Figure 8 indicates that a 40° approach gives the lowest cost for the case investigated. The results in this example are not particularly sensitive to the value of the approach used for for the variable duty exchangers, due to the large amount of "fixed duty" heat associated with the pumparound streams in the

TABLE 3

APPROACH ECONOMICS FOR SINGLE TRAIN EXCHANGERSYSTEM. OPTIMUM APPROACH IF SAME VALUE USED FOR ALL VARIABLE DUTY EXCHANGERS

		APPROA	CH °F
	<u>30</u>	<u>40</u>	50
Exch. Duty MMBTU/Hr	77.29	76.12	74.95
Incremental Exchanger Duty MMBTU/Hr	2.34	1.17	0.0
Incremental Heater Duty MMBTU/Hr	0.0	1.17	2.34
Incremental Fuel Cost for 3 years - \$	0.0	12,700	25,400
Surface Cost - \$	334,000	314,800	249,600
Incremental Heat Cost, \$ @ \$3.00/1000 BTU/Hr Capacity	0.0	4,700	9,400
Total Equipment Cost, \$	334,000	319,500	309,000
Incremental Equipment Cost, \$	25,000	23,200	25,400
Total Equivalent Incremental Equipment Cost, \$ (including 3 yrs Fuel Cost)	25,000	23,200	25,400

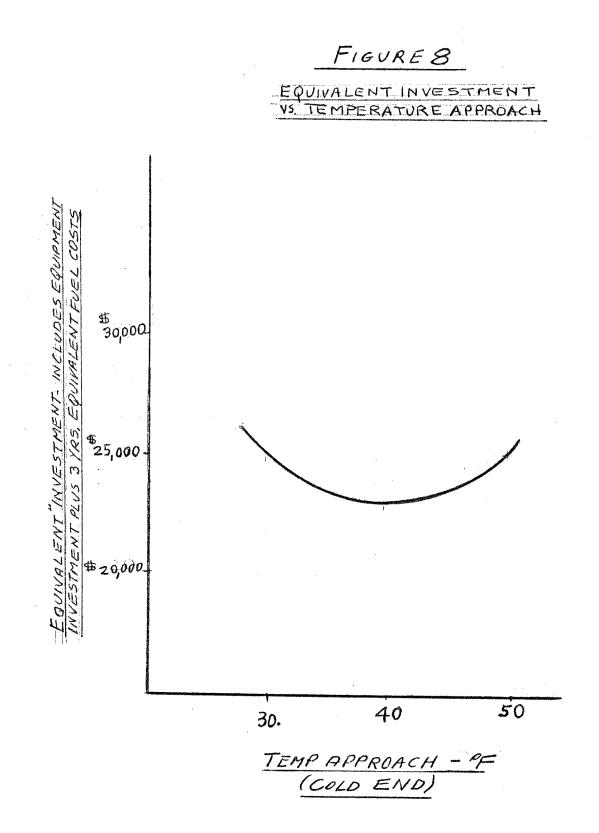
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1) See Figure 8 for plot of results.

2) Basis - 3 yrs. of fuel savings (before taxes)

•	3 yrs Ed	quiv. Fuel	Cost =	<u>1.17 MM</u> × 0.33 \$/MM × 3 yrs.
				.75 Effy x (8750 x .93) Hrs/Yr. =
		•		\$12,700



preheat train. This will be true of many preheat trains.

To further investigate the subject of temperature approach, two more computer runs were made for a single train exchanger system. The results appear as the output for sample problems #1 and #2 in Appendix B. The arrangement of the exchangers in the train differed slightly from that on which the calculations of Table 3 were based. One run was made using a 40°F temperature approach for each variable duty exchanger (sample problem #1 in Appendix B.) For the other computer run the temperature approaches used for the variable duty exchangers were 60°F, 50°F, 30°F and 20°F, with the lower values being used for the hotter exchangers (Sample problem #2 in Appendix B). Comparative heat duties as well as fuel and equipment costs are shown in Table 4.

It will be noted that the incremental cost for the "varied approach" case is less than for the "40°F approach" case. However, the difference of approximately \$2,000 is so small as to be almost insignificant, representing only about 0.6% of the total actual equipment cost.

As to the economics of a split train system (following the desalter) versus a single train system, it has been thought that the split train system is more economical where large capacity crude units are involved. However, the results of sample problem #3 in Appendix B, as summarized in Table 5, show a yearly return of but 7% on the incremental investment required for the split train system. Use of a split train system is certainly not justified for the case on which this sample problem was based. The crude

TABLE 4

APPROACH ECONOMICS FOR SINGLE TRAIN EXCHANGER SYSTEM

COMMON APPROACH VALUE VS. VARIED APPROACH VALUES FOR VARIABLE-DUTY EXCHANGERS

	Single Value 40°F	Varied Values 60-20°F
Exch. Duty, MM BTU/Hr	73.2	.73.5
Incr. Exch. Duty, MM BTU/Hr	0	0.3
Incr. Heater Duty, MM BTU/Hr	2.9	2.6
Incr. Fuel Cost for 3 yrs, \$	31,300	28,100
Surface Cost, \$	11,600	10,400
Incremental Heat Cost, \$, @ \$3.0/1000 BTU/Hr Capacity	248,930	251,220
Total Equipment Cost, \$	260,530	261,620
Incremental Equip. Cost, \$	• 0	1,090
Total "Equivalent" Incremental Equip. Cost (Includes 3 yrs Fuel Cost)	31,300	29,190

NOTES: 1) Basis: - 3 yrs Fuel Savings (Before Taxes)

3 yr. Equiv.	Fuel Cost	$= \frac{1.17}{0.75 \text{ Effy}}$	x 0.33 5 /MM x 3 yrs
		x (8750 x	.93) Hrs/Yr = \$12,700

unit in this case was a large one and the low return on investment raises considerable doubt as to whether many cases will arise in which a split train system would be justified.

TABLE 5

ECONOMIC COMPARISON OF SINGLE TRAIN VS. SPLIT TRAIN PREHEAT EXCHANGER SYSTEMS

	Single Train System	Split Train System
Exch. Duty MMBTU/Hr	305.11	307.0
Incr. Htr. Duty, MMBTU/Hr	1.89	0.0
Exch. Cost, \$	931,400	1,035,500
Cool Cost, \$	224,200	224,200
Total Surf Cost, \$	1,155,600	1,259,700

Yearly Savings @ HT Value of \$0.33/MM BTU/Hr.

Heat to Oil:

1.89 MM BTU/Hr. x \$0.44/MM Ht. x 8250 Hrs/Yr. = \$6,800/yr. Fired

% Annual Return on Incremental Equip. Investment:

\$1,259,700 - \$1,155,600 = \$98,100

\$6800/\$98,100 = 7.0%

APPENDIX A

- 1. Program Features
- 2. Program Variables
- 3. Program Instructions

APPENDIX A

1. Program Features

Some of the principal features of the program are enumerated and explained below.

a. Array of Heat Streams

Input and output data for the program are conveniently stored and handled in the form of an array. The various heat streams correspond to the columns of the array and there are fourteen of them. The various characteristics of each stream, or the calculated values for that stream, correspond to the rows of the array. There are eighteen of these rows. Thus, the subscripted variable HTSTR (I, J) represents any input or output value related to any of the preheat streams, where I can have any value from I to 18 and J any value from 1 to 14. For example, HTSTR (4, 4) would designate the °API of preheat stream #4.

The array is first printed to show input data: The streams have been rearranged at this point in ascending order of their "Pseudo T's". Other array positions not containing input data show "0.0" at this point. After the preheat calculations have been carried out and the significant results have been stored in their proper positions, the array is again printed, this time showing not only the input data but all the pertinent output data as well. Of course provision had to be made for the fact that in some cases there will be more output streams than input streams. This happens, for example, when one of the heating streams must be split into hot and cold streams to bring the crude to the re-

quired desalting temperature. The lower temperature stream heats the crude to its desalting temperature, while the higher temperature stream exchanges heat with the crude leaving the desalter. b. Rearrangement of Heat Streams

Heat streams need not be arranged in any particular order when being submitted as input. The program will rearrange the heat streams in the proper order in accordance with their "heat transfer potential" called "Pseudo T" and defined by formula in the list of Program Variables. This formula is somewhat empirical but appears to give satisfactory results. However, a variable has been included in the program which permits the formula to be "adjusted". For further flexibility, provision has been made so that heat streams can be submitted in any desired order and not be rearranged, i.e. the preheat calculations will be carried out with the heating streams supplying heat to the crude in predetermined sequence. This feature might be desirable if, for example, the amount of heat available from one stream, say the crude residue, were large, and it was decided to "split" the duty between two exchangers, the high temperature exchanger presumably being the last in the train, and the low temperature exchanger located at any desired point in the train but at a lower crude temperature level.

c. Suitability to Crude Unit Preheat

While the program could quite easily be adapted to other types of preheat systems, it is specifically intended for a crude distillation unit. Crude units almost always include an electrolytic desalter as discussed in Chapter I. The desalting process

should take place at a rather specific temperature, related to the nature of the crude but usually approximating 260°F. The program takes this problem into account and proportions the heat exchanger duties so that the required desalting temperature is obtained between exchangers. The program also assures that the duties of the exchangers immediately upstream and downstream of the desalter are of suitable magnitude, that is not too small to be practical. A crude temperature rise requirement of at least 10°F provides for this. Furthermore, the program provides for the fact that a temperature drop occurs when the crude flows through the desalter. The temperature to the next exchanger is 5-10°F lower than that from the preceding exchanger. Quite often a flash drum is included in a preheat train, sometimes in addition to, and sometimes instead of, a desalter. The quantity and temperature of the crude will usually change when flowing through a flash drum and the program is also sufficiently versatile to take this into account.

d. Types of Preheat Streams

There are two principal types of preheat streams. Sidestreams withdrawn from the tower exchange heat with the crude in the order of their heat transfer potential, and down to a temperature corresponding to an "economic" cold end approach. This temperature approach is a function of fuel cost, exchanger cost, etc. and is to some extent related to the heat transfer characteristics of the other streams from which heat may be transferred. Usually, however, this optimum approach is fairly constant over a considerable range in the value of the above factors. A value of 40°F is

frequently satisfactory in cases where fuel and exchanger costs are "normal". Streams of this first type may be designated "variable duty" streams.

Streams of the second type may be designated "fixed duty" streams. Tower pumparound streams are the principal examples of this type of stream. For such streams, outlet exchanger temperatures and heat duties are supplied to the program as input data, rather than calculated as with product streams. If, as is sometimes the case, a vapor heat exchanger is used to preheat crude, it should be treated as a pumparound stream, and a "I" should be placed in the proper position to designate it as such.

e. Parallel Trains

When dealing with small or medium sized crude units, all the exchangers providing heat to the crude are usually arranged in series for the sake of simplicity and to avoid inclusion of exchangers that might be somewhat too small to be economical. When dealing with large units however, say 100,000 BPSD (barrels per stream day) or more, it has been found advantageous to split the crude into two parallel streams immediately downstream of the desalter. This arrangement makes it possible to preheat the crude to higher temperatures than would otherwise be possible. The program makes provision for this. The program user can specify that the calculations be performed and results printed for a single train system only; or he can specify the run be made for a parallel train system. In the latter case, not only will the single train calculations be performed and printed, but the program will continue on through the calculations for a system with parallel trains

of exchangers downstream of the desalter (trains "A" and "B"). The results for both systems will be printed and comparison can be made of the final preheat temperatures, amounts of exchanger and cooler surface, and the relative costs of such surface.

f. Temperature Approach

An individual value for "cold end" temperature approach must be entered for each variable duty heating stream. The need for achieving an optimum preheat system made it seem advisable to make provision for using "varied" approach values.

g. Subroutine "SPHT"

A subroutine entitled "SPHT", is incorporated in the program. Every time a heat exchanger duty, cooler duty, or change in temperature is calculated, a specific heat value must be employed that is correct for the particular temperature range involved. The subroutine calculates the specific heat value as a function of temperature and the °API of the fluid undergoing the temperature change. There are three cases for which the subroutine must determine a specific heat value. The simplest is when two temperatures are known and can be given as arguments, along with the °API of the liquid. The second is when the heat duty and the hotter temperature, along with the °API, are the arguments. The third is when the duty and colder temperature (again with the °API) are the arguments. For the latter two cases, the subroutine performs a trial and error type of calculation, in which the second trial gives a sufficiently accurate specific heat value. In the first case, with both temperatures known, the specific heat can be calculated directly.

APPENDIX A

2. Program Variables

The variables used in "Preheat" are defined as follows: HTSTR (1, J) - This array is used for storing input and output data associated with the various streams available for preheating crude. "J" represents a particular preheat stream while "I" represents either an input value or a calculated value for that stream. "J" can be any number from 1 to N, where N is the value read into the computer representing the number of heat streams. "I" is any of 18 values associated with each stream, either as input or calculated. The various "I" variables are as follows:

HTSTR	(1,	J)		Stream Name, alpha meric 3 words totalling 10
HTSTR	(2,	J)	ý	characters used for each name
HTSTR	(3,	J)	5	
HTSTR	(4,	J)	-	Specific gravity as °API
HTSTR	(5,	J)	-	quantity of heat stream, lbs/hr.
HTSTR	(6,	J)	-	inlet (hot) stream temp., °F.
HTSTR	(7,	J)	ends	temp. of stream from "system", °F.
HTSTR	(8,	J)		either "O" or "I". If a "I" is entered

then the stream is a pumparound stream with a fixed amount of heat to be transferred. If a "O" is entered, then the stream is not a pumparound and the amount of heat to be exchanged must be calculated, primarily as a function of the "cold end" atemperature approach to the crude entering the heat exchanger.

HTSTR (9, J) - Exchanger Duty - BTU/hr.

HTSTR (10, J) - Temperature of heating stream from exchanger, F.

HTSTR (11, J) - Temperature of crude leaving exchanger

HTSTR (12, J) - Cooler duty, BTU/hr.

HTSTR (13, J) - Pseudo, T, °F.

- Pseudo T is the name given to an empirical function that is regarded as indicative of the heat transfer potential of a heating stream. The program causes the streams to be rearranged, in ascending order, in accordance with the calculated Pseudo T values, before the preheat calculation proceeds. The Fortran formula employed is:

HTSTR (13, J) = HTSTR (6, J) - (FACT*CRLB/HTSTR (5, J) or Pseudo T = t_1 - (FACT × $\frac{W}{W}$)

The value recommended for the factor employed (FACT) is 10.0. If experience should indicate it to be desirable, a different factor can be introduced as input data to alter the order in which the streams exchange heat with the crude.

> HTSTR (14, J) - Exchanger heat transfer surface, sq.ft. HTSTR (15, J) - cooler heat transfer surface, sq.ft. HTSTR (16, J) - Exchanger Cost, \$ HTSTR (17, J) - Cooler Cost \$ HTSTR (18, J) - "Approach" - The "cold end" temperature

approach to be used for the heating stream. No value is entered for a pumparound stream.

N - number of heating streams.

MODE - either "]" or "2" must be read into MODE. If "]", calculations are made on a single train arrangement only. If "2", the calculations are first made for a single train and then for a parallel train arrangement so the results can be compared.

IFFL - either "1" or "0" must be entered under IFFL. If "1", the presence of a flash drum in the train is indicated and the quantity of flashed crude leaving the flash drum and its temperature and specific gravity must be included as input data. If "0", there is to be no flash drum and consequently no flashed crude data is provided as input.

NOAR - either "1" or "0" must be read into "NOAR". If "NOAR" is 0 (considered the more usual case) the streams will be rearranged in order of ascending "Pseudo T" values. If "NOAR" is "1", the heat streams will not be arranged in ascending order in accordance with their "Pseudo T" values, but remain in the predetermined order in which their data is read into the array "HTSTR".

CRAPI	.	specific gravity of crude, °API.
CRLB		quantity of crude, lbs/hr.
CRTIN	-	temperature of crude to unit, °F.
TW I	-	temperature of cooling water to users, °F.
TW2		temperature of cooling water from coolers, °F.
FCRAPI	-	specific gravity of flashed crude, °F.
FCRLB	-	quantity of flashed crude, lbs/hr.
FCRTIN	-	temperature of crude from flash drum, °F.
DESALT		temperature of crude to desalter, °F.

TTOL - temperature tolerance, or allowable deviation from prespecified value of desalting temperature, °F.

FUCOST - cost of fuel, \$/MM BTU/hr.

ACOST - average cost of exchanger (and cooler) surface, \$/sq.ft.

UAV - average heat transfer coefficient for exchangers, and coolers.

PAYRS - number of years allowed for "paying off" an investment, years.

DROP - drop in crude temperature from desalter inlet to outlet, °F.

ECAP - economic "cold end" temperature approach between heating stream leaving and exchanger and crude entering the exchanger, °F.

CP - specific heat, BTU/lb/°F.

DELT - temperature difference, °F.

NB - number of exchangers before desalter.

NAFT - the number of the first exchanger after the desalter. NAFT will equal NB + 1.

MAFT - number of exchangers following desalter in single train.

NEWN - number of heating stream after split at desalter and/or after division a large heating stream into 2 parallel streams with parallel trains.

FACT - factor to be employed in formula for calculating

XMTD - log mean temperature difference for exchanger or cooler, °F.

DELTH - hot end temperature difference for exchanger or cooler, °F.

DELTC - cold end temperature difference for exchanger or cooler, °F.

SPLIT _ "split" is to contain "l" if a stream is split to provide heat downstream as well as upstream of desalter. "O" in split means no such "split" occurs.

SUM 9 - sum of exchanger duties, BTU/hr. SUM 14 - sum of exchanger surfaces, sq. ft. SUM 15 - sum of cooler surfaces, sq. ft. SUM 16 - sum of exchanger costs, \$ SUM 17 - sum of cooler costs, \$ A(I,J) - A train array (lst parallel train). B(I,J) - B train array (2nd parallel train). SUMA - sum of heat duties of A train exchangers. SUMB - sum of heat duties of B train exchangers. DIF - DIF = SUMA - SUMB. - increase in temperature of crude in exchangers. RISE NAT - number of exchangers in A train. - number of exchangers in B train. NBT

BARCH HAFCR - quantity of crude lbs/hr. thru each of Trains A & B. SALT - temperature from desalter (DESALT - DROP).

Subroutine Variables

T]	- high temperature
Т2	- lower temperature
Q	- duty, BTU/hr.
XLB	- stream quantity, lbs/hr.
COUNT	- number of iterations (0 to 1).
ΑΡΙ	- Specific gravity, °API.

APPENDIX A

3. Program Instructions

Data cards must be prepared and placed in back of the program deck in the usual manner. As discussed under "Features", the input data associated with the heating streams and all the results considered significant for output are stored in the array named HTSTR (I, J) where variable "J" represents the streams providing heat to the crude and variable "I" represents values associated with the stream. "I" may represent a property such as "API or the quantity in lbs/hr.; or it may represent a calculated result such as the temperature of crude from the exchanger or the duty of the exchanger corresponding to the heat stream. The other input data to be provided is specified in the description of the individual cards which follows:

Data Card 1 - "Integers"

All the variable values for this card must be entered as integers, right justified.

Columns	Variable Name
1 - 2	N, number of heating streams entered here.
3 - 4	MODE - enter ''l'' for a single stream exchanger
	system and "2" if both a single stream arrange-
	ment and a parallel stream arrangement are
	desired.
5 - 6	IFFL - enter "1" if a flash drum is to be
	included at some point in the heat exchanger

train and "O" if no such drum is included.

Columns

Variable Name

NOAR - enter "1" if the heating streams are to remain in the order in which they are entered on the input data card and "0" if (as would be usual) the program is to rearrange the streams in ascending order of their "Pseudo T's".

Data Card 2 - Crude Data

All the variable values punched on this card as to decimals (floating point).

Columns	Variable Name
1 ,- 10	CRAPI - specific gravity of crude, °API.
11 - 20	CRLB - quantity of crude, lbs/hr.
21 - 30	CRTIN - inlet crude temperature, °F.
31 - 40	TWI - inlet water temperature, °F.
41 - 50	TW2 - exit water temperature, °F.
51 - 60	FCRAP I – specific gravity of flashed crude
	(if flash drum included), °API.
61 - 70	FCRLB - quantity of flashed crude, lbs/hr.
71 - 80	FCRTIN- temperature of flashed crude, °F.

Data Card 3 - Miscellaneous Data

Enter these variable values as decimals.

Column	Variable Name
1 - 10	DESALT - desalting temperature, °F.
11 - 20	TTOL - allowable deviation from desalting.
·	temperature (+ or -), °F.

Columns	Variable Name
21 - 30	FUCOST - cost of fuel, \$/MM BTU.
31 - 40	DROP - temperature drop of crude in flowing
	through desalter, °F.
41 - 50	UAV - average heat transfer coefficient for
	exchangers and coolers, BTU/hr/°F./ft.sq.
51 - 60	PAYRS - number of years for investment ''payback''
61 - 70	ACOST - Cost of exchanger and cooler surf,
	\$/ft. sq.
71 - 80	ECAP - economic exchanger "cold end" tempera-
	ture approach, °F (may or may not be
	entered).

Data Card 4 - Factor

Enter this variable as a decimal number in columns 1-10 of this card.

The usual value is 10.0.FACT is used by the program in the calculation of "Pseudo T" values for each heating stream.

Data Cards 5 and 6 - Stream Names - HTSTR (1-3, J)

Stream names are to be entered alphamerically in columns

Two cards must be included even though the second may be blank.

Data Cards 7 thru 2N + 6 - Input Data for Heating Streams

(N above equals the number of heating streams).

Enter this data as decimals. Two cards must be included for each stream even if the second is a blank.

lst Card

130 00		
	Columns	Variable Name
	1 - 10	HTSTR (4, J) - specific gravity of heating
		stream, °API.
	11 - 20	HTSTR (5, J) - quantity of heating stream,
		lbs/hr.
	21 - 30	HTSTR (6, J) - inlet temperature of heating
		stream, °F.
	31 - 40	HTSTR (7, J) - temperature of heating stream
	, '	leaving cooler, °F. (enter "O" if stream is
		a pumparound stream).
	41 - 50	HTSTR (8, J) - enter ''l' if stream is a pump-
		around stream (with "fixed" duty). Enter a
		"O" otherwise.
	51 - 60	HTSTR (9, J) - enter duty, BTU/Hr, if stream
		is a pumparound stream. Otherwise leave blank.
,	61 - 70	HTSTR (10, J) - Enter temperature of stream
		leaving exchanger in case of a pumparound (fixed
		duty) stream. Otherwise leave blank.
	71 - 80	To be left blank.
<u>2nd Ca</u>	rd	
	1 - 60	To be left blank.
	61 - 70	HTSTR (18, J) - leave blank if the stream is a
		pumparound (fixed duty) stream. Otherwise enter
	:	the "cold end" temperature approach for the ex-
		changer.

Column

Variable Name

71 - 80 To be left blank.

Data Cards 2N + 7 thru 34

Include enough blank cards to bring the total number of data cards to 34. This will introduce "0.0's" into the array in the positions where no stream values would otherwise be introduced, which is desirable when the array is written out.

Sample Input

The data input form which follows is included as an example only. The data shown corresponds generally to the input data for sample problems #1 and #2 included in Appendix B.

Output

Input data printed on the <u>first</u> output page for convenience includes data on the crude stream and on the flashed crude stream, if flashing occurs. Other data used on heat balances and economic calculations, such as desalting temperature, cooling water temperatures, fuel cost, etc., are also printed.

On the <u>second</u> page is printed the heating stream array showing all the input data provided relative to these streams. The streams appear as rearranged in order of ascending "Pseudo T" values rather than in the order in which they were "read in" (unless NOAR = 1, in which case no rearrangement occurs).

The heating stream array for a single train arrangement is always printed on the <u>third</u> output sheet. The order of the streams will be the same as on the preceding sheet, but it will be observed that calculated values for each stream, such as exchanger duty, cooler duty, etc., now appear in place of the previously printed "O" values. The calculated temperature of the crude leaving each exchanger in the train is also printed.

It should be noted that the streams are identified as pumparound streams if a "l" appears in row "PA?". Calculated values of "Pseudo T" are also printed.

In the event the programmed calculations result in the splitting of one of the heating streams into a cold stream and hot stream, to achieve the required desalted temperature, the two streams are printed in sequence. The temperature of the crude from the "cold" stream represents the temperature to the desalter (DESALT). The "hot" stream will heat the crude further in the stream immediately following the desalter (or following a flash drum should one be included in the system). Below the single train heat stream array are printed totals for the combined exchanger duties, exchanger surfaces, cooler surface, etc., for the entire single train arrangement.

If operating MODE 'l" was specified in the input data, then only the single train calculations are made and this third sheet will be the last sheet of output data.

Fourth and fifth output sheets are printed if the program proceeds according to MODE "2". In this case, after the single train crude preheat calculations have been completed and printed, the program continues on to perform calculations for a "split" train. The crude stream leaving the desalter is split in half. If the duty of any of the heating streams is found to be large (i.e. sufficiently large to heat the crude as much as 60°F), that

stream also is split in half to give two heating streams. The resulting heating streams are arranged in order of their "Pseudo T" values in the heat stream array. Next, the heat streams are arranged in two "parallel" arrays called "A" and "B". Array "A" will thus be comprised of alternate streams from the HTSTR array, starting with the first heat stream after the desalter and continuing on through the array, using the 3rd, 5th, etc. streams after the desalter. Array "B" will similarly be comprised of the 2nd, 4th, etc. streams after the desalter. After the calculations to preheat the two (half quantity) crude streams have been performed, using the heating streams in array, "A" and "B" respectively, the amount of heat transferred is summed up for each of the trains, and the sum compared. If the totals differ by more than the amount of the last exchanger duty of the array with the higher duty summation, then that stream is transferred to the other array to make the two summations nearly equal.

On the <u>fourth</u> output sheet, the heat streams preceding the desalter are printed out, for convenience, with all their input: and calculated values appearing. On the <u>fifth</u> output sheet are printed the newly formed "A" train and "B" train arrays. In addition, values for the total exchanger duty, total exchanger and cooler surfaces, and total exchanger and cooler costs which have been calculated by the program, are also printed out for ease of comparison with the corresponding values for the previously calculated single train arrangement.

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APPENDIX B

- Program Statement List for "Preheat". All the statements comprising the main program and for Subroutine "SPHT" are listed. Comment cards are included to aid in following and using the programs.
 - 2. Explanation of Output for Sample Problems.
 - Output for Sample Problem #1. Single Train System with 40°F approach for variable duty exchangers.
 - 4. Output for Sample Problem #2. Single Train system with varied temperature approach values for variable duty Exchangers.
 - 5. Output for Sample Problem #3. Single Train and split train systems with 40°F approach for variable duty exchangers.

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	0003			CIMENSION 8(19,7)	
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-	0005		1	FORMAT(412)	. 1
1	-006			READ(1,5)CRAP1, CRLB, CRTIN, TW1, TW2, FCRAP1, FCRLB, FCRTIN	
: 	C007		2	FORMAT (8F10.0)	
***	8100			READ(1,5)DESALT,TTOL,FUCOST,ACOST,UAV,PAYRS,DRUP,ECAP	
	0009			READ(1,5)FACT	
	- <u>CO10</u>		2	READ(1,211(HTSTR(1,J),1=1,3),J=1,14) FORMAT(8(2A4,A2)/6(2A4,A2))	
	<u> </u>		.	FURMAI(B(ZA4,AZ)/O(ZA4,AZ)) READ(1,4)(((TSTR(1,J),T=4,19),J=1,14)	
	0012		i.	FORMAT(8F10.0/8F10.0)	
				*RTE(3,105)	••••••••••••••••••••••••••••••••••••
	C014		105	FORMAT('1'//55X,'OUTPUT SHEET 1'//55X,'HISC. INPUT DATA'/)	
	$-\frac{0019}{-0016}$	emploteere		KRITE(3,106)CRAPT, CRLD, CRTIN	
	0017		106	FORMAT(3X, 'CRUDE DATA', 5X, 'API=', F4.1, 5X, 'LBS/HR=', F10.0, 5X,	
				L+IN TEMP=*,F4.0/)	
-	0018		r.a. *	WRITE(3,107)FCRAPI,FCRLB,FCRTIN	
4.0-10 4 00-40	-0019-			FORMAT13x, *FL.CRUDE DATA*, 5X, *API=*, F4.1, 5X, *LBS/HR**, F10.0,	
				15X, IN TEMP= ', F4.0/)	
				wktTet3,104)DESALT,TTOL,ACOST,UAV,DRUP	-
	0021			FORMAT(3X, 'TEMP TO DESALTER=', F4.0, 5X, 'TEMP TOL=', F4.1, 5X,	
				1+SURF_CUST=+,F4.1,5X,+UAV=+,F4.1,5X,+DESALTEK_TEMP_DROP=+,F4.1/)	
			C WRI	TE OUTPUT SHEET 1 SHOWING MISCELLANEOUS INPUT DATA	
	-0022		-	wRITE(3,131) N, MCDE, IFFL, NOAR, TW1, TW2, FACT	
	0023	·. /		FORMAT(3X, 'N=', 12, 5X, 'MODE=', 12, 5X, 'IFFL=', 12, 5X, 'NOAR=', 12, 5X,	
iotana terra		******		1*TW1=*,F4.0,5X,*TW2=*,F4.0,5X,*FACT=*,F4.1/)	
			C CAL	C PSEUDO T FOR EACH STRM	
	0024			DU + J=1, N	-
	C025		6	HTSTR(13,J)=HTSTR(6,J)-(FACT*CRLB/HTSTR(5,J))	
Anna Anna Anna Anna Anna Anna Anna Anna		,		CIMENSION TEMP(19)	
	C027			IF (NCAR) 113, 112, 113	· · · · · · · · · · · · · · · · · · ·
				ANGE STMS IN ORDER OF ASCENDING PSEUDO T*S	
	C028	 	110	¥=N-1	
	0029	General		-00 8 J=1,M	
-	C030				
	0032		· · · · · · · · · · · · · · · · · · ·	- CO 8 K=L,N IF(HTSTR(13,J)-HTSTR(13,K))8,8,7	4
-	0032 .			1+(HISIR(13,J)-HISIR(13,R))8,8,7 CO 9 1=1,19	A.S. 51000000000000000000000000000000000000
	C034			TEMP(1) = HTSTR(1,J)	
	<u>- 0034</u>			TEMP(1)=HISIK(1,J) -HTSTR(1,J)=HTSTR(1,K)	
7	0036		(HTSTR(I,J) = HTSTR(I,K)	
		 		CONTINUE	
				TE REARRANGED HTSTR ARRAY WITH INPUT DATA AS DUTPUT SHEET 2	
				TE REARRANGED HISTR ARRAT WITH INPUT DATA AS DUTPUT SHEET 2	
	0039			write(3,108)	
: Manana				FORMAT(+1+//55X,+OUTPUT_SHEET_2+//)	۰ موسین کار استان می از این از این از این
	VV			TURNALL TYJJAT UUTUT UNEET E TTT	
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FORTAMA LY G LEVEL 18 MAIN DATE = 71011 12/20/24 PAG 0041 kRITE(3,40) C042 kRITE(3,40) C044 kRITE(3,40) C045 kRITE(3,41) (HTSTR(1,3),3=1,4),1=4,10 C046 kRITE(3,42) (HTSTR(1,3),3=1,4),1=4,10 C047 kRITE(3,42) (HTSTR(1,3),3=1,4),1=4,10 C047 kRITE(3,42) (HTSTR(1,3),1=3,1,4),1=4,10 C047 kRITE(3,42) (HTSTR(1,3),1=3,1,4),1=4,10 C047 kRITE(3,42) (HTSTR(1,3),1=3,1,4),1=4,10 C047 kRITE(3,42) (HTSTR(1,3),1=3,1,4),1=4,10 C047 kRITE(3,42) (HTSTR(1,3),1=3,1,4),1=4,10 C047 kRITE(3,42) (HTSTR(1,3),1=3,1,4),1=4,10 C047 kRITE(3,42) (HTSTR(1,3),1=3,1,4),1=4,1=1,1=1,1=1,1=1,1=1,1=1,1=1,1=1,1=1	E 000
C042 NR1[E(3,43)(tHTSTR(1,J),J=1,K),J=1,K) C043 NR1[E(3,43)(tHTSTR(1,J),J=1,K),J=5,K),J=5,K1 C044 [F(N=71)10,L1(F)TR(1,J),J=1,K1,J=5,K1] C045 [IL RATE[3,45] C046 RK1[E(3,43)(tHTSTR(1,J),J=1,41,J=5,K1] C047 NR1[E(3,43)(tHTSTR(1,J),J=1,41,J=5,K1] C047 [IL C3,45](L0,K),L0,K7,T1,L0,K1,Z*,T0,K,4*,T1, C047 [IL C3,45](L0,K),L0,K7,T1,L0,K1,Z*,T0,K,4*,T1,L0,K,4*,	E 000
0043 RTTE(3,4)1((HTSTR(1,J),J=1,K,1=4,18) 0044 (F(H*1110;TIT) 0045 III RTTE(3,43)((HTSTR(1,J),J=4,14),1=4,18) 0047 RTTE(3,43)((HTSTR(1,J),J=4,14),1=4,18) 0047 RTTE(3,43)((HTSTR(1,J),J=4,14),1=4,18) 0049 (100,H)=5,43)((HTSTR(1,J),J=4,14),1=4,18) 0049 (100,H)=5,43)((HTSTR(1,J),J=4,14),1=4,18) 0050 (4) FORM(155X, *1510)(HTSTR(1,J),J=4,14),1=4,18) 0050 (4) FORM(15X, *1510)(HTSTR(1,J),J=4,14),1=4,18) 0050 (4) FORM(15X, *1510)(HTSTR(1,J),J=4,14),1=4,18) 0050 (4) FORM(15X, *1510)(HTSTR(1,J),J=4,14),1=4,18) 0050 (4) FORM(15X, *1510)(HTSTR(1,J),10,*14,*10,*10,*10,*10,*10,*10,*10,*10,*10,*10	
C044 C045 111 kTE(1,45) C046 kTFE(3,45) ((MTSTR(1,J),J=5,14),I=4,14),I=4,18) C047 kTFE(3,45) ((MTSTR(1,J),J=4,14),I=4,18) C047 1100xf5,100xf6,10(KTSTR(1,J),J=4,14),I=4,18) C049 43 FORMATISSX,TSTROLE TRAINT/J00x7127X,T8,10X,T9,10X,T0T, C047 43 FORMATISSX,TSTROLE TRAINT/J00x7127X,T8,10X,T9,10X,T0T, C050 45 FORMATISSX,TSTROLE TRAINT/J00x7127X,T8,10X,T0T, C EXCLOREFUNCESALT C CHRC WHETHAG THE CRUCE THEP FROM EACH SUCCESSIVE EXCHANGER EQUALS THE DESALT C CHRC WHETHAG THE CRUCE THEP FROM EACH SUCCESSIVE EXCHANGER EQUALS THE DESALT C CHRC WHETHAG THE CRUCE THEP FROM EACH SUCCESSIVE EXCHANGER EQUALS THE DESALT C CHRC WHETHAG THE CRUCE THEP FROM EACH SUCCESSIVE EXCHANGER EQUALS THE DESALT C CHRC WHETHAG THE CRUCE THEP FROM EACH SUCCESSIVE EXCHANGER EQUALS THE DESALT C CHRC WHETHAG THE CRUCE THEP FROM EACH SUCCESSIVE EXCHANGER EQUALS THE DESALT C CHRC WHETHAG THE CRUCE THEP FROM EACH SUCCESSIVE EXCHANGER EQUALS THE DESALT C CHRC WHETHAG THE CRUCE THEFT FROM EACH SUCCESSIVE EXCHANGER EQUALS THE DESALT C CHRC WHETHAG THE CRUCE THEFT FROM EACH SUCCESSIVE EXCHANGER EQUALS THE DESALT C055 C ELT-WHISTRON FROM THE STRONG SUCCESSIVE EXCHANGER EQUALS THE DESALT C056 C ELT-WHISTRON FROM THEFT FROM EACH SUCCESSIVE EXCHANGER EQUALS THE DESALT C057 C T STRON FROM THE STRONG SUCCESSIVE EXCHANGER EQUALS THE DESALT C056 C ELT-WHISTRON FROM THE STRONG SUCCESSIVE EXCHANGER EQUALS THE DESALT C057 C ELT-WHISTRON FROM THE STRONG SUCCESSIVE EXCHANGER EQUALS THE DESALT STRONG SUCCESSIVE EXCHANGER EQUALS THE STRONG SUCCESSIVE EXCHANGER EQUALS SUCCESSIVE EXCHANGEN EXCHANGEN EXCHANGEN EXCHANGEN EXCHANGEN EXCHANGEN EXCHANCES THE C057 C ELT-WHISTRONG SUCCESSIVE SUCCESSIVE EXCHANGEN EXCHANG	
0046 KITE(13,4)I(HITSR(1,3),J=14,14),I=4,18) 0047 KRITE(13,4)I(HITSR(1,1),J=14,14),I=4,18) 0049 43 FORMATISSX,*SINGLE TRAIN//30X,*1*;10X,*3*,10X,*4*, 0050 45 FORMATISSX,*SINGLE TRAIN//30X,*1*;10X,*1*,10X,*10*, 0050 45 FORMATISSX,*SINGLE TRAIN(CMT0*/27X,*0*,10X,*10*, 0051 110X,*112*10X,*12*10X,*14*/1 0052 45 FORMATISSX,*SINGLE TRAINCONTO*/27X,*0*,10X,*10*, 0052 10 HITMER THE CRUDE TEMP FROM FACH SUCCESSIVE EXCHANGER EQUALS THE DESALT 0052 10 HITMER THE CRUDE TEMP FROM FACH SUCCESSIVE EXCHANGER EQUALS THE DESALT 0053 CALL SMTHHER THE CRUDE TEMP FROM FACH SUCCESSIVE EXCHANGER EQUALS THE DESALT 0054 HITMER THE CRUDE TEMP FROM FACH SUCCESSIVE EXCHANGER EQUALS THE DESALT 0055 10 HITMER THE CRUDE TEMP FROM FACH SUCCESSIVE EXCHANGER EQUALS THE DESALT 0056 CALL SMTHHER THE CRUDE HERSTR(10,1) HITSTR(10,1) HITMER (10,1) HIT	
0047 KRITE(3,4)1(HTSTR(1,J),J=8,14),[4,[4,[4,]) 0049 40 FORMAIT53X,*ISINGLE TRAIN#/J30X,*I*,10X,*2*,10X,*3*,10X,*4*, 110X,*5*,10X,*0*,10X,*7*/) 0050 45 FOUMAIT3X,*NAMEL*12X;*T(3A41) 0050 45 FOUMAIT3X,*NAMEL*12X;*T(3A41) 0050 45 FOUMAIT3X,*NAMEL*12X;*T(3A41) 0050 45 FOUMAIT3X,*NAMEL*12X;*T(3A41) 0050 45 FOUMAIT5X,*SINGLE TRAIN CONTO//27X,*8*,10X,*9*,10X,*10*, 1107,*12*,10X,*12*,10X,*14*/17 C EXECUS DEFOUE DESALT C CHECK WHETHER THE CRUDE TEMP FROM =ACH SUCCESSIVE EXCHANGER EQUALS THE DESALT— C CHECK WHETHER THE CRUDE TEMP FROM =ACH SUCCESSIVE EXCHANGER EQUALS THE DESALT— C CHECK WHETHER THE CRUDE TEMP FROM =ACH SUCCESSIVE EXCHANGER EQUALS THE DESALT— C CHECK WHETHER THE CRUDE TEMP FROM =ACH SUCCESSIVE EXCHANGER EQUALS THE DESALT— C CHECK WHETHER THE CRUDE TEMP FROM =ACH SUCCESSIVE EXCHANGER EQUALS THE DESALT— C COSS C CHL SPHI(HATSTR(4,1),HTSTR(4,1),HTSTR(10,1),0,0,0,0,CP) 0052 10 FISTR(10,1) =CRIIN*FISTR(11,K)+HTSTR(10,1),0,0,0,CP) 0055 DELT=HTSTR(4,1),13,14 0056 DELT=HTSTR(4,1),13,14 0060 I FUHTSTR(4,1),HTSTR(10,1)+HTSTR(10,1),0,0,0,CP) 0062 C ALL SPHI(HTSTR(4,1),HTSTR(10,1)+HTSTR(10,1),0,0,0,CP) 0064 14 CALL SPHI(CRAPI,0,CRUP) (MTSTR(10,1)+HTSTR(10,1)) 0064 14 CALL SPHI(CRAPI,0,CRUP) (MTSTR(10,1)+HTSTR(10,1),0,0,0,CP) 0065 DELT=HTSTR(4,1),HTSTR(11,K),HTSTR(10,1),CRUB,CP) 0066 C CELT=HTSTR(4,1),HTSTR(11,K),HTSTR(10,1),CRUB,CP) 0066 C CALL SPHI(HTSTR(11,1)+10,DESALT,0,PC,0) 0066 H SIGN (HTSTR(11,1)+10,DESALT,0,0,0,CP) 0070 C0 T0 12 0071 C0 T0 12 0072 19 NB-J 0072 (MTSTR(11,1)+DESALT 0076 CHICSTR HIT,JHEDSALT 0076 CHICSTR HIT,JHEDSALT 0076 CHICSTR HIT,JHEDSALT 0077 CHICSTR HITSTR(11,K),DESALT,0,,0,CP) C HEAN THE ALLOWABLE TULERADACE,THEN THE HEATING STRM WHICH PRODUCES THE 0076 CHICSTR HITSTR(11,K),HOELMET THE HEATING STRM WHICH PRODUCES THE 0077 CHICSTR HITSTR(11,K),HOELMET THE CRIGHAL EXCHES, EXCEEDS DESALT,IT-DUES-SO-BY C MORE THAN THE ALLOWABLE TULERADACE,THEN THE HEATING STRM WHICH PRODUCES THE 0079 HTSTR(9,J)=DUTYI 0079 HTSTR(9,J)=DUTYI 0079 HTSTR(9,J)=DUTYI	
00+0 40 FORMATISSX_1SINGLE_TRAIN*/30X,*1**10X,*2*,10X,*3**10X,*4**, 00+0 43 FORMATISSX_TNAME*13X,713A41) 0050 45 FORMATISSX_SINGLE_TRAIN CONTO//27X,*3**10X,*3**10X,*10*, 105X-11**10X,*12**10X,*12**10X,*14*/1 0050 45 FORMATISSX_TSINGLE_TRAIN CONTO//27X,*3**10X,*3**10X,*10*, 105X-11**10X,*12**10X,*12**10X,*14*/1 0050 45 FORMATISSX_TSINGLE_TRAIN CONTO//27X,*3**10X,*3**10X,*10*, 0051 10 FORMATISSX_TSINGLE_TRAIN CONTO//27X,*3**10X,*10*, 0052 10 FORMATISSX_TSINGLE_TRAINSTRAIN 0053 CALL_SPHTUM THE ALLONGLE TOLERANCE] 0054 HISTRI(3,1)+HISTR(4,1)+HISTR(10,1)+TSTR(10,1) 0055 11 CALL_SPHT(CRAPIAC,CRLB) 0056 DELTHISTR(1,1)+HISTR(1,1)+GPC+HISTR(10,1)+GTSTR(10,1) 0057 HISTR(1,1)+HISTR(1,1)+HISTR(1,1)+HISTR(10,1)+0,+0,-CP) 0058 12*2 0057 HISTR(1,1,1)+HISTR(1,1)+HISTR(10,1)+0,+0,-CP) 0066 14 FORMENTISTR(1,1,1)+FORM(1,1)+HISTR(10,1)+0,+0,-CP) 0066 14 CALL SPHT(CRAPIAC,0,+HISTR(1,1,1)+HISTR(10,1)+0,+0,-CP) 0066 HISTR(11,1,1)+HISTR(1,1,1)+HISTR(10,1)+1,0,+0,+0,+0,+0,+0,+0,+0,+0,+0,+0,+0,+0,+	
1107,157,102,107,107,177) 0044 35 FORMAT1357,173A471 0050 45 FORMAT1357,173A471 C EXCHS DEFORE DESALT C CHECK WHETHER THE CRUDE TEMP FROM TACH SUCCESSIVE EXCHANGER EQUALS THE DESALT C CHECK WHETHER THE CRUDE TEMP FROM TACH SUCCESSIVE EXCHANGER EQUALS THE DESALT C CHECK WHETHER THE CRUDE TEMP FROM TACH SUCCESSIVE EXCHANGER EQUALS THE DESALT C CHECK WHETHER THE CRUDE TEMP FROM TACH SUCCESSIVE EXCHANGER EQUALS THE DESALT C CHECK WHETHER THE CRUDE TEMP FROM TACH SUCCESSIVE EXCHANGER EQUALS THE DESALT C CHECK WHETHER THE CRUDE TEMP FROM TACK SUCCESSIVE EXCHANGER EQUALS THE DESALT C CHECK WHETHER THE CRUDE TO CHEARCE) 0052 10 FISTRIO,11=CRTINNHISTRIG(1)-HISTRIO,0,0,CP) 0053 C CLL SPHTINTSTRIG,1)*CP*HISTRIG(6,1)-HISTRI(10,1)) 0055 DELT=HISTRIG,1)*CP*HISTRIG(6,1)-HISTRI(10,1),0,0,CP) 0056 DELT=HISTRIG,1)*CP*HISTRIG(6,1)-HISTRI(10,1),0,0,CP) 0062 CALL SPHTICRAPIO,0,HISTRI(1)*K)+HISTRI(10,1),0,0,CP) 0064 14 FISTRIG(1)+HISTRIG(1)*CP*HISTRI(10,1),CLB,CP) 0065 DELT=HISTRIG(1)+SPHTIGRIG(1)*FISTRI(10,1),CLB,CP) 0066 C CALL SPHTICRAPIO,0,HISTRI(1)*K)+DELT 0066 C CALL SPHTICRAPIO,0,HISTRI(1)*K)+DELT 0067 C FITHISTRI(1),JHISTRI(1)*K)+DELT 0066 C CALT=HISTRI(1),JHISTRI(1)*K)+DELT 0070 C0 T0 12 0071 C0 T0 2 0072 19 RB=J 0072 19 RB=J 0072 19 RB=J 0072 C19 KB=J 0073 C19 KB=J 0074 CALL SPHTICRAPIONEDESALT100,10,0,CP) CIFWHEN THE ALLOWABLE TULERANCE,THEN THE HEATING STAM WHICH PRODUCES THE C HIGGRIFY THE ALLOWABLE TULERANCE,THEN THE HEATING STAM WHICH PRODUCES THE C HIGH THAN THE ALLOWABLE TULERANCE,THEN THE HEATING STAM WHICH PRODUCES THE C HIGH THAN THE ALLOWABLE TULERANCE,THEN THE HEATING STAM WHICH PRODUCES THE C HIGH THAN THE ALLOWABLE TULERANCE,THEN THE HEATING STAM WHICH PRODUCES THE C HIGH THAN THE ALLOWABLE TULERANCE,THEN THE HEATING STAM WHICH PRODUCES THE C HIGH THAN THE ALLOWABLE TULERANCE,THEN THE HEATING STAC	
0050 45 FQHMAT(55X,*5INGLE TRAIN CONTD*//27X,*0*,10X,*10*,	
110%,11+1;0%,-112*,10%,+13*,10%,+14*// C EXCNS BEFORE DESALT C CHECK HHER THE CRUDE TEMP FROM EACH SUCCESSIVE EXCHANGER EQUALS THE DESALT- C ING TEMP (HITHIN THE ALLOWABLE TOLERANCE) 0051 0052 10 + INTSTR(10,1)=CRT1N+TSTR(10,1) 0053 CALL SPHI(HISTR(4,1),HISTR(10,1)=HISTR(10,1)) 0054 0055 11 CALL SPHI(CRAP1,0,-CRF1N,HISTR(4,1),ISTR(10,1)) 0055 12 CALL SPHI(CRAP1,0,-CRF1N,HISTR(4,1),ISTR(10,1)) 0056 0057 HISTR(1,1)=CRT1N+NDELT 0058 0057 HISTR(1,1),ISTR(1,1),ISTR(10,1),0,0,0,CP) 0056 0057 HISTR(1,1),ISTR(10,1),ISTR(10,1),0,0,0,CP) 0061 13 HISTR(1,1),ISTR(10,1),ISTR(10,1),0,0,0,CP) 0063 0064 14 CALL SPHI(CRAP1,0,0,CHITSTR(11,1,1,1)=CREDIT 0064 15 HISTR(1,1,1)+INSTR(10,1),1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,	
C CHECK HHETHER -THE CRUDE TEMP FROM FACH SUCCESSIVE EXCHANGER EQUALS THE DESALT C ING TEMP KYTTHIN THE ALLOWABLE TOLERANCE) C051 110 TF HITSTR(0,1) 10,11 C052 10 HTSTR(10,1) =CRTINH/HTSTR(10,1) C053 CALL SPHT(HTSTR(5,1) >CPC(HTSTR(10,1)+0,0,0,CP) C054 HTSTR(10,1) =HTSTR(5,1) >CPC(HTSTR(10,1)+GTR(10,1)) C055 CHI CALL SPHT(HTSTR(4,1),1,GTR(4,1)+GTR(10,1)+0,0,0,CP) C056 DELT=HTSTR(0,1) 13,13,14 C056 J=2 C059 J=2 K=J=1 C050 IF (HTSTR(0,J) 13,13,14 C060 IF (HTSTR(0,J) HTSTR(11,K)+HTSTR(10,J),0,0,0,CP) C062 CALL SPHT(HTSTR(4,J),HTSTR(11,K)+HTSTR(10,J),0,0,0,CP) C064 IA CALL SPHT(CAPAI,0,0,HTSTR(11,K),HTSTR(10,J),0,0,0,CP) C065 CELT=HTSTR(4,J),J+HTSTR(11,K)+HTSTR(10,J),CRLB,CP) C066 IA CALL SPHT(CAPAI,0,0,HTSTR(11,K),HTSTR(10,J),CRLB,CP) C066 CELT=HTSTR(11,J)=CDESALTJ16,18,18 C066 IS IF (HTSTR(11,J)=10,-DESALTJ16,18,18 C066 IS IF (HTSTR(11,J)=10,-DESALTJ16,18,18 C070 G0 T0 L2 C071 IF (HTSTR(11,J)=DESALT C073 CALL SPHT(CAPAI,HTSTR(11,K),HESTR(0,J),CRLB,CP) C074 CH HTSTR(11,J)=DESALT C075 HTSTR(11,J)=DESALT C076 CALL SPHT(CAPAI,HTSTR(11,K),DESALT,0,0,CP) C IF WHEN THE CRUDE TEMP FROM THE CR(GINAL EXCHS, EXCEEDS-DESALT,11-DUES-SD BY C MORE THAN THE ALLOWABLE TOLERANCE, THEN THE HEATING STRM WHICH PRODUCES THE C HIGH TEMP IS SPLIT INTO THO HEATING, STREMS, C077 CUTY= LOSALT-HTSTR(11,K)+HTSTR(10,J)+HTSTR(19,J)+HTSTR(5,J),CP) C HIGH TAMP IS SPLIT INTO THO HEATING, STREMS, C077 CUTY= LOSALT-HTSTR(11,K)+OELT HEATING STREMS, C077 CUTY= LOSALT-HTSTR(11,K)+OELT HEATING STREMS, C077 CUTY=LOSALT-HTSTR(11,K)+OELT HEATING STREMS, C077 CUTY=LOSALT-HTSTR(11,K)+HTSTR(10,J)+HTSTR(5,J),CP)	
C ING TEMP (WITHIN THE ALLOWABLE TOLERANCE) C051 110 tr HHISTR(10,1)=CDRIN+FTSTR(18,1) C052 10 tr STR(10,1)=CDRIN+FTSTR(18,1) C053 CALL_SPHT(HTSTR(4,1)+HTSTR(16,1)-HTSTR(10,1)) C055 11 CALL_SPHT(CRAPI,0)-CRFIN+HTSTR(10,1)-CRED+CP C056 DET=HTSTR(1,1)+TSTR(10,1)+CRED+CRED C057 HTSTR(1,1)+TSTR(1,1)+TSTR(10,1)+CRED+CP C058 J=2 C059 12 K=J=1 C059 12 K=J=1 C060 IF (HTSTR(4,J))13,13,14 C061 13 HTSTR(10,J)+HTSTR(0,J)+HTSTR(10,J),0.,0,CP) C062 CALL_SPHT(HTSTR(4,J)HTSTR(6,J)+HTSTR(10,J),0.,0,CP) C063 TFSTR(4,J)+HTSTR(5,J)+CP*(HTSTR(6,J)+HTSTR(10,J),0.,0,CP) C064 14 CALL_SPHT(CRAP10,0.HTSTR(11,K)+HTSTR(10,J),CRED+CP) C065 CET=HTSTR(11,J)+HTSTR(5,J)+CP*(HTSTR(6,J)-HTSTR(10,J),0.,0,CP) C066 HTSTR(11,J)+HTSTR(11,K)+DELT C066 CET=HTSTR(11,J)+HTSTR(11,K)+DELT C066 HTSTR(11,J)+DCSALT116,18,18 C069 16 J=J+T C070 CG TO 12 C071 CG TO 12 C072 19 NB=J C074 AEW=NH1 C074 CALL SPHT(CRAP1,0.HTSTR(11,K)+DESALT,0.,0.,CP) C1F WFEN-THE CRUDE TEMP FROM THE CRIGINAL EXCHS, EXCEEDS DESALT,1T-DUES-S0-BY C MISTR(11,J)=DESALT C076 CALL SPHT(CRAP1,HTSTR(11,K)+DESALT,0.,0.,CP) C HIGH TEMP IS SPLIT INTT (11,K)+DESALT,0.,0.,CP) C HIGH TEMP IS SPLIT INTO THO HEATING STREM WHICH PRODUCES THE C HIGH TEMP IS SPLIT INTO THO HEATING STREMS; C 077 CALL SPHT(HTSTR(11,J)=DESALT,0.,0.,CP) C HIGH TEMP IS SPLIT INTO THO HEATING STREMS; C 077 CALL SPHT(HTSTR(11,K)+DESALT,0.,0.,CP) C HIGH TEMP IS SPLIT INTO THO HEATING STREMS; C 077 CALL SPHT(HTSTR(11,K)+DESALT,0.,0.,CP) C HIGH TEMP IS SPLIT INTO THO HEATING STREMS; C 077 CALL SPHT(HTSTR(11,K)+DESALT,0.,0.,CP) C HIGH TEMP IS SPLIT INTO THO HEATING STREMS; C 077 CALL SPHT(HTSTR(11,K)+DESALT,0.,0.,CP) C HIGH TEMP IS SPLIT INTO THO HEATING STREMS; C 077 CALL SPHT(HTSTR(11,K)+DESALT,0.,0.,CP) C HIGH TEMP IS SPLIT INTO THO HEATING STREMS; C 077 CALL SPHT(HTSTR(11,K)+DESALT,0.,0.,CP) C HIGH TEMP IS SPLIT INTO THO HEATING STREM	
6051 110 + 1+(HTSTR(H_1)+1)(0,10,1) 0052 10 + ISTSR(10,1)-CRTIN+HTSTR(10,1)+HTSTR(10,1)+0,0.,CP) 0053 CALL_SPHI(HTSTR(4,1)+HTSTR(4,1)+HTSTR(10,1)+0,0.,CP) 0054 HTSTR(10,1)+HTSTR(10,1)+GRLD,CP) 0055 11 CALL_SPHI(GRAP1,0,CRTIN+HTSTR(4,1)+GRLD,CP) 0056 DELTHTSTR(10,1)+CRCRLD 0057 HTSTR(11,1)+CRTIN+HTSTR(4,1)+HTSTR(4,1)+GRLD,CP) 0058 J=2 0059 12 + K=J=1 0050 ELTHTSTR(10,1)+HTSTR(10,1)+HTSTR(10,1),00.,CP) 0061 13 + HTSTR(4,1)+HTSTR(11,K)+HTSTR(10,1)+00.,CP) 0062 CALL SPHI(HTSTR(4,1),HTSTR(10,1)+HTSTR(10,1)) 0064 14 CALL SPHI(CRAPI,0,HTSTR(10,1)+HTSTR(10,1),CRLB,CP) 0066 TSTR(11,1,1)=HTSTR(11,K)+HTSTR(10,1),CRLB,CP) 0066 HTSTR(11,1,1)=HTSTR(11,K)+DELT 0067 CHTHTSTR(11,1)+10DESALT)16,1B,1B 0068 15 IF(HTSTR(11,1)+10DESALT)16,1B,1B 0069 16 - J=J+1 0071 GV T0 12 0072 19 KB=3 0073 MAFUJ+1 0074 KENN=N+1 0075 HTSTR(11,J)=DESALT 0076 CHTSTR(10,J)=DESALT	
0052 10 htthistr(10,1)=CRTIN+FISTR(10,1) 0053 CALL_SPHI(HISTR(4,1)+HISTR(10,1)+HISTR(10,1), CALB,CP) 0054 HISTR(9,1)=HISTR(5,1)=CP*(HISTR(10,1)+HISTR(10,1)) 0055 L1=CALL_SPHI(CRAP1,0,C+CRLB) 0057 HISTR(9,1)/1(CP*CRLB) 0057 HISTR(10,1)=CRTIN+HISTR(10,1), HISTR(10,1) 0064 13 0057 HISTR(4,1)/113, 13, 14 0061 13 0062 CALL_SPHI(HISTR(4,1), HISTR(10,1), HISTR(10,1), 0, 0, 0, CP) 0062	
0054 HTSTR(9,1)=HTSTR(5,1)=CP*(HTSTR(6,1)-HTSTR(10,1)) 0055 11 CALL-SPHI(GRAPI,0,:GRTIN,HTSTR(9,1),GREB,CP) 0056 DELT=HTSTR(1,1)/(CP*CRL0) 0057 HTSTR(1,1)=CRTIN+DELT 0058 J=2 0059 12-K=J=L 0060 IF(HTSTR(10,1))13,13,14 0061 13 HTSTR(10,1)=HTSTR(10,1)+HTSTR(10,1),0.0.0.,CP) 0062 CALL SPHI(HTSTR(15,1)=CP*(HTSTR(10,1)-HTSTR(10,1),0.0.0.,CP) 0063 -FISTR(1,1)=HTSTR(15,1)=CP*(HTSTR(10,1)-HTSTR(10,1)) 0064 14 CALL SPHI(CRAPI,0HTSTR(11,K),HTSTR(19,1),CRLB,CP) 0065 CELT=HTSTR(11,0)-HTSTR(11,K),HTSTR(10,1),CRLB,CP) 0066 TSTR(11,1)=HTSTR(11,K)+DELT 0067 IF(HTSTR(11,1)+10,-DESALT)16,18,18 0068 15 IF(HTSTR(11,1)+10,-DESALT)16,18,18 0069 16 J=J+1 0071 C0 12 0071 17 IF(ITSTR(11,K), DESALT)16,18,19 0072 19 HESTR(11,K), DESALT,0.,0.,0.,CP) C-IF WHEN THE GRUDE TEMP FROM THE ORIGINAL EXCHS, EXCEEDS DESALT,IT-DUES SD-BY C MORE THAN THE ALLOWABLE TULERANCE, THEN THE HEATING STRM WHICH PRODUCES THE	
0055 11 CALL-SPHI(CRAPI,0., CRFIN,HTSTR(4,1), CREB,CP) 0056 DELT=HTSTR(4,1)/(CP+CRLB) 0057 HTSTR(11,1)-CP+CRLB) 0058 J=2 0059 12 K=J-1 0060 IF(INTSTR(10,1)+ISTR(11,K)+HTSTR(10,1),0.,0.,CP) 0061 13 HTSTR(10,1)+HTSTR(10,1),HTSTR(10,1),0.,0.,CP) 0062 CALL SPHI(HTSTR(4,1),HTSTR(10,1),HTSTR(10,1),0.,0.,CP) 0063 +TSTR(4),1/(CP+CRLB) 0064 14 CALL SPHI(CRAPI,0.,HTSTR(11,K),HTSTR(10,1),CRLB,CP) 0065 CELT=HTSTR(11,0)-HTSTR(11,K),HTSTR(10,1),CRLB,CP) 0066 HTSTR(11,1)+HTSTR(11,K)+DELT 0067 IF(HHSTR(11,1)+O=DESALT)16,18,18 0068 15 IF(HTSTR(11,1)+10-DESALT)16,18,18 0069 16 J=J+1 0071 17 IF(HTSTR(11,1)+10,-DESALT)16,18,19 0072 19 NB=J 0073 NAFI=J+1 0074 KAFI=J+1 0075 HTSTR(11,J)=DESALT 0076 CALL SPHI(CRAPI,HTSTR(11,K),DESALT,0.,0.,CP) 0077 CO 12 0078 HSTR(11,J)=DESALT 0079 IT=F(HTSTR(11,K),DESALT,0.,0.,CP) 0076 CALL SPHI(APP CR	
0056 DELT=HTSTR(9,1)//CP4CRLB) 0057 HTSTR(1,1)=CKTIN+DELT 0058 J=2 C059 12 K=J=L 0061 13 HTSTR(10,J)13,13,14 0061 13 HTSTR(10,J)=HTSTR(11,K)+HTSTR(10,J),0.,0.,CP) 0062 CALL SPHI(HTSTR(4,J))+TSTR(5,J)=CP+IHTSTR(10,J)-HTSTR(10,J)) 0063 +TSTR(4,J)=HTSTR(5,J)=CP+IHTSTR(10,J)=CRLB,CP) 0064 14 CALL SPHI(CRAPI,0.,HTSTR(11,K),HTSTR(9,J),CRLB,CP) 0065 EET=HTSTR(11,J)=HTSTR(11,K)=DET 0066 HTSTR(11,J)=HTSTR(11,K)=DET 0067 IF(HTSTR(11,J)=HTSTR(11,K)=DET 0068 15 IF(HTSTR(11,J)=HTSTR(11,K)=DES 0069 16 J=J=H 0068 15 IF(HTSTR(11,J)=10,=DESALT=116,18,18 0069 16 J=J=H 0071 C0 IO 12 0072 19 AB=J 0073 MAFI=J+1 0075 HTSTR(11,J)=DESALT=10; DESALT=10; DES	
0057 HTSTR(11,1)=CRFIN+DELT 0058 J=2 0057 12 K=J=1 0060 IF(HTSTR(16,J))13,13,14 0061 13 HTSTR(16,J)+HTSTR(1,J)+HTSTR(10,J),0,0,CP) 0062 CALL SPHT(HTSTR(4,J)+HTSTR(6,J)+HTSTR(10,J),0,0,CP) 0063 +TSTR(4,J)+HTSTR(5,J)+CP(HTSTR(10,J),0,CLP) 0064 14 CALL SPHT(CRAP!,0,HTSTR(11,K),HTSTR(10,J),0,CLP) 0065 CELT=HTSTR(11,J)+TSTR(11,K)+DET 0066 HTSTR(11,J)+TSTR(11,K)+DET 0067 IF(HTSTR(11,J)+TSTR(11,K)+DET 0068 15 IF(HTSTR(11,J)+TO,-DESALT)16,18,18 0069 16 J=J+1 0071 17 IF(HTSTR(11,J)+10,-DESALT)16,18,18 0072 19 NB=J 0073 NAF[=J+1] 0074 NAF[=J+1] 0075 HTSTR(11,J)=DESALT 0076 CALL SPHT(CRAPI,HTSTR(11,K),DESALT,0,0,0,CP) C076 CALL SPHT(CRAPI,HTSTR(1,K),DESALT,0,0,0,CP)	
12 K=j=1 0060 IF(HITSTR(A,J))13,13,14 0061 13 HITSTR(10,3)+HITSTR(11,K)+HTSTR(10,J),0.,0.,CP) 0062 CALL SPHT(HTSTR(4,J),HTSTR(6,J),HTSTR(10,J),0.,0.,CP) 0063 +TSTR(10,J)+HTSTR(11,K),HTSTR(10,J),CRLB,CP) 0064 14 CALL SPHT(CRAPI,0.,HTSTR(11,K),HTSTR(10,J),CRLB,CP) 0065 CELT=HTSTR(11,J)+HTSTR(11,K)+HTSTR(10,J),CRLB,CP) 0066 HTSTR(11,J)=HTSTR(11,K)+DELT 0067 IF(HITSTR(11,J)+DESALT)15,T7,T7 0068 15 IF(HITSTR(11,J)+DESALT)15,T7,T7 0069 16 J=J+1 0067 IF(HITSTR(11,J)+DESALT)15,T7,T7 0068 15 IF(HITSTR(11,J)+DESALT)16,18,18 0069 16 J=J+1 0071 17 IF(HITSTR(11,J)=DESALT)16,18,18 0072 19 NB=J 0073 NAF[=J+1] 0074 NEWN=N+1 0075 CHITSTR(11,HTSTR(11,K),DESALT,0.,0.,CP) C074 NEWN=N+1 0075 CHITCRAPI+(HTSTR(11,K),DESALT,0.,0.,CP) C076 CALL SPHTICRAPI+(HTSTR(11,K),DESALT,0.,0.,CP) C17 CALL SPHTICRAPI+(HTSTR(11,K),DESALT,0.,0.,CP) C076 CHUTHENDESALT-HTSTR(11,K),DESALT,0.,0.,CP)	
0060 IF(INTSTR(R,J))13,13,14 0061 13 HTSTR(10,J)+HTSTR(11,K)+HTSTR(10,J),0.,0.,CP) 0062 CALL SPHT(HTSTR(4,J),HTSTR(10,J),0.,0.,CP) 0063 +TSTR(9,J)=HTSTR(15,J)*CP*(HTSTR(10,J)+HTSTR(10,J)) 0064 14 CALL SPHT(CHRP1,0.,HTSTR(11,K),HTSTR(10,J),CRLB,CP) 0065 CELT=HTSTR(11,J)=HTSTR(11,K)+HTSTR(10,J),CRLB,CP) 0066 HTSTR(11,J)=HTSTR(11,K)+HTSTR(10,J),CRLB,CP) 0067 IF(HTSTR(11,J)=DESALT) 0068 15 IF(HTSTR(11,J)=DESALT) 0069 16 J=J+1 0071 17 IF(HTSTR(11,J)=10.=DESALT)16,18,18 0072 19 AB=J 0071 17 IF(HTSTR(11,J)=10.=DESALT)16,18,19 0072 19 AB=J 0073 AAFI=J+1 0074 NEW=N=H 0075 HTSTR(11,K)=DESALT 0076 CALL SPHT(CRAPI,HTSTR(11,K),DESALT,0.,0.,0.,CP) C076 CALL SPHT(CRAPI,HTSTR(11,K))=CESALT,0.,0.,CP) C076 CALL SPHT(CRAPI,HTSTR(11,K))=CESALT,0.,0.,CP) C077 CHENE, THE GRUDE TEMP FROM THE ORIGINAL EXCERS EXCEEDS-DESALT,IT DOES SO-BY C HOME THAN THE ALLOWABLE TOLERANCE, THEN THE HEATING STREAMS. C077 CUTY1(IDESALT-INTSTR(11,K))=CELHANC, STREAMS	
0661 13 HTSTR(10, j) + HTSTR(11, k1 + HTSTR(10, j), 0., 0., CP) 0662 CALL SPHITHTSTR(1, j) + HTSTR(6, j) + HTSTR(10, j), 0., 0., CP) 0663 + TSTR(1, j) + HTSTR(6, j) + CP*(HTSTR(6, j) + HTSTR(10, j)) 0664 14 CALL SPHIT(CRAP1, 0., HTSTR(11, K1, HTSTR(9, J), CRLB, CP) 0665 CECT=HTSTR(10, j) + HTSTR(11, K1, HTSTR(9, J), CRLB, CP) 0666 HTSTR(11, J) = HTSTR(11, K1, HTSTR(9, J), CRLB, CP) 0667 IF (HTSTR(11, J) = DESALT) + HTSTR(9, J), CRLB, CP) 0668 15 IF (HTSTR(11, J) = DESALT) + DESALT)	
0063 +TSTR4(9,J)=HTSTR4(5,J)=CP=(HTSTR4(6,J)=HTSTR4(10,J)) 0064 14 CALL SPHT(CRAPI,0HTSTR(11,K),HTSTR(9,J),CRLB,CP) 0065 CELT=HTSTR(11,J)=HTSTR(11,K)+DELT 0066 HTSTR(11,J)=HTSTR(11,K)+DELT 0067 IF(HTSTR(11,J)=DESALT)15,17,17 0068 15 IF(HTSTR(11,J)=LOSALT)16,18,18 0069 16 J=J+1 0070 C0 TO 12 0071 17 IF(HTSTR(11,J)=LOSALT)16,18,19 0072 19 NB=J 0073 NAFI=J+1 0074 KENN=N+1 0075 HTSTR(11,J)=DESALT 0076 CALL SPHT(CRAP1,HTSTR11,K),DESALT,0.,0.,0.,CP) C076 CALL SPHT(CRAP1,HTSTR11,K),DESALT,0.,0.,CP) C1F wFEN THE GRUDE TEMP FROM THE ORIGINAL EXCHS, EXCEEDS DESALT,IT DUES SO-8Y C HORE THAN THE ALLOWABLE TOLERANCE,THEN THE HEATING STRM WHICH PRODUCES THE C HIGH TEMP IS SPLIT INTO THO HEATING STREAMS. C077 CUTY1=(DESALT-HTSTR(11,K),PCLHACP C076 CUTY1=(DESALT-HTSTR(11,K),PCLHACP C077 CUTY1=(DESALT-HTSTR(11,K),PCLHACP C076 CUTY1=HTSTR(11,K),POTHTSTR(10,J),HTSTR(9,J),HTSTR(5,J),CP) 0079 HTSTR(9,J)=DUTY1 0060 CALL SPHT	
0064 14 CALL SPHT(CRAPI,0.,HTSTR(11,K),HTSTR(9,J),GRLB,CP) 0065 CEET=HTSTR(1,J)+ICP*CRLB1 0066 HTSTR(11,J)=HTSTR(11,K)+OELT 0067 IF(HTSTR(11,J)+10DESALT)15,17,17 0068 15 IF(HTSTR(11,J)+10DESALT)16,18,18 0069 16 J=J+1 0070 GU TO 12 0071 17 IF(HTSTR(11,J)=10DESALT)18,18,19 0072 19 Ms=J 0073 NAFT=J+1 0074 NEW=N+1 0075 HTSTR(11,J)=DESALT 0076 CALL SPHT(CRAP1,HTSTR(11,K),DESALT,0.,0.,CP) C115 CALL SPHT(CRAP1,HTSTR(11,K),DESALT,0.,0.,CP) C276 CALL SPHT(CRAP1,HTSTR(11,K),DESALT,0.,0.,CP) C416 CALL SPHT(CRAP1,HTSTR(11,K),DESALT,0.,0.,CP) C576 CALL SPHT(CRAP1,HTSTR(11,K),DESALT,0.,0.,CP) C416 CHICH TEMP FROM THE ORIGINAL EXCHES EXCEEDS-DESALT,IT-DUES SO-BY C417 CHICH TEMP THE ALLOWABLE TULERANCE,THEN THE HEATING STRM WHICH PRODUCES THE C417 CUTY1=(DESALT-HTSTR(11,K))*CRLM*CP C077 CUTY1=(DESALT-HTSTR(11,K))*CRLM*CP C078 DUTY2=HTSTR(4,J)=0.,HTSTR(10,J),HTSTR(9,J),HTSTR(5,J),CP) C411 SPHT(HTSTR(4,J)=0.,HTSTR(10,J),	
C065 CET=HISTR(1+,j)/(CP+GRLB) C066 HISTR(11,j)=HISTR(11,K)+DET C067 IF(HISTR(11,j)=HISTR(11,K)+DET C068 15 IF(HISTR(11,j)=L0,-DESALT)16,18,18 C070 C0 TO 12 0071 17 IF(HISTR(11,j)=L0,-DESALT)16,18,19 C070 C0 TO 12 0071 17 IF(HISTR(11,j)=L0,-DESALT)18,18,19 C070 C0 TO 12 0071 17 IF(HISTR(11,j)=DESALT) C073 NAFI=J+1 C074 NEWN=N+1 0075 HYSTR(1,d)=DESALT C076 CALL SPHT(CRAP1,HTSTR(11,K),DESALT,0.,0.,CP) C1F HHCN THE CRUDE TEMP FROM THE ORIGINAL EXCHS+ EXCEEDS DESALT,IT DUES SO BY C MORE THAN THE ALLOWABLE TOLERANCE,THEN THE HEATING STRM WHICH PRODUCES THE C MORE THAN THE ALLOWABLE TOLERANCE,THEN THE HEATING STRM WHICH PRODUCES THE C MIGH TEMP IS SPLIT INTO TWO HEATING STREAMS+ C077 CUTY1=(DESALT-HTSTR(11,K))*CRLH*CP C076 CUTY1=(DESALT-HTSTR(11,K))*CRLH*CP C077 CUTY1=(DESALT-HTSTR(11,K))*CRLH*CP C076 CUTY1=(DESALT-HTSTR(11,K))*CRLH*CP C077 CUTY1=(DESALT-HTSTR(4,j)=0.THTSTR(10,j)+HTSTR(10,j)+HTSTR(5,j)+CP)	
0067 IF(HTSTR(11,J)+DESALT)15,17,17 0068 15 IF(HTSTR(11,J)+10DESALT)16,18,18 0069 16 J=J+1 0070 GU TO 12 0071 17 IF(HTSTR(11,J)+10DESALT)18,18,19 0072 19 NB=J 0073 NAF(*J)+ 0074 NEWN=N+1 0075 HTSTR(11,J)+DESALT 0076 CALL SPHT(CRAPI,HTSTR(11,K),DESALT,0.,0.,CP) C1F WHEN THE CRUDE TEMP FROM THE ORIGINAL EXCHS. EXCEEDS-DESALT,IT-DUES-S0-BY C MORE THAN THE ALLOWABLE TOLERANCE,THEN THE HEATING STRM WHICH PRODUCES THE CHIGH TEMP IS SPLIT INTO TWO HEATING.STREAMS. C077 CUTY1=(DESALT-HTSTR(11,K))+CRLH*CP C076 CUTY2=HTSTR(4,J)+OUTY1 0079 HTSTR(4,J)+OUTY1 0070 CALL SPHT(HTSTR(4,J)+O.,HTSTR(10,J),HTSTR(9,J),HTSTR(5,J),CP)	
C068 15 IF(HTSTR(11,J)+10,-DESALT)16,18,18 C069 16 J=J+1 C070 G0 T0 12 0071 17 IF(HTSTR(11,J)-10,-DESALT)18,18,19 0072 19 NB=J C073 NAFI=J+1 C074 NEWN=NN1 0075 HTSTR(11,J)=DESALT C076 CALL SPHT(CRAP1,HTSTR(11,K), DESALT,0.,0.,CP) C1F WHEN THE CRUDE TEMP FROM THE ORIGINAL EXCHS, EXCEEDS DESALT,IT DOES S0 BY C MORE THAN THE ALLOWABLE TOLERANCE,THEN THE HEATING STRM WHICH PRODUCES THE C HIGH TEMP IS SPLIT_INTO TWO HEATING STREAMS, C077 CUTY1=(DESALT-HTSTR(11,K))+CRLH*CP C070 DUTY2=HTSTR(9,J)=DUTY1 0079 HTSTR(9,J)=DUTY1 0000 CALL SPHT(HTSTR(4,J)+0.,HTSTR(10,J),HTSTR(9,J),HTSTR(5,J),CP).	
C069 16 J=J+1 C070 G0 T0 12 0071 17 IF (HTSTR(11,J)=10DESALT)18,18,19 0072 19 NB=J C073 - NAFT=J+1 C074 NEWN=N+1 0075 - HTSTR(11,J)=DESALT C076 CALL SPHT(CRAP1,HTSTR(11,K),DESALT,0.,0.,CP) C IF WHEN THE CRUDE TEMP FROM THE ORIGINAL EXCHS. EXCEEDS DESALT,IT DOES SO BY C WORE THAN THE ALLOWABLE TOLERANCE,THEN THE HEATING STRM WHICH PRODUCES THE C HIGH TEMP IS SPLIT INTO TWO HEATING STREAMS. C077 CUTY1=(DESALT-HTSTR(11,K))*CRLH*CP C076 CUTY2=HTSTR(9,J)-DUTY1 0079 HTSTR(9,J)=DUTY1 0080 CALL SPHT(HTSTR(4,J),0.,HTSTR(10,J),HTSTR(9,J),HTSTR(5,J),CP).	#12.000.000 (Marked States of States)
0071 17 IF (HTSTR(11,J)=10DESALT)10.10.10.10.10.10.10.10.10.10.10.10.10.1	
0072 19 NB=J C073 NAFT=J+1 C074 NEWN=N+1 0075 HTSTR(11,J)=DESALT C076 CALL SPHT(CRAPI,HTSTR(11,K),DESALT,0.,0.,CP) C IF WHEN THE CRUDE TEMP FROM THE ORIGINAL EXCHS. EXCEEDS DESALT,IT DUES SD BY C MORE THAN THE ALLOWABLE TOLERANCE,THEN THE HEATING STRM WHICH PRODUCES THE C HIGH TEMP IS SPLIT INTO TWO HEATING STREAMS. C077 C UTY1=(DESALT-HTSTR(11,K))*CRLH*CP OUTY2=HTSTR(9,J)=DUTY1 OO000 GALL SPHT(HTSTR(4,J)*O., HTSTR(10,J), HTSTR(9,J), HTSTR(5,J), CP)	t
C073 NAFT=J+1 C074 NEWN=N+1 O075 HISTR(11,J)=DESALT C076 CALL SPHT(CRAPI,HTSTR(11+K),DESALT,0.,0.,CP) G-IF WHEN-THE CRUDE TEMP FROM THE ORIGINAL EXCHS. EXCEEDS DESALT,IT DUES SO BY C MORE THAN THE ALLOWABLE TOLERANCE,THEN THE HEATING STRM WHICH PRODUCES THE C MORE THAN THE ALLOWABLE TOLERANCE,THEN THE HEATING STRM WHICH PRODUCES THE C MORE THAN THE ALLOWABLE TOLERANCE,THEN THE HEATING STRM WHICH PRODUCES THE C MORE THAN THE ALLOWABLE TOLERANCE,THEN THE HEATING STRM WHICH PRODUCES THE C MORE THAN THE ALLOWABLE TOLERANCE,THEN THE HEATING STRM WHICH PRODUCES THE C MORE THAN THE ALLOWABLE TOLERANCE,THEN THE HEATING STRM WHICH PRODUCES THE C MORE THAN THE ALLOWABLE TOLERANCE,THEN THE HEATING STRM WHICH PRODUCES THE C MORE THAN THE ALLOWABLE TOLERANCE,THEN THE HEATING STRM WHICH PRODUCES THE C HIGH TEMP IS SPLIT INTO TWO HEATING STREAMS. C077 CUTY1=(DESALT-HTSTR(11,K))*CRLH*CP C076 DUTY2=HTSTR(9,J)=DUTY1 0079 HTSTR(9,J)=DUTY1 0060 CALL SPHT(HTSTR(4,J)+0.*HTSTR(10,J)+HTSTR(9,J)+HTSTR(5,J)+CP).	******
C074 NEWN=N+1 C075 HISTR(11,J)=DESALT C076 CALL SPHT(CRAPI,HTSTR(11,K),DESALT,0.,0.,CP) C MORE THAN THE CRUDE TEMP FROM THE ORIGINAL EXCHS. EXCEEDS DESALT,IT DUES SO BY C MORE THAN THE ALLOWABLE TOLERANCE,THEN THE HEATING STRM WHICH PRODUCES THE C MORE THAN THE ALLOWABLE TOLERANCE,THEN THE HEATING STRM WHICH PRODUCES THE C MORE THAN THE ALLOWABLE TOLERANCE,THEN THE HEATING STRM WHICH PRODUCES THE C HIGH TEMP IS SPLIT INTO TWO HEATING STREAMS. C077 C UTY1= (DESALT-HTSTR(11,K))*CRLH*CP C078 OUTY2=HTSTR(9,J)=OUTY1 O000 CALL SPHT(HTSTR(4,J);0.;HTSTR(10,J);HTSTR(9,J);HTSTR(5,J);CP)	-
C076 CALL SPHTICRAPI, HTSTR(11,K), DESALT, 0., 0., CP) C IF WHEN THE CRUDE TEMP FROM THE ORIGINAL EXCHS. EXCEEDS DESALT, IT DUES SO BY C MORE THAN THE ALLOWABLE TOLERANCE, THEN THE HEATING STRM WHICH PRODUCES THE C HIGH TEMP IS SPLIT INTO TWO HEATING STREAMS. C077 CUTY1=(DESALT-HTSTR(11,K))*CRLH*CP C078 DUTY2=HTSTR(9,J)-DUTY1 0079 HTSTR(9,J)=DUTY1 0060 CALL SPHT(HTSTR(4,J);0.;HTSTR(10,J);HTSTR(9,J);HTSTR(5,J);CP)	
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C HIGH TEMP IS SPLIT INTO HEATING STREAMS. C077 CUTY1=(DESALT-HTSTR(11,K))*CRLH*CP CO70 CUTY2=HTSTR(9,J)-DUTY1 C079 HTSTR(9,J)=DUTY1 CO00 CALL SPHT(HTSTR(4,J);0.;HTSTR(10,J);HTSTR(9,J);HTSTR(5,J);CP)	
C070 DUTY2=HTSTR(9,J)-DUTY1 0079 HTSTR(9,J)=DUTY1 0080 CALL SPHT(HTSTR(4,J),0.,HTSTR(10,J),HTSTR(9,J),HTSTR(5,J),CP)	*********
0079 HTSTR(9,J)=DUTY1 CALL SPHT(HTSTR(4,J),0.,HTSTR(10,J),HTSTR(9,J),HTSTR(5,J),CP) CALL SPHT(HTSTR(4,J),0.,HTSTR(10,J),HTSTR(9,J),HTSTR(5,J),CP)	
<u>GOBO</u> <u>GALL</u> SPHT(HTSTR(4,J),O.,HTSTR(10,J),HTSTR(9,J),HTSTR(5,J),CP)	
	Him. and with sugge
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FORTRAN	IV G LEVEL															
0081	IN O CLULL	18		MAIN	•		DATE =	710	11		12/20/	24	i de print de Anna de Sa	·	PAGE O	100
~ ~ ~ ~ ~			STR(9,J)/		R(5,J))							EN#7%**			
0082			TSTR16,J) ,J)=HTSTR		ELT	•				1			a ta cara a	•		
	C INCR	EASE J	OF STREAM HEATING S	S AFTER	DESALTI				ROOM	IN ARI	AY FOR	THE			*********	
0084 0085		MAFT*N-	-NB 4=1, MAFT													
		J=N+1=													ganitetin yoshini ada ada ada ada a	
0087		L=J+1 ·								i a			• • •			
0088			[=1,19 [,L]=HTSTR	/ T / N	One and the second s					· · · · · · · · · · · · · · · · · · ·						
C089			AFTER DESA		RESPON	о то на	TPORT		FSPL	IT-ST	RM					
0090		J=NB														
0091		L=NB+1		*****							adaugan ang pang pang pang pang pang pang pa		• ,	•.		-
0092		CO 21 HTSTRE	[=1,5 [, <u>l</u>]=HTSTR	11-11												-
0094			6.L)=STORE					5 - F	1997 - 19 1							
0055		HTSTRI	7,1.1=0.													-
0096 0097	· · · · · · · · · · · · · · · · · · ·		8,L)=HTSTR 9 ,L)=DUTY2				E j	• • • • • • • • • • • • • • • • • • •					Anna dia mandri amin'ny fisiana amin'ny fisiana amin'ny fisiana amin'ny fisiana amin'ny fisiana amin'ny fisiana			
0098			9,L]=00112 10,L)=HTST							· ·						
0099	and the second secon	00-22-	1=12,17					*****								
0100			I,L)=0.0	•	e a la constante de la constan		<u> </u>			1. 1						
<u></u>		SPLIT= GO TC														
-0103-			=117578111,	J1	·											
C104	a dia kaominina dia kaomini	NB≖J		- '				1	· · · ·							
<u> </u>		NAFT=J Newn=N		na constanto e bañas sens e tam el Bronder						6 m. 4 - 44 m june an				andiger and the party	and generated as a data set of the second	history
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C108		CO TO	23							e series		;;;				•
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0109			ESALT-DROP		THENT	'### ~~^ @++	ne-oone	6071		M	11-0F	Ŧ 146	·			
			RE MADE TH						-3 001			11116 	i senti. The tr			
C110			L1 24,24,2	25			******									17thour
0111	24	FCRLB= FCRTIN		·				، میرونی میرونی								
C113	1 .		=CRAPI				an the second						· · · · · · · · · · · · · · · · · · ·			
		€R#-PP	EHEAT CALC		XCHS. /	FTER D	ESAL TER	•						-	an a	******
0114 0115			11)26,26,2	27					·							
0115		-J=NAFT HTSTR(10,J)=FCR	TIN+HTST	R(18.11							· · ······				
			PHTINTSTR				R110, JI	,0.,	0.,CP)						70. - 10
C118		HTSTR	9,J)=HTST	R(5,J)*C	P*(HTS1	[R(6,J)	-HTSTR (10.J	11 1		15	1. A.				
			PHT (FCRAP) ITSTR (9+NA)			518191N	AFTIF	RLBy	691					adadaa ahaa ahaa aasaa a	191 9: -	Koare
0121-			11,NAFT1=			, .									daen store room	Parlow
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· · · ·			A				1000 01 01 1 1 1 1 1 1 1 1 1 1 1 1 1 1			an a			<		No	******
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<u>∎</u>	· · ·					· · · · · · · · · · · · · · · · · · ·							****			-
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0122	L=NAFT+1	
0123	L = NAFI + 1	
0124	K≖J~1	
C125	IFIHTSTR18, J1128, 28, 29	
0126	28 HTSTR(10, J)=HTSTR(11, K)+HTSTR(18, J)	
0127	CALL SPHT (HTSTR(4, J), HTSTR(6, J), HTSTR(10, J), U.,	0.,CP)
0128	HTSTR(9, J)=CP+HTSTR(5, J)+(HTSTR(6, J)-HTSTR(10, J	
¢129	-29-CALL SPHT (FCRAPI, 0., HTSTR111,K1,HTSTR19, J1,HTST	
C130	DELT=HTSTR(9,J)/(CP*FCRLB)	
0131		
	CALCULATE COOLER DUTIES.	
0132		
0133	IF(HTSTR(8,J))31,31,33	
0134	-31 CALL SPHI (HTSTR 14, J), HTSTR 110, J), HTSTR 17, J), 0.,	0.,CP)
6135	HTSTR(12,J)=CP+HTSTR(5,J)+(HTSTR(10,J)-HTSTR(7,	())
0136		
0137	CELTC=HTSTR(7, J)-TW1	
0138	XMTD=(DELTH-DELTC)+.9/ALOG(DELTH/DELTC)	**************************************
C139	HTSTR(15,J)=HTSTR(12,J)/(XMTD+50.)	
C140		
0141	33 CONTINUE	
	CALCULATE COOLER SURFACES & CUSTS.	
0142	DO 35 J=2, NEWN	
C143	K-J-1	
C	CALC. HT EXCH SURFS & COSTS	
-0144	32-DELTH=HTSTR(6)J)-HTSTR(11)J)	
0145	DELTC=HTSTR(10,J)-HTSTR(11,K)	
0146	*MTD=(DELTH-DELTC)*.9/ALOG(DELTH/DELTC)	
0147	HTSTR(14,J)=HTSTR(9,J)/(XMTD*50,)	(a) A set of the se
-0148		
0149	DELTH=HTSTR(6,1)-HTSTR(11,1)	
-0150	DELTC+HISTR(10,1)-CRTIN	
C151	XMTD=(DELTH-DELTC) *.9/ALOG(DELTH/DELTC)	
-0152		
0153	HTSTR(16,1)=HTSTR(14,1)*ACOST	
E	-GET-TOTAL PREHT- DUTY, EXCH SURF & COST&COOLER SURFA	CE COST FOR SINGLE TRAIN
	C EXCHANGER SYSTEM.	
0154		1996 - 1997 - 199 - 1997 - 199
0155	SUM14=0.0	
-0156	SUM16=0.0	
0157	SUM15=0.0	All and the second s
-6158		
		(a) A set of a descent of the des
0159	CO 36 J=1.NEWN	
0159	CO 36 J=1, NEWN 	
-6160	SUM9=SUM9+HTSTR(9+J)	
- <u>C160</u> 0161		
C160 0161 G162	SUM9=SUM9+HTSTR(9,J) SUM14=SUM14+HTSTR(14,J) SUM16=SUM16+HTSTR(16,J)	
C160 0161 - G162 - C163	SUM9=SUM9+HTSTR(9,J) SUM14=SUM14+HTSTR(14,J) SUM16=SUM16+HTSTR(16,J) SUM15=SUM15+HTSTR(15,J)	
C160 0161 G162	SUM9=SUM9+HTSTR(9,J) SUM14=SUM14+HTSTR(14,J) SUM16=SUM16+HTSTR(16,J)	
C160 0161 G162 C163	SUM9=SUM9+HTSTR(9,J) SUM14=SUM14+HTSTR(14,J) SUM16=SUM16+HTSTR(16,J) SUM15=SUM15+HTSTR(15,J)	
C160 0161 - G162 - C163	SUM9=SUM9+HTSTR(9,J) SUM14=SUM14+HTSTR(14,J) SUM16=SUM16+HTSTR(16,J) SUM15=SUM15+HTSTR(15,J)	
C160 0161 	SUM9=SUM9+HTSTR(9,J) SUM14=SUM14+HTSTR(14,J) SUM16=SUM16+HTSTR(16,J) SUM15=SUM15+HTSTR(15,J)	
C160 0161 - G162 - C163	SUM9=SUM9+HTSTR(9,J) SUM14=SUM14+HTSTR(14,J) SUM16=SUM16+HTSTR(16,J) SUM15=SUM15+HTSTR(15,J)	
C160 0161 - G162 - C163	SUM9=SUM9+HTSTR(9,J) SUM14=SUM14+HTSTR(14,J) SUM16=SUM16+HTSTR(16,J) SUM15=SUM15+HTSTR(15,J)	
C160 0161 G162 C163	SUM9=SUM9+HTSTR(9,J) SUM14=SUM14+HTSTR(14,J) SUM16=SUM16+HTSTR(16,J) SUM15=SUM15+HTSTR(15,J)	
C160 0161 - G162 - C163	SUM9=SUM9+HTSTR(9,J) SUM14=SUM14+HTSTR(14,J) SUM16=SUM16+HTSTR(16,J) SUM15=SUM15+HTSTR(15,J)	
C160 0161 - G162 - C163	SUM9=SUM9+HTSTR(9,J) SUM14=SUM14+HTSTR(14,J) SUM16=SUM16+HTSTR(16,J) SUM15=SUM15+HTSTR(15,J)	
C160 0161 G162 C163	SUM9=SUM9+HTSTR(9,J) SUM14=SUM14+HTSTR(14,J) SUM16=SUM16+HTSTR(16,J) SUM15=SUM15+HTSTR(15,J)	

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				SYSTEM ON OUTPUT SHEET M		· · · ·
0165	L I	WRITE(3,141)		AS WELL AS THE INPUT VAL	LUES.	
0166	T		755X, OUTPUT SHEET 3	*77]	lan ar on the second	-
0167	•	WRISE(3,40)		· · · ·	· · · · · · · · · · · · · · · · · · ·	
0168	anny, any defect of freemanter	K=MIN0(7,N)		• • • •		
0169	itus characteriteriteriteriteriterit		((HTSTR(I,J),I=1,3),J ((HTSTR(I,J),J=1,K),			
0171		41 FORMAT(3X. "A	API +, 15X, 7F12.1/3X, 1	LBS/HR +, 12X, 7F12.0/3X, 11		
		17F12.0/3X., 'T	TOUT,F*,12X,7F12.0/3)	X,*PA7*,15X,7F12.0/3X,*1	EX.DUTY,BTU/	Bert Office We surface and the Monte State Construction respective
		2HR +4X +7F12.		+6X+7F12+C/3X+*TEMP CRUE		
		43X. PSEUDOT		*COOL.DUTY,BTU/HR*,2X,71 SURF,SQFT*,6X,7F12.0/3X		
· · · · · · · · · · · · · · · · · · ·				EXCOST\$ +11X,7F12.0/3X,		
4		6'COOL.COST,S	\$*+7X+7F12+0/3X+*APP	ROACH, F . 8X, 7F12.0//)		•
0172	Anno 1997 (1999) (1997) (1997) (1997) (1997) (1997) (1997) (1997) (1997) (1997) (1997) (1997) (1997) (1997) (19	1FTNEWN-7144	· · ·	an ann ann ann ann an Annaichte an ann ann an an an an an an an an an a	، ۱۹۹۳ کې د د د د د د د د د د د د د د د د د د	
0173		42 kRITE(3,45)	(tHTSTR(1,J),1=1,3),			
0175			((HTSTR(I,J),J=8,14),			
		WRITE THE SUP OF		SACOSTS ON OUTPUT SHEET	NO.3 FOR SINGLE	
) م م 19 کر میں		TRAIN SYSTEM.				·
			SUM9;SUM14;SUM16;SUM TOTAL DUTY='.F11.0.*	TIS, SUMI7	CHPE=1.FR.0.	telejähan vääntökää panavitäinen vannan, muun en
VLII				-7.0/3X, TUTAL COOLER		-
. `		2*FTSQ1/3X,11	TOTAL COOLER COST=\$"			
0178	, ,	CIPENSION TE			a de la companya de la contra de	en en ferste men kan en septitischen in som et binget ist og som og den hag en geste megne og som og som et so
0179		GU TO (300,2 Start of two tra	-		•	
· • · · ·				5. SPLIT ANY HEATING STR	EAM IN HALF WHICH	
		RATSES THE TEMP	CF THE CRUDE MORE TH	HAN 60 F. ADD THE NEW S		
		ARRAY IN THE COP 200 CO47 J=NAFT				
C180 C181			TNEWN 9,J)/(FCRLB*.6)	· · · · ·		
0182	*****	IF (RISE=60.	• · · · · · · · · · · · · · · · · · · ·			an trade mengatur mela di terde mela di mengera per
C183 .	i sur Sur sur	48 K=J+1				
		CO 49 L=K.Nt				
C185		00 49 I=1,19			s. 	
C187			HTSTR(5,J)/2.			
<u>C188</u>			HTSTR(9, J1/2.			
0189		CO 150 I=1,1	19	· · ·		•
0190	1	150 HTSTR(1,K)=			*******	**************************************
-0191 		CO 54 L=K,NI 				
0193		M=L+1				an e e e e e e e e e e e e e e e e e e e
	Antibitation and a second s	-54-HTSTRIL,#1=			*****	Járden tendező kezeteken jarga yangan az aktor (a material a material a material a fel a fel a fel a fel a fel
C195		NEWN=NEWN+1				
		J=J+1		an a		
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0197	47	CONTINUE					inini da Aldrey de Marcin a Frankrika munda in a Aldrey da Andrey		in gehen in der Andelstergene vorden zu eingenen an einer
0198		WRITE(3,101) NEWN							
0199		FORMAT('1', 3X, 'NEW							
0200	L SEI	UP A TRAIN AND B T	KAIN		•				
		- <u>K=1</u>							
0202		DO 50 J=NAFT.NEWN:	2	den en en			n Madalay Managan Mandalay		
0203		-00 - 203 - 1 = 1 + 19				·	· .		/
0204	203	A(I,K)=HTSTR(I,J) -NAT=NAT+1						· · · · · · · · · · · · · · · · · · ·	00-11-11-01-01-01-01-0-0-0-0-0-0-0-0-0-
0206	50	K=K+1					ang sa Manggan ang sa		
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0208	2	NBT=0						: .	
<u> </u>		D() 51 J=MAFT,NEWN,	2			terre de		• ``	1
		-00-204-1-1,19						**************	
C212		B(I,K)=HTSTR(I,J)						•	
			an de la constante de la const						and an
C214		AIN-SUM-OF-ATRAIN-O	-	UTIES &	COMPARE T	HEM		in the second	
C215		SUMA=0.0			•				
6216		-00-55 J=1,NAT						********	1999) - Fals II. (1994) - Fals II. (199
C217 	55	SUMA=SUMA+A(9,J)			· · · · · · · · · · · · · · · · · · ·			4. consideration and a state of the construction of the state of the s	in the second second
0219		DO 56 J=1,NBT							
		5-5UMB=SUMB+8(9,J)-		,	·····				ga 1937 - 19 00 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994
6221		CIF=SUMA-SUMB							
		IFT THE LAST EXCH FI AN ATTEMPT TO EQUA							
		-IF(01F)58+64+57-							
0223		7 IF(DIF-A(9,NAT))	64,64,60			e de la ser			en de la composition de la composition La composition de la c
0224	60	9 J=NRT+1					genten saltanestanisiisinganetjanensymbolisi erisiinen olas	ann an an Alban an Angele ann an Alban an An Anagele an	a yang di baran dan sebanan yang di di barat dan sebana dan sebana dan sebana dan sebana dan sebana dan sebana
0225	•	DO 59 I=1,19 		• • • • • • • • • • • • • • • • • • •				Realization and a surgering of the West of the reason of the West of the surgering of the West of the surgering	
6227		9 A(I,NAT)=0.0			· · ·				· · ·
		-NAT=NAT-1			terre and the second statements of the second s	and the second			
0229		NBT=NBT+1	<i>i</i> .			•			: •
	S:		1.64.64	**************************************	ana kata kacamanga Situ ta Kasarin sana				alada yan dan yang menangkat di dan sin di kanangkat di kanangkat di kanangkat di kanangkat di kanangkat di ka
		1-J=NAT+1	1104104	An				1969-1999	
		CO 62 I=1,19							
0233			· · · · · · · · · · · · · · · · · · ·					na kalenda a matematika da ana " 1996 di silanda da da mana ang mana ang	
0233 	· · · · ·								· · ·
0233 		2 E(I,NBT)=0.0							
0233 							atun an		
0233 6234 0235 0236 0237		NBT=NAT+1 NBT=NBT-1 KE-PREHEAT-CALCS-FO	K ATRAIN.		tenerae, etc.commerciales d'Essenado				
C233 C234 C235 O236 C237 C238		NAT-NAT+1 NBT=NBT-1 KE-PREHEAT CALCS-FO 4 SALT=DESALT-DROP	K ATRAIN.					الله میرد با این میرد این میرد این میرد با این میرد این میرد این میرد میرد میرد این میرد میرد این میرد این میر است هم این میرد این م	
0233 6234 0235 0236 0237		NBT=NAT+1 NBT=NBT-1 KE-PREHEAT-CALCS-FO	K ATRAIN.		1944 - 19				
0233 6234 0235 0236 0236 0237 0238 0239	C MA (64	NAT-NAT+1 NBT=NBT-1 KE-PREHEAT CALCS-FO 4 SALT=DESALT-DROP	K ATRAIN.						
0233 0234 0235 0236 0237 0238		NAT-NAT+1 NBT=NBT-1 KE-PREHEAT CALCS-FO 4 SALT=DESALT-DROP	RATRAINS						
0233 0234 0235 0236 0237 0238 0239	C MA (64	NAT-NAT+1 NBT=NBT-1 KE-PREHEAT CALCS-FO 4 SALT=DESALT-DROP	R-ATRAIN.						
0233 0234 0235 0236 0237 0238 0239	C MA (64	NAT-NAT+1 NBT=NBT-1 KE-PREHEAT CALCS-FO 4 SALT=DESALT-DROP	R ATRAIN.						
C233 C234 C235 O236 C237 C238 O239	C MAI 6.	NAT=NAT+1 NBT=NBT-1 KE PREHEAT CALCS FO 4 SALT=DESALT-DROP HAFCR=FCRLD/2.					<u>ىمەرەمەرىيىنى بىرىمەرەبەر مايەلەرمەرىي</u>		
C233 C234 C235 O236 C237 C238 O239	C MA (64	NAT=NAT+1 NBT=NBT-1 KE PREHEAT CALCS FO 4 SALT=DESALT-DROP HAFCR=FCRLD/2.							

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FORTRAN IV G LEVE	L 18	MAIN	DATE = 71011	12/20/24	PAGE 0007
0240	IF(A(8,1))				
0241 5	2 A110.11=SA			afrey with resur all to the play of an end of the second and a second second second second second second second	
0242	A(11,1)=A(10,1)			·
0243		A(4,1),A(6,1),A(10,1			
0244		,1)*CP*(A(6,1)-A(10,			
0245	3 CALL SPHTI	FCRAPI, 0., SALT, A19,1	, HAFCR, CP)		
0246	DELT=A(9,1)/(CP*FCRL8/2.)			a tet de la composición de
C247	A(11,11=SA	LT+DELT	n an		۵
0248	DO 69 J=2,	NAT			
0249	K=J-1				
0250	IF(A(8,J))		1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1		
C251	57 A(10, J) = A(11,K)+A(18,J)			
0252	CALL SPHT(A(4,J),A(6,J),A(10,J),0.,0.,CP)		
		,J1*CP*(A(6,J)-A(10,	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		
	58 CALL SPHT(FCRAPI, 0. , A(11, K), A	(9.J).HAFCR.CP)		1.4
		1/1CP*FCRLB/2.1		**************************************	
	59 A(11.J)=A(
		ALCS FOR BTRAIN.			
0257		103,102,103			
	02 E(10,1)=A(-1
		B(4,1),B(6,1),B(10,1	1.00(9)	· · · ·	•
0259		-1)*CP*(8(6,1)-B(10,	4-+		
0280					
		FCRAP1,0.,SALT,B19,1	IT HAFCKIGFT		
C262		1/1CP*FCRL8/2.1	· · · ·		
0263	B(11,1) = SA		·		•
<u> </u>		NBI			
0265	K=J-1		and the second		
C266	TP18(8,J))				
0267	70 E(10,J)= E	(11,K)+B(18,J)			
	CALL SPHI1	B(4, J), B(6, J), B(10, J	1.0.,U.,CP1		
C269		i,J)*CP*(B(6,J)~B(10,	J)) ((())		
<u> </u>	71-CALL SPHIT	FCRAP1,0.,8(11,K),8(4, JI, HAFCR, CP)		an a
0271	DELT=B(9,	I)/(CP*FCRLB/2.)		· · · · · · · · · · · · · · · · · · ·	
	72-8(11;1)=8(11,K1+DELT		******************	
СМ	AKE COOLER CA	LCS FOR ATRAIN.	a ser a s		
		NAT		an and an international second and an an an and an an an an an and an	
0274	IF(A(B,J))	74,73,73			
		A(4, J), Att0, J), At7, J	1.0CP1		
0276		P*A(5,J)*(A(10,J)-A(7			
		10,J1-TW2			, and the second secon
0278	DELTC= A(· · ·		The second s	
		H-DELTC)*.V/ALOGIDEL	-TH # 1161-TP-1		
		(12,J)/(XMTD*50.)	, the DELIGE		
0280	· · · · · ·				
0281		(15, J) * 10.			
0282	73 CONTINUE		4 (t.	1 · · · · · · · · · · · · · · · · · · ·	
		ALCS FUR BTRAIN.			
0283	DU 75 J=1				
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	0285				B(10, J), B(0.,CP)			an ta an				
	C287		DELTH=B(LO, J)-TW2	*(B(10,J)-	·D(/,J))					n sela de la const Altra de las est Altras de las est	a seran an Maria		•
	0288	Res Lite		TH-DELTC)*.9/ALOG(DELTHIDE	LTC)	te ne te	н. 1.					
· · · · · ·	0290 0291			3 (12,J)/ (3(15,J)*1	XMTD*50.1	÷.								
	0292		CONTINUE	ERS DONE	,EXCHS FOL	LUN.								
			S-FUR-FI	ST ATRAI	N-EXCH.						1. · · · · · · · · · · · · · · · · · · ·			
	0293		CELTH=A(erend in the With With water contained to the						· · · · · · · · · · · · · · · · · · ·		
÷.	0294)*.9/ALOG(DELTH/DE	LTC)						in the second	
	0296		A(14)1)=	419 ,11/ 1X	MTD+50-1				£					
	0297		.A(16,1)= SS-FOR-FT											ter of the second
	0298	U UALL	CELTH=B(5,1)-B(11	+1)									
	-0299		CELTC=81			000 24400						*****	n gel a la conseigne a d istant	6.11-1 4
	0300 - 0301)*.9/ALOG((MTD*50.)	UCLIN/DE	LICI		i di sel sui Antonio di Stato					
	0302	an a	B(16,1)=	8(14,1)*1	0.					graf u				
	0303	C CAL(CO 77 J=		AIN EXCHS	•							·	
	-0304		-K=J-1	E \$ 1344 \$										Mattachia managa
	0305			6,J)-A(11								x		
·····	- 0306 - - 0307		+ DELTC=A(XMTD=IDE		1, K))*.9/ALOG		I TC)			· . · ·				,0000-0-000-0000
	-0308	na many international statements	-A(14,J)=	*/////*	MTD+50-1-							han a share a s		
	0309		= (16, J) =	•		•		· .		a .	an a	1		
	0310	C CALI	CO 78 J=		AIN EXCHS	•	· · · ·							(new long of the second se
mani	-0311	<u>.</u>	- K=J-1				. I							1
	0312			(1) - B(1)										
	-0313 0314			10,j)-8(1 LTH-DELT(1,K) ()*.9/ALOG	(DELTH/DE	LTCY				kapadéné – réskeren papanén	· · · · ·	·	
	-0315-		-8+14+11=	819, J)/()	(MTD+50.)							****		nandosena sua
	0316		= (16,J) =			VCUC. 0.000	05-055			-				
	0317	C JUP	SSUM9=0.		TC. FOR E	ACTIO DEFU	INC UCSA	LILKa			an an an Anna an Anna an Anna an Anna	j j		
	-0318-		-SSUM14=0	• 0	an the second			,,,,,.,.,,,,,,,,,,,,,,,,,,,,,,,						
	0319 - 6320 -	······	SSUM16=0 				· · · ·			· · · ·	· · · ·			ĸ
-	C321		SSUM17=0					al station				. ,		*******
	-0322	nya myakan mwanana na kata na k	-00-79-1-	1,NB										Initiation
	0323 -6324			UM9+HTSTF	₹(9,J) ST R{]4,J}-					18. J. A.	•	· · ·		
	0325				STR(16,J)			· · ·						
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0327	79 SSUM17=SSUM17 C SUMMATION OF DUT1	7+HTSTR(17,J) IES,ETC, FOR ATRAIN	EXCHS.			
0328	ASUM9=0.0				0	۰,
0329	ASUM14=0.0			na a firmanna air an shirinna u dala na shealinna ku an iar shar na anna a firshar shara shara.		
0330	ASUM16=0.0					
	ASUM15=0.0					
0332	ASUM17=0.0	r				in the second
0334	ASUM9=ASUM9+A					
0335	ASUM14=ASUM14	-				
0336	ASUM16=ASUM16				· · · · · · · · · · · · · · · · · · ·	
0337	ASUM15=ASUM1	-		ang pang bahan kanang pang pang pang pang pang pang pang	enter ander and the second state of the second s	****
C338	BO ASUM17=ASUM17		<i></i>		· · · · · ·	:
0000		IES, ETC. FOR BTRAIN	EXCHS.			
0339	BSUM9=0.0 BSUM14=0.0					
C340	BSUM16=0.0		1. A		·	
0342	USUM15=0.0					
0343	BSUM17=0.0				and the second	
0344	CO 81 J=1.NB		an addenin ter provenin min min and an and a	gymanne elen galanna fan a nann gellen en na hann gellen in de staar de staar de staar de staar de staar de st 1		Mana da kata da
0345	BSUM9=BSUM9+I		·	· · · · · · · · · · · · · · · · · · ·		
0346	BSUM14=BSUM14					
0347	BSUM16=HSUM16 BSUM15=BSUM11					
C348 C349	81 85UM17=BSUM1					
¢τεν	C SUMMATIUNITUTAL				*	
0350	TSUM9=SSUM9+	•			1977) 1979 - Angel Ang	
<u>c351</u>		4+ASUM14+BSUM14				
0352		6+ASUM16+BSUM16			·	
0353		5+ASUM15+BSUM15	. I		ala - Andrew	
0354	ISUMI/=SSUMI	7+ASUM17+BSUM17 \ y Fur Exchs Before -1		DIIT		******************************
0355	WRITE (3,85)	H FUR EXCHA DEFURE	PERMITER CH OUT	HOT DIRET HOR TO		
0356		1HTSTK(1,J),[=1,3),	J=1,NB)			
0357		(HTSTR(4,J),J=1,NB)				
<u> </u>		(HTSTR15, J), J=1,NB)				
0359		(HTSTR(6,J),J=1,NB)				
0360		-(HTSTR(7,J),J=1,NB)		n a far fan de ser fan	and a second	
C361		(HTSTR(8,J),J=1,NB)				
		-(HTSTR(9,J),J=1,N0) (HTSTR(10,J),J=1,N0				,
		-(HTSTR(11-J)-J=1-NH	•		*	an a
0365		(HTSTR(12,J),J=1,NB				
		-1HTSTR113,J1,J=1,N8		and a second second second second second second second second		
0367	WRITE(3,96)	(HTSTR(14,J),J=1,NB)			
<u> </u>	wRITE(3,97)-	-(HTSTK(15,J),J=1,NB	1	tennen site ärten en e		
0369	WRITE(3,98)	(HTSTR(16,J),J=1,NB) 3. Comparison (1997)		· · · · · · · · · · · · · · · · · · ·	•
	*RITE(3,99)	-+++TSTR+17,J1,J=1,NB	1			
				#1946-18-00-1954-19-00-1954-1954-1954-1954-1954-1954-1954-1954		
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0371		E(3,100)(HTSTR(18,J)					
0372		AT1+1+//30X,+OUTPUT	SHEET 41//23X1	XCHANGERS DEFU	RE DESALTER.		1078-81-10-10-10-10-10-10-10-10-10-10-10-10-10
	1/)	AT(3X, *API*, 15X, 4F12					
C373 0374		AT(3X, LBS/HR, 12X, 4			: <u>.</u>	a far a star a st	•
		AT 13X - 11N - F* - 13X - 4F				-	
0376	1 A	AT(3X, "TOUT, F", 12X, 4					
-0377		AT13X,*PA7*,15X,4F12					
0378		AT(3X, 'EX.DUTY,BTU/		· · · ·		·	
-0379		AT13X, EXOUT TEMP, F*	.6X,4F12.0)			Ang bengang pang pang pang pang pang pang pang	*******
0380	93 FORMA	ATI3X, TEMP CRUD OUT	[,F',2X,4F12.0]	an a			·· •,
0381	94 FORMA	AT (3X, CCUL . DUTY, BTU	J/HR+,2X,4F12.01-		and attended and a second s	in the factor of the second	
0382		AT(3X, 'PSEUDOT', 11X,		· · · ·		and the second second	
		AT (3X, + EX. SURF, SQFT+				*****	-
0384		AT(3X, COOL.SURF, SQF			and for the state of the state		
0385		AT(3X,*EXCOST,**,10X					Ann 10
0386	99 FUKM#	AT(3X, COUL COST, \$*,	7X,4F12.01	AN HEATTHE CTI			
· ^ ~ ^ 7	C-PUI U. 5	-IN-AAARRAY POSITIO	JNS-NUT-UCCUPTED	ET HEATING SIP	(EAM3:		
0387	LOG FORMA K=NAT	AT(3X, *APPROACH, F*, 7	/X:4112.01				
		26 J=K,7					
0389 		26 J = K + I	· · · · · · · · · · · · · · · · · · ·				an management of the standard of t
0390	126 A(I,						
		-IN-+B+ARRAY-POSITIC	ANS NAT ACCUPTED	-AV-HEATING-ST	RFAMS.	-	
0392	K=NB1	•••••••••••••••••••••••••••••••••••••••	JN9 NUT 000011-2	Di timitare al.	All MITTURE		
		27 J=K +7		, 		an the descent is a large of the Tange is a distance with a state of	
0394		27 1=1,19		1. A.			• •
	127 0(1,	J)=0.0					
	C WRITE "A"	ARRAY WITH PREHEAT	VALUES AS CALCUI	ATED ON OUTPUT	I SHEET NO.4.		
	hRITt	E(3+120)		аланы та ур адаан алар арыла та	· · · · ·	*****	200-00-00-00-00-00-00-00-00-00-00-00-00-
0397		E(3,43)((A(1,J),I=1,		•	• *		
6398		E(3,41)((A(F,J),J=1)	17)11=41181				
		ARRAY WITH PREHEAT	VALUES AS CALCU	ATED ON OUTPU	SHEET NU.4.	· · · · ·	
		E(3,121)	· · · · · · · · · ·			*******	1997-09-000000
0400		IE(3,43)((B(I,J),I=1)		1		hater <u>ia and</u>	
		(6(3,41)((8(1,J),J=1)		·····	an a freide an an an Barris ann an Ard an dùr an a' daoine an Ard an	Januar Marked Balack progenuit (1999) and the second second second second second second second second second s	
· ·		JMS OF DUTIES, ETC. FO	OR SPLIT TRAIN ST	ISTEM.			
		FE(3,128)-TSUM9			and with the other states and the states of the states	****	an a
04C3	6	FE(3,129) TSUM14			المردين المراجع المرجع الم مستقد المرجع ا	a a star a s	
		ATCLOX, TOT EX SURF	+SQ-++=+++++++++++++++++++++++++++++++++				
C405		TE(3,122) TSUM15	05 50 5T-1 5 8-0	1			
		4AT(10X+*TOT-COCL-SU([E(3,123) TSUM16	Khy54 ht= yr orv				400 Antoning and a
0407		1613,1231 150M16 MAT-(10X,**TOT-EXCH-CO:	CT 4-1 E12 01		·		
0409		TE(3,124) TSUM17	2112-115001			Real and a second	
		4AT-(10X+*TOT-COCL-CO	CT_4=+-F-12-01				
0411		MAT(11*//55X * OUTPUT	· · · · ·	A TRAIN!)			
		MATILOX, TOT-DUTY, BTI		4. 11575 619 - F			
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	0413	2	12	1 FC	DRMAT	(60)	••B	TRA	IN•/	')																-
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	IV G LEVEL 18	1	SPHT		DATE = 71011		12/20/24		PAGE 000
0001	SUB	BROUTINE SPHT(API, T1, T2, Q	XL8,CP1					
		U.CALC CP AT	AV. OF TIET2		an in an year of the second			-	
0002		(Q)6,5,6		- Adamatan produktion produktion and a					
0003		(11+12)72. TO 9							1
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	C TRIAL V	VALUE OF CP.	Jev writer	FRUA VEL.	AND ATE F	LULTIT	UALU FINGT		
0005	6 COU	UNT=0.0		-		1			
C006 -	CEL	LT=Q/(.55*XLB)	/		•		*		
-0007		(11)2,3,2			*****	alarah menjadi kana dan kenala pada basa		••••••••••••••••••••••••••••••••••••••	an a state for considering a spectrum
8200		TI-DELT/2.				fin en			
00C9 C010		TC 9 T2+DELT/2.							
-0010 -0011		=-34+-00275+AP	* ********	~0000029/	« <u> </u>	anana ana ara ara ara		An	Name and American Street St
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APPENDIX B

EXPLANATION OF OUTPUT FOR SAMPLE PROBLEMS

Program Output _ Sample Problem 1

Three output sheets are included, which are essentially self-explanatory. They represent the results obtained from a computer run for a sample problem referred to as problem #1. This problem corresponds to the preheat system for a relatively small crude unit with a feed rate of approximately 30,000 BPSD. Only a "single train" run was made because the crude unit was so small. A 40°F temperature approach was used for all the variable duty exchangers.

Program Output - Sample Problem 2

Three output sheets are presented. This problem is identical with sample problem #1 except that varied temperature approaches were used for the variable duty exchangers. The approaches used ranged from 60°F down to 20°F with the higher values; used for the low temperature exchangers.

Program Output - Sample Problem 3

Five output sheets are included. The first three are for a "single train system". The fourth and fifth apply to a splittrain system. Since problem #3 corresponds to the preheat system of a rather large crude unit with a feed rate of almost 100,000 BPSD of crude, the run made was of the type giving results for both single and split train preheat systems. A temperature approach of 40°F was used for all variable duty exchangers.

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API	57.0	32.2	42.6		42.6		32.2		
LBS/HR	289300.	44420.	280000.	280000.			187000		
TIN,F	245.	463.	350.	407.	440.	529.	463.		
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API	28.5	24.0	33.3	0.0	0.0	0.0	0.0			· · · ·
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API	52.0	52.0	44.2	21.4	24.8	11.8	44.2		
-LBS/HR		1210000.	139000				1050000.	· · · · · · · · · · · · · · · · · · ·	
TIN,F	290.	340.	425.	615.	565.	675.	475.		
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EX.DUTY,BTU/HR									· · · · · · · · · · · · · · · · · · ·
EXOUT TEMP,F	125.	215.	289.	306.	318.	333.	355.		· · · · · · · · ·
-TEMP CRUDE OUT F		259	266.						
COOL.DUTY,BTU/HR		0.	13941342.	4350593.	6708251.	1555106.	0. 463.		1. A.
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COOL.SURF, SQFT				828	1229	170.			
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	69445.	0.	37826.	8279.	12290.	1698.	340832.		
APPROACH # F	40.	0.	40.	40.	40.	40.	0.	· · ·	
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NAME	IVAC MPA	2VAC PA	ATH GO	n an				· · · · · · · · · · · · · · · · · · ·	
API	28.5	24.0	33.3	0.0	0.0	0.0	0.0		
LBS/HR		201000.	275000.		· 0 •	0.	0.	······	
TIN,F	500.	600.	590.	0.	0.	0.	. 0.	a de la companya de l	
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APPROACH,F	0.	40.	40.	0.	0.	0.	. U.		
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TIN,F TOUT,F	100.	340.						· · · ·			· .		
EX.DUTY.BTU/HR	27711984.	1.92200000.											
EXOUT TEMP,F TEMP CRUD OUT,F	128.	259.				· · ·	· · · · ·	· · · · · · · · · · · · · · · · · · ·				4	
COOL.CUTY,BTU/HR PSEUDOT	246.	330.				······					· · · · · · · · · · · · · · · · · · ·		
COOL.SURF, SQFT		0.	-					•					
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APPROACH, F	40 •		······································						· · · · · · · · · · · · · · · · · · ·				
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NAME	HV NAPH	IVAC 255	PA2	1VAC MPA		· · · · · · · · · · · · · · · · · · ·	·	
API	44.2	24.8	44.2		· 0.0	0.0	0.0	
-LBS/HR	139000.					0.		
TIN,F	425.	. 565.	475.	500.	0.	0.	0.	
	115.	150			0			
PA?	0.	0.	1.	1.	. 0.	0.	0.	
EX.DUTY,BTU/HR						Q	Q	
EXOUT TEMP,F	289.	322.	355.	445.		· U.	U .	
TEMP CRUDE OUT F			419• · 0•		0.	······································	0.	
COOL.DUTY,BTU/HR —PSEUDOT	13941342.	6708251.	U.	0.		U •		
EX SUDE COET		2240	- 10514	15014	Δ	0. 	0.	
EX-SURF,SCFT COOL-SURF,SQFT	3410+	2240.	19914.	19710.	0	0	0.	
EXCOST\$	34179.	22402.	195136.	159159.	0.	0.	0.	
-COOL.COST,\$	37173	122902.	1401000	1391394			0.	
APPROACH F		40.	0.	0.	0.	0.	0.	
AFFRUACII	40.			•••	·····		• • •	
		and the second						
· :	. . .	· · · · · · · · · · · · · · · · · · ·	•	- B-TRAIN			· · · · · · · · · · · · · · · · · · ·	
· · · · · · · · · · · · · · · · · · ·			· ·					
NAME	IVAC 3SS	2VAC RES	PA2	- 2VAC PA	ATH - GO			
API	21.4	11.8	44.2	24.0	33.3	0.0		
-LBS/HR	53000.	 50000.	<u> </u>	201000.	275000		0.	
TIN,F	615.	. 675.	475.		590.	0.		
-TOUT,F							0.	
PA?	0.	0.	1.	1.	0.	0.	0.	
-EX.DUTY,BTU/HR	11126515.				21110112		Q	
EXOUT TEMP,F	289.	319.	355.	509.	483.	0.	0.	•
TEMP CRUDE OUT,F							······································	
COOL.CUTY,BTU/HR	4350593.	1555106.	0.	0.	51011008.	0.	· 0	
			10120	227.	7333	V .		
EX.SURF,SCFT -COOL.SURF,SQFT	1777.	1721.	18120.	2174.	9462	0.	0.	
EVCOSTE	17760	17711	181205.	.21941.	17477.		10 a	
-COOL.COST,\$	111000	112110	101203.		94621	0	0.	
APPROACH,F	40.	40.	0.	40-	40.	0.	0.	•
ALLKOACITY			and and a second se	a carrier and a second	40.			
	· · · ·	. •					· · ·	· · · · · ·
TOT DUTY,BTU	J/HR= 30702080			den de la deserva	in a second	the manufalling design of a second		
TOT EX SURF	SQ FT= 10355	50.		· · · · · ·			and the second	the second second second
TOT COOL SUP	RF, SQ FT= 2241	L6.	a la la famina na sua manana se	ty na standard and a standard				
TOT EXCH COS			1 - E - 1					
TOT COCL CCS	ST,\$= 22415	59		i in the second se				ан ад доцад и ад андараан султуулар жанабанат - 4 - 4 - каналадаан
		•						76
			i in the second se			شيبه بالإستانية الاران		•••

APPENDIX C

Example of Selection of Optimum Temperature Approach by Ten Broeck's Method

A sample calculation is given to illustrate Ten Broeck's method of determining the optimum cold end temperature approach for the exchangers in a preheat train. Figures 9 and 10, which give "P" values required in the application of this method, are included.

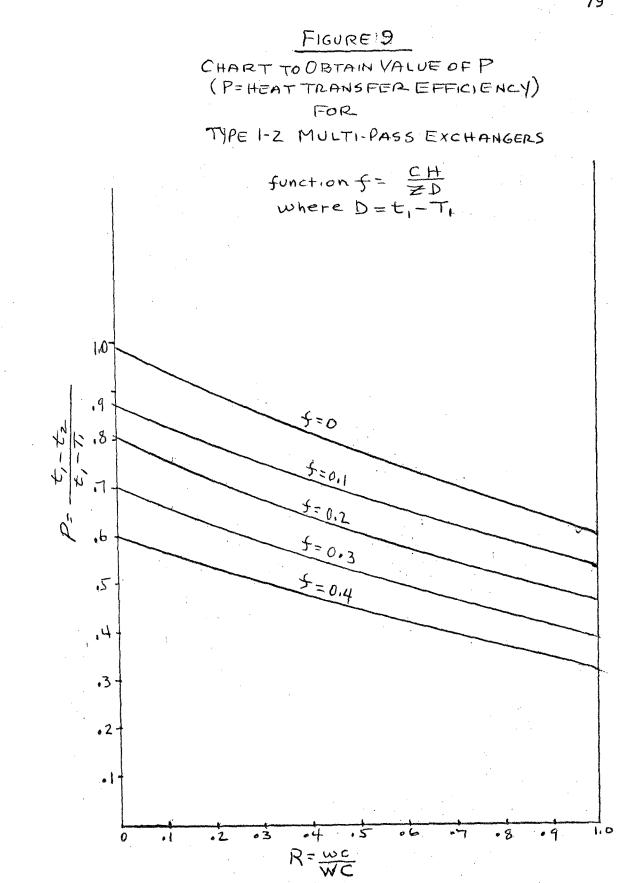
TABLE 6

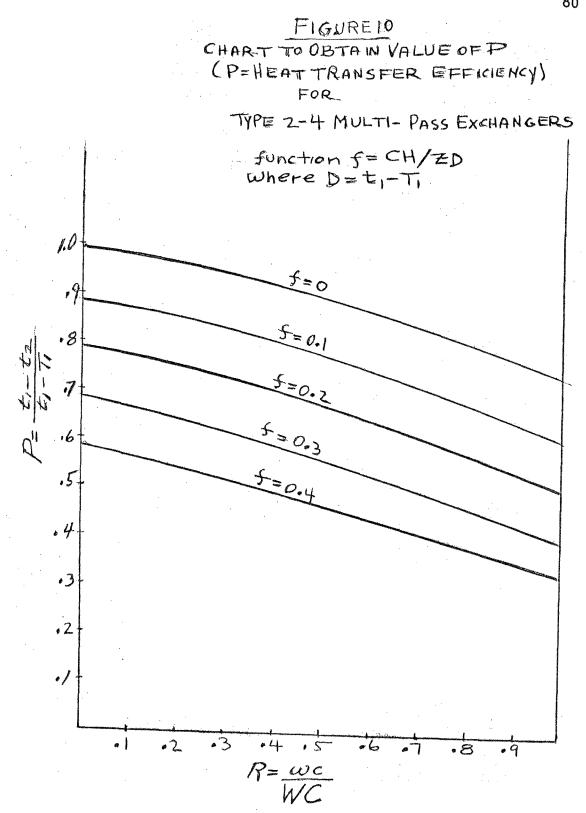
USE OF TEN BROECK'S METHOD TO GET COLD END TEMPERATURE APPROACH FOR AN EXCHANGER IN AN EXCHANGER TRAIN OR BANK. (Note 1) $R = \frac{T_2 - T_1}{t_1 - t_2} = \frac{WC}{WC} = \frac{34860 \times 67}{347,760 \times 64} = 0.105$ <u>CH</u> = .64H = .64 × 8.1 = .64 × 8.1 = .12 ZD Z, (529-332) 197 Z, 197 × .22 where D = t, - T, H= 1141E = 114×.33×10=8.1 (sorexch) YU .93×50 Ha: Bil also (for cooler) Z = C3F3 = ,66 × 55=,36 $Z_2 = C_2 F_2 - Z_3 R_3 P_3 = -36 - (.36 \times .204 \times .85) = .30$ $Z_{p} = C_{1}F_{1} - Z_{2}R_{2}P_{2} - Z_{3}R_{3}P_{3} - (64x.55) - (0.30 \times .53 \times .44)$ (NOTE Z.) From Figure 9, with R= 105, and CH = 0.12, then P= 0.82 Then cold-end approach $t_2 - T = D(1-P) = (529 - 332)(.18)$

Then 35° FIS APPROACH TO BE ENTERED AS HTSR (18, J)

Notes: 1) Example cale above for 5. TH EXCH. IN SAMPLE PROBLEM #1 IN APPENDIX C. 2) Z, APPLIES TO THE EXCH. FOR WHICH APPROMEN IS being Cal. culated and depends on Z's of all subsequent echangers . In this Case Zz corresponds to Zy and Zito Zbr

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NOMENCLATURE

A = area of exchanger, ft. sq.API = Specific gravity, °API °API = $\frac{141.5}{\text{Sp.gr.}}$ - 131.5 C = specific heat of crude c = specific heat of side stream E = incremental exchanger cost, \$/ft.sq. $D = t_{1} - T_{1}$ $F = H_f + H_{wat} + \frac{H_2}{t_2 - twa}$ G = cost of water, \$/thousand gallons H = 114 ie/YU H_{f} = value of incremental heat, \$/million BTU H_{W} = cost of water, \$/million BTU removed i = rate of depreciation or amortization $P = \frac{t_1 - t_2}{t_1 - T_1}$ Q = rate of heat transfer, BTU/hr. $R = \frac{T_2 - T_1}{t_1 - t_2} = \frac{wc}{WC}$ S = savings, \$/yr. T = temperature of crude stream, °F. t = temperature of side stream, °F. twl = inlet water temperature, °F. tw2 = outlet water temperature, °F. DeltH = $t_1 - T_2$, hot end approach, °F.

- DeltC = $t_2 T_1$, cold end approach, °F.
- U = overall coefficient of heat transfer.
 - W = rate of crude stream, lbs/hr.
 - w = rate of sidestream, lbs/hr.
 - Y = fraction of year in operation.
 - Z = function related to position of exchanger in preheat train (See example in appendices)

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- (3) Whistler, A. M. "Heat Exchangers as Money Makers" Petroleum Refiner - Vol. 27, No. 1, January, 1948.