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Conceptual Design of an Advanced Absorption Cycle: The Double-Effect Regenerative Absorption Refrigeration Cycle

Kim Dao

September 1978

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CONCEPTUAL DESIGN OF AN ADVANCED ABSORPTION CYCLE: THE DOUBLE-EFFECT REGENERATIVE ABSORPTION REFRIGERATION CYCLE

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ABSTRACT

An advanced absorption refrigeration cycle was proposed as a heat-activated refrigeration system. Referred to as the double-effect regenerative absorption cycle or cycle 2R, it improves the performance of the conventional single-effect absorption cycle at high heat source temperatures. The performance of cycle 2R continually improves as input temperatures rise, in contrast to the conventional double-effect absorption cycle that has a sharp cut-off temperature below which it ceases to operate. Cycle 2R operates with two subcycles, the first-effect and the second-effect subcycles. The second-effect subcycle is a conventional single-effect cycle activated by heat rejected from the first-effect subcycle. The first-effect subcycle is a new absorption cycle operating with a multi-pressure-stage boiling process (boiler) driven by the heat source in such a way that the boiling process occurs essentially at constant temperature. A regeneration process between the first-effect boiler and the second-effect generator makes possible the recovery of heat that otherwise would be lost, thus improving the efficiency of the system.

The advantages of cycle 2R over the conventional cycles are:

- A continuously higher practical coefficient of performance (COP) at increasing input temperatures, following the Carnot COP trend (about 63%).

- A much lower practical cut-off input temperature. Practically, cycle 2R works at any heat source temperature about 40°F higher than the condensing temperature. Theoretically, cycle 2R has no cut-off temperature.

NOMENCLATURE

Z : mass flow rates relative to the mass flow rate of line 2 (Fig. 3)

r : return ratio defined as:

$$r = \frac{\text{(mass flow rate from station 10 to station 11)}}{\text{(total mass flow rate at station 10)}} .$$ See Fig. 1 or 2.

s : fraction of the total mass flow rate from station 1 to station 2 diverted to station 7 (Fig. 1 or 2)

T : temperature, °F

X : concentration, weight fraction of refrigerant in mixture (either vapor or solution)

p : pressure, psia

h : enthalpy, Btu/lb

G : generator

C : condenser

E : evaporator

R : recuperator

B : boiler

O : condenser-absorber

Terms used in computer print-outs:

DT = $T_4 - T_3$ (See Fig. 3)

Max. Recoverable Heat in Preheater: Total heat obtained when Z_3, Z_4, Z_{14}, Z_{15} and Z_{16} are cooled to T_0 in the preheater.

INTRODUCTION

The double-effect regenerative absorption refrigeration cycle (or cycle 2R) is an effort by the Lawrence Berkeley Laboratory to design an efficient cooling system for solar applications. Present solar-activated cooling systems have either a low efficiency or a sharp cut-off temperature that prevents the effective use of highly variable solar radiation. Conventional single-effect absorption systems have a low coefficient of performance (COP) of the order of 0.70 and a sharp cut-off input temperature of about 200°F. Conventional double-effect absorption systems have a good COP of about 1.10 but unfortunately, they also have a sharp cut-off input temperature of about 300°F. This high cut-off temperature may render the system inoperative (or operative with very low collector efficiencies) during a considerable period when solar radiation is low. Rankine-vapor compression systems have no cut-off input temperatures but their COP's are likely limited to less than 50% of the Carnot COP.

The cycle 2R described in this report has a continuously increasing COP at higher temperatures, approaching 63% of the Carnot COP. This cycle works efficiently with input temperatures from 160°F to about 300°F (the condenser and the evaporator temperatures being 110°F and 40°F, respectively).

DESCRIPTION OF CYCLE 2R

The operation of cycle 2R is described below and numerically traced in Figure 1 (thermodynamic cycle) and Figure 2 (schematic of the conceptual design of the system). Note that in Figure 1 the boiling process, station 7 to station 8, is represented by eight essentially constant pressure boiling stages whereas in Figure 2 that same process is represented by only three boiling stages. Correspondingly, for the resorption process from station 9 to station 3 there are nine essentially constant pressure resorption stages in Figure 1 and only four in Figure 2. The correspondence between Figure 1 and Figure 2 is complete if:

- the middle boiling (zig-zag) coil of the boiler in Figure 2 is visualized as repeating itself six times.

- the resorption (zig-zag) coil and pump-stage i of the generator in Figure 2 are visualized as repeating themselves six times.

Cycle 2R consists of two subcycles, numerically traced in Figures 1 and 2: the second-effect subcycle (stations 1-2-3-4-5-6), and the first-effect subcycle (stations 2-7-12-11-8-9-10-13-3).

OPERATION OF THE SECOND-EFFECT SUBCYCLE

The second-effect subcycle is a conventional single-effect absorption cycle that incorporates the high pressure (HP) vapor line within the solution preheater (Fig. 2) so that more heat recuperation is possible. Rectification of the HP vapor in the preheater produces a condensate that is extracted about halfway through the preheater.
In the second-effect subcycle the strong solution (rich in refrigerant)

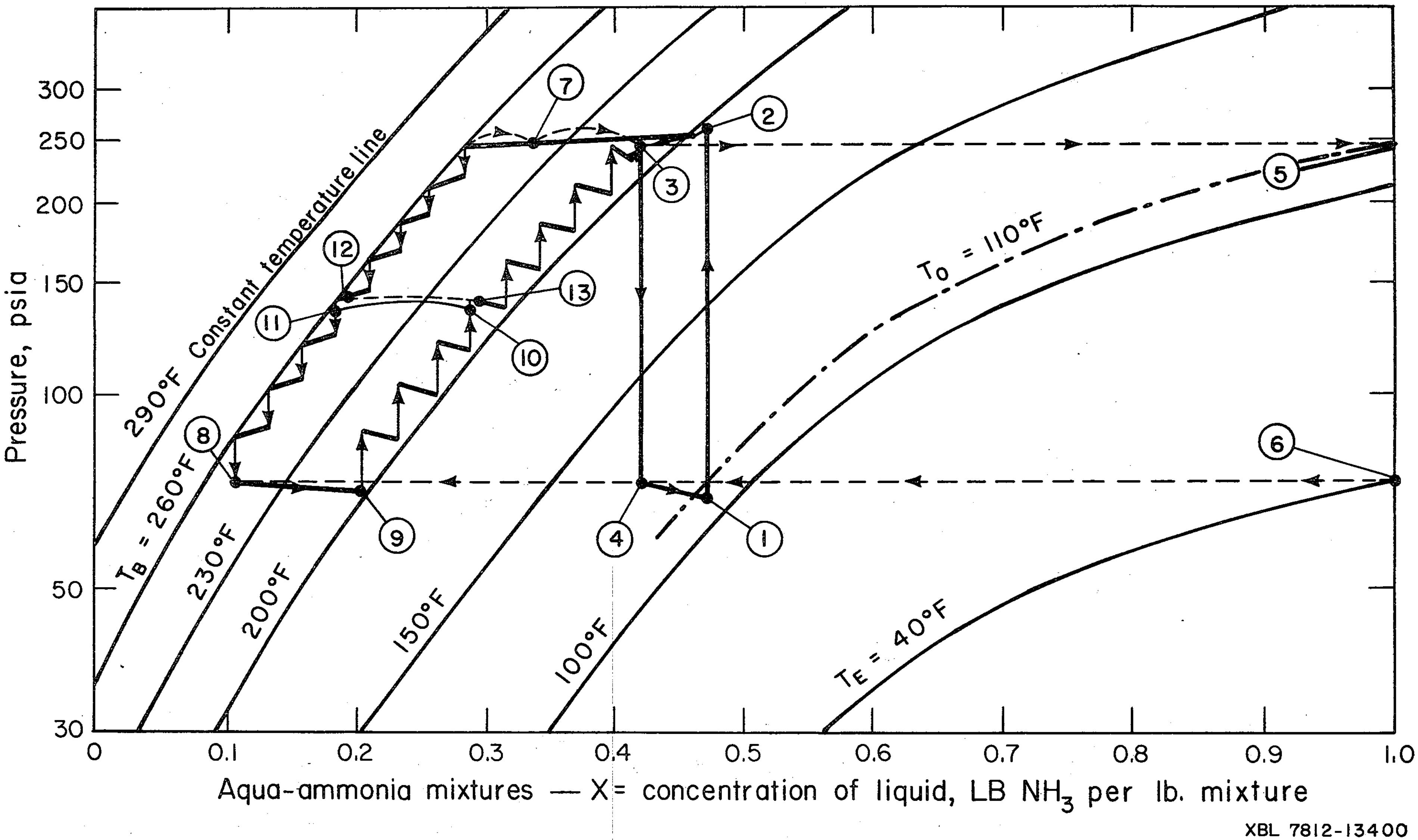

Figure 1. Thermodynamic diagram of cycle 2R.

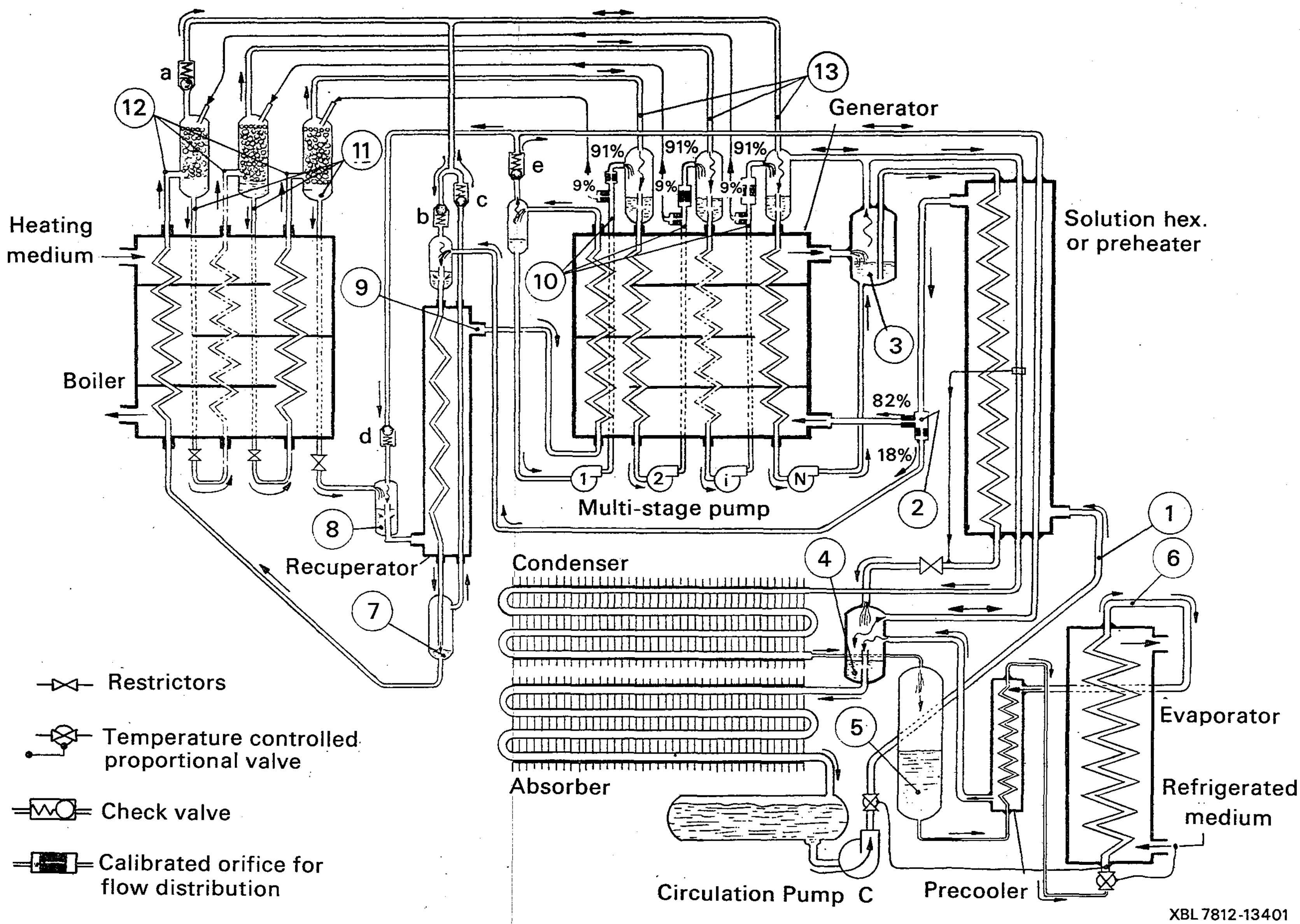

Figure 2. Conceptual design of cycle 2R refrigeration systems.

at station 1 is circulated by pump C from the evaporator pressure through the preheater to station 2 at a pressure slightly higher (about 15 psi) than the condenser pressure. At station 2 the mass flow rate of the strong solution is split into two streams by two calibrated orifices. Because the pressure drop across the two orifices is almost equal, the sizes of the orifices determine the relative mass flow rates of the streams. This flow splitting need not be accurate since its influence on the performance of cycle 2R is small. For the NH_3/H_2O pair, an allocation of 17% to 22% of strong solution diverted to station 7, and 78% to 83% to station 3 seems to be a good choice.

The second-effect subcycle continues from station 2 to station 3 through the generator (shell side of the generator). This is a constant pressure generating (or boiling) process heated by the resorption processes from station 9 to station 3 (tube side of the generator). At station 3, the generating process 2-3 (shell side) produces a mixture of vapor and weaker solution at condenser pressure. This mixture is separated into its two components which are fed into different lines of the preheater where they exchange heat to the strong solution. The cooled weak solution exciting the preheater at station 4 is expanded through a restrictor to the inlet of the absorber where it starts absorbing the refrigerant vapor coming from the evaporator. The cooled high pressure vapor exiting the preheater is fed into the condenser where it condenses at station 5 and is stored in a tank.

The condensed liquid refrigerant is precooled and expanded into the evaporator for the production of refrigeration. The expansion valve for the liquid refrigerant is controlled proportionally to the difference in temperatures between the refrigerated medium and a preset value. This valve closes completely at and below the preset temperature. The maximum opening of this expansion valve sets a limit to the maximum cooling capacity of the system.

The circulation outlet, pump C, is also fitted with a temperature (or pressure) controlled proportional valve. When the evaporating temperature (or pressure) rises above a preset value, this valve opens, and conversely it closes when the temperature drops below the preset value. The maximum pumping capacity of pump C is chosen such that there is enough solution to absorb the maximum refrigerant flow to the evaporator under the most unfavorable conditions. For instance, it is capable of a circulation ratio (circulation ratio = strong solution flowrate/refrigerant flow rate) of about 17 for NH_3/H_2O solutions.

Because the system is intended to operate within a given range of temperature conditions, two storage tanks are used to adjust the concentration of the solutions: the refrigerant storage tank at the exit of the condenser and the strong solution storage tank at the exit of the absorber. For example, on a very hot day the absorber temperature can reach 130°F, if NH_3/H_2O solutions are used in the system, and the concentration of the strong solution can be 0.41 at pump C (the evaporator temperature being 40°F). On a relatively cooler day, on the other hand, the absorber temperature can be 105°F, producing a strong solution concentration of 0.49. The excess NH_3 resulting from the concentration change is stored in the refrigerant storage tank. The original solution charge must be strong enough for the lowest anticipated absorber temperature and the highest evaporator temperature. Storage tank volume must be calculated according to the anticipated concentration changes and the solution-holding capacity of the system.

To operate cycle 2R at its maximum, that is, to operate it within a large range of temperature conditions with a COP approaching a high percentage of the Carnot COP, it would be desirable to manage the storage of the heating, cooling and refrigerated media such that the system operates at its highest COP. For example, with a heat source of 270°F, a heat sink of 75°F (night cooling), and a cold storage at 45°F, the COP of the system can be about 1.4. A possible scheme would be the storage for a heat sink by night cooling, a cold storage, and operation of the cycle 2R during solar energy collection without a hot storage.

OPERATION OF THE FIRST-EFFECT SUBCYCLE:

The first-effect subcycle consists of four main processes:

1. The boiling process (stations 7-12-11-8) in which the solution uses heat from the heat source to generate vapors at many pressure stages such that the whole process occurs at approximately constant temperature. In Figure 1, the boiling process starts at station 7 and continues at constant pressure until the solution reaches its maximum boiling temperature (260°F as shown in Fig. 1) compatible with the heat source temperature and with the heat transfer characteristics of the boiler. This segment of the boiling process corresponds to the first (from left) zig-zag coil of the boiler in Figure 2. At the end

of the coil the solution is separated from the vapor. Since this vapor is at condenser pressure, it is fed to the condenser via the preheater. But before entering the preheater, this vapor is partially rectified by direct contact in a packed pipe with a cooler solution bled from the generator. The 9% bleeding lines are shown in Figure 2.

At the end of this first segment of the boiling process, the solution (separated from its vapor) is expanded through a restrictor to a lower pressure stage for further boiling. This boiling process continues throughout the many pressure stages, where the solution boils at constant pressure until it reaches the maximum boiling temperature (e.g., 260°F as shown in Figure 1). At the end of each boiling stage, such as at station 12, the vapor and the solution are separated into two different paths: the solution path which continues the boiling process (that is diverted to station 11 for expansion to a lower pressure boiling stage), and the vapor path to station 13. The vapor path from stations 12 to 13 is part of the solution return process discussed later.

2. The regeneration process (heat exchange process between line 2-7 and line 8-9). At the exit of the last boiling stage, the solution (separated from its vapor) is expanded to evaporator pressure. This solution at high temperature and low pressure is very weak. It can absorb vapor boiled off from the evaporator to release a substantial amount of heat at high temperature (line 8-9). This heat is absorbed by the boiling strong solution (at condenser pressure) from station 2 to station 7. The vapor generated by the boiling at stations 2 to 7 augments the vapor from the generator (stations 2 to 3) for a higher

system COP. The regeneration process occurs in the recuperator shown in Figure 2. The operation of check valves a, b, c, d and e in Figure 2 will be detailed later.

3. The resorption process (stations 9-10-13-3). At the outlet of the recuperator, station 9, the solution temperature is determined by the heat transfer characteristic of the recuperator. This temperature may not match the temperature of the resorption process, that is, the temperature of the generator. Therefore this solution is fed into the first coil of the generator (from left of Fig. 2) so that further heat exchange can occur for temperature matching.

The resorption process starts at pump stage 1 where the solution coming from station 9 is pumped to the first resorption stage. Each resorption stage occurs at essentially constant pressure across each corresponding zig-zag coil of the generator (Fig. 2). Each pressure stage of the resorption process corresponds to a boiling stage at the same pressure. Each boiling stage produces vapor (such as the vapor flowing from station 12 to station 13) that is absorbed by the solution pumped up from a lower pressure stage (such as at station 10).

The resorption process continues until station 3, where the outlet solution mixes with the weak solution exiting the shell side of the generator (that is, exiting the generating process 2-3).

4. The solution return process (stations 10-11-12-13). The solution return process is the ensemble of flow paths similar to paths 10-11 and 12-13. Each pair of paths, such as 10-11 and 12-13, occurs at constant pressure in a packed segment of pipe where the hot vapor

produced by each boiling stage exchanges heat and mass (by direct contact) with the solution bled from station 10. The return ratio is about 8% to 14% for NH_3/H_2O solutions and 8 pressure stages, that is, 8% to 14% of the output of each pump stage is returned to the boiler. The remaining 86% to 92% of the solution continues the resorption process. The value of the return ratio does not greatly influence the performance of cycle 2R. A good return ratio for NH_3/H_2O solutions seems to be 10%±2%.

OPERATION OF THE CHECK VALVES

Let T_{off} be the cut-off temperature of the conventional single-effect absorption cycle. If cycle 2R is to be operated only with input temperatures higher than, say, $T_{off} + 15°F$, then the check valves labeled a, b, c, d and e in Figure 2 are not needed. They are used only to insure the proper flow direction of the vapors when the input temperatures change from higher to lower than T_{off}.

Operation of cycle 2R with input (boiler) temperature higher than T_{off} has been described above. In that operating regime, check valve a is opened by the high pressure vapor produced in the first coil of the boiler. The vapor is produced by the solution exiting station 7 which is at a cooler temperature than the boiler, and thus continues to boil in the first coil. The vapor is at a higher pressure than that of the condenser. The same higher pressure closes check valve b and opens c so that the vapor generated in the recuperator can escape to the condenser. At the same time, the pressure at station 9 is lower than that of the evaporator (because of the cooling and absorption of vapor), allowing the evaporator vapor to be fed to the recuperator through valve d. This same lower pressure closes valve e, allowing absorption to continue in the generator from station 9 to the inlet of pump stage 1.

In operating regimes with input temperatures less than T_{off}, cycle 2R functions with the same processes described above, except for the following:

1. <u>Solution return process</u>

- Lines 10-11 have the same flow direction but are cooling down instead of heating up.

- Lines 12-13 have the same flow direction but are heating up instead of cooling down.

2. <u>Regeneration process</u>

- Line 8-9 has the same flow direction but is boiling and giving off vapor instead of absorbing.

- Line 2-7 has the same flow direction but is absorbing vapor coming from the condenser instead of generating vapor for the condenser.

Thus, the regeneration process decreases the vapor output to the condenser and increases the vapor load to the absorber. This reduction of performance is understandable because with a lower input temperature, a lower COP is expected. Here, the first-effect subcycle of cycle 2R can be considered as a heat pump subcycle that uses the boiler heat input to pump heat from the heat sink to a temperature high enough to run the second-effect subcycle.

Check valve a is now closed because the temperature at station 7 is higher than that of the boiler; thus, the solution continues to absorb the vapor coming from the condenser in the first coil of the boiler. The pressure in this absorption process is necessarily lower than that of the condenser. Therefore, valve b is opened and valve c is closed. Process 8-9 is now a boiling process giving off vapor at higher pressure than that of the evaporator. This high pressure closes valve d and opens valve e to allow the produced vapor to escape to the absorber.

ESTIMATION OF THE PERFORMANCE OF CYCLE 2R

Figure 3 and the assumptions listed in Table 1 are used to estimate the COP of cycle 2R using NH_3/H_2O solutions.

ASSUMPTIONS CONCERNING THE MASS FLOW RATES

- All mass flow rates are relative to line 2, that is,

  $Z_2 = 1.0$ lb/hr

- Let r be the return ratio, then (for 8 stages)

$$Z_{10} = 8r \frac{Z_9+Z_3}{2} = R(Z_9+Z_3) .$$

  (For 8 pressure stages r is from 0.08 to 0.14 and R from 0.32 to 0.56.)

- The ratio Z_2/Z_1 is given as s (s is about 14% to 22%).

Other assumptions

- To simplify the calculations for the preheater, it is assumed that the strong solution entering the generator is at a temperature equal to: T_2 = saturated Temp. at X_1 and $P_C + 15$ psia.

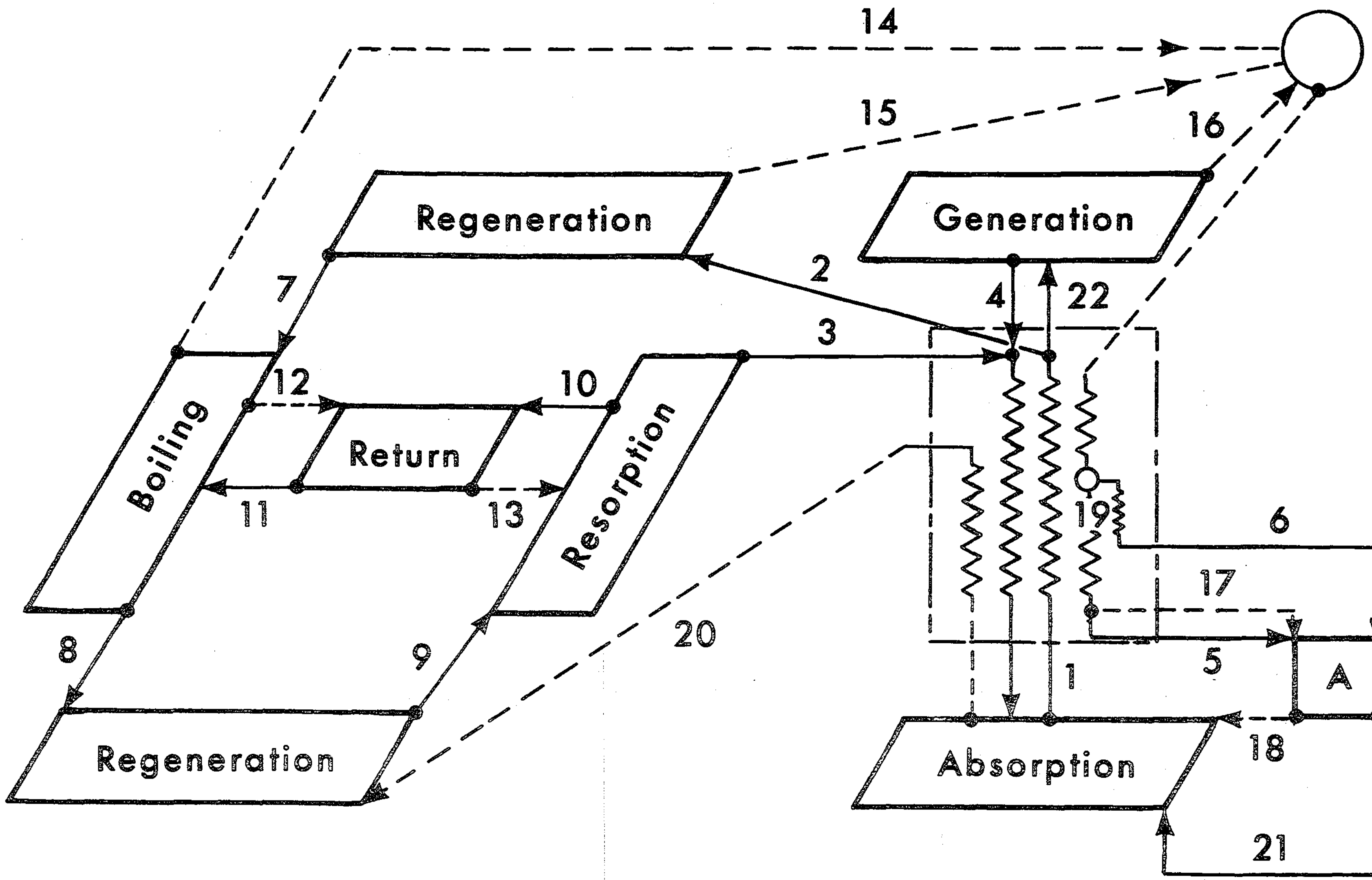

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Figure 3. Schematic system used to estimate the COP of cycle 2R. Box A represents the condenser, evaporator and precooler.

Table 1. Assumptions concerning the properties of the lines in Figure 3.

T_B: highest boiling temperature

T_O: lowest absorbing and condensing temperature

T_E: lowest evaporator temperature

T_{off}: saturated temperature of the solution of station 1 and at P_C+15

P_C: condenser pressure

P_E: evaporator-absorber pressure

Line No.	Temperature, °F	Pressure, psia	Saturated Phases
1	T_O	P_E	Liquid
2	T_{off}	P_C+15	
3	T_4-DT	P_C	
4	T_4	P_C	
5	T_0+20	P_C	
6	$(T_4+T_0)/2$	P_C	
7	T_7	P_C	
8	T_B	$P_L=P_E(P_C/P_E)^{0.15}$	
9	T_4-DT	P_E	
10	T_4-DT	P_M	
11	T_{11}	$P_M=P_E(P_C/P_E)^{0.33}$	
12	T_B	P_M	Vapor
13	T_4	P_M	
14	T_4	P_C	
15	T_4	P_C	
16	T_4	P_C	
17	T_0+20	P_C	
18	T_0-20	P_E	
19	$(T_4+T_0)/2$	P_C	
20	T_4-10	P_E	
21	T_0-10	P_E	Liquid
22	T_{off}	P_C+15	Liquid

- Other heat exchanger characteristics are given as a temperature approach. For example, the precooler has a temperature approach of 10°F (lines 21 and 18 have a temperature of T_0 - 10°F).
- DT is the difference between the highest temperature of the generation process (T_4) and the lowest temperature of the resorption process (T_9 and T_3). DT is about 2° to 6°F.

METHOD OF CALCULATION

The unknowns to be calculated are:

- the 21 mass flow rates, Z_1 to Z_{21},
- the temperatures T_7, T_4 and T_{11}, for a total of 24 unknowns.

Eighteen mass and species balances can be written around the components of the system. There are three given mass distribution conditions, namely:

$$Z_2 = 1.0;$$

$$Z_{10} = 8r(Z_9 + Z_3)/2, \quad r = 0.08 \text{ to } 0.14;$$

and

$$Z_2 = sZ_1, \quad s = 0.14 \text{ to } 0.22,$$

or

$$Z_2 = sZ_{22}/(1-s);$$

and 3 energy balances, namely:

Return process -- $Z_{12}\, h_{12} + Z_{10}\, h_{10} = Z_{11}\, h_{11} + Z_{13}\, h_{13}$,

Regeneration -- $Z_{20}\, h_{20} + Z_8\, h_8 - Z_9\, h_9 = Z_{15}\, h_{15} + Z_7\, h_7 - Z_2\, h_2$,

Resorption -- $Z_{13}\, h_{13} + Z_9\, h_9 - Z_{10}\, h_{10} - Z_3\, h_3 = Z_{16}\, h_{16} + Z_4\, h_4 - (Z_1 - Z_2)h_2$.

Thus, there are 24 equations for 24 unknowns. The cooling load is calculated from:

$$Q_E = Z_{18}\, h_{18} + Z_{21}\, h_{21} - Z_{17}\, h_{17} - Z_5\, h_5 - Z_6\, h_6 \;,$$

where h_{17} is evaluated at the outlet of the condenser, that is, at saturated liquid at T_c and X_{17}. X_{17} is the saturated concentration of the vapor at P_c and T_c + 20°F. Lines 5 and 6 are expanded directly into the precooler.

The heat input Q_B is calculated from:

$$Q_B = Z_{14}\, h_{14} + Z_{12}\, h_{12} + Z_8\, h_8 - Z_7\, h_7 - Z_{11}\, h_{11} \;,$$

$$COP = Q_E/Q_B \;.$$

Table 2 summarizes the solution of the mass and species balances.

The above coefficients F_i are calculated assuming T_4 and T_7 are known. Initial values can be taken as: $T_4 = T_{off}$ + 10°F and $T_7 = T_B$ - 10°F. Values for the concentrations and enthalpies are taken (at known saturated T and P) from "Physical and Thermodynamic Properties of Ammonia-Water Mixtures," Research Bulletin No. 34, IGT, AGA.

Now, T_7 is corrected by the energy balance of the regeneration process:

$$Q_R = Z_{20}h_{20} + Z_8h_8 - Z_9h_9 \;,$$

$$Z_{15}/Z_2 = (Q_R - Z_7h_7 + Z_2h_2)/Z_2h_{15} = A \;.$$

Since

$$Z_{15}/Z_2 = (X_2-X_7)/(X_{15}-X_7) = A \;,$$

$$X_7 = (X_2 - AX_{15})/(1-A) \;.$$

Therefore, T_7 corrected = table $(X_7,\, P_c)$ and

$$h_7 = [\text{table } (X_7,\, T_7) + 0.6\; h_7 \text{ previous}]/1.6 \;.$$

Table 2. Mass flow rates as functions of X.

Solve the mass balances for the lines:	To get these mass flow rates:	(R and S given)
8; 9; 20	$Z_9 = F_9Z_{20}$	$F_9 = (X_{20}-X_8)/(X_9-X_8)$
	$Z_8 = F_8Z_{20}$	$F_8 = F_9-1$
9; 13; 10; 3	$Z_3 = F_3Z_{20}$	$F_3 = F_9[(1-R)X_{13} - (X_9-RX_{10})]$ $/[(1+R)X_{13} - (X_3+rX_{10})]$
	$Z_{13} = F_{13}Z_{20}$	$F_{13} = F_3(1+R) - F_9(1-R)$
	$Z_{10} = F_{10}Z_{20}$	$F_{10} = R(F_9 + F_3)$
7; 15; 2	$Z_7 = F_7Z_2$	$F_7 = (X_{15}-X_2)/(X_{15} - X_7)$
	$Z_{15} = F_{15}Z_2$	$F_{15} = (1-F_7)$
8; 14; 7; 10; 13 Solve for Z_8 and set Z_8=F_8Z_{20} to get Z_{20}	$Z_{20} = F_{20}Z_2$	$F_{20} = F_7(X_{14}-X_7)/(F_8(X_{14}-X_8)-$ $F_{10}(X_{14}-X_{10}) + (X_{14}-X_{13})F_{13}$
	$Z_{14} = F_{14}Z_2$	$F_{14} = F_7 + F_{20}(F_{10}-F_{13}-F_8)$

T_4 is corrected by the energy balance of the resorption process:

$$Q_G = Z_{13}h_{13} + Z_9h_9 - Z_{10}h_{10} - Z_3h_3 ,$$

$$Z_{16}/(Z_1-Z_2) = [Q_G + (Z_1-Z_2)h_2 - Z_4h_4]/(Z_1-Z_2)h_{16} = B,$$

where Z_1, Z_4 are given by the mass and species balances for the lines 16, 4 and (1-2) as:

$$Z_1 = Z_2/S ,$$

$$Z_4 = (X_{16}-X_2)(Z_1-Z_2)/(X_{16}-X_4) ,$$

and

$$X_4 = (X_2-BX_{16})/(1-B) .$$

Therefore:

$$T_4 \text{ corrected} = \text{Table } (X_4; P_C) ,$$

and

$$h_4 = [\text{Table } (X_4, T_4) + 0.6\ h_4 \text{ previous}]/1.6.$$

This iterative procedure converges very fast, and five to seven iterations should produce results accurate to a few hundredths of a degree, °F.

As of now the following results have been obtained:

T_7 and T_4

$Z_2 = Z_2$

$Z_3 = F_{20}\ F_3\ Z_2$

$Z_7 = F_7\ F_2$

$Z_8 = F_{20}\ F_8\ Z_2$

$Z_9 = F_{20}\ F_9\ Z_2$

$$Z_{10} = F_{20}\, F_{10}\, Z_2$$
$$Z_{13} = F_{20}\, F_{13}\, Z_2$$
$$Z_{14} = F_{14}\, Z_2$$
$$Z_{15} = F_{15}\, Z_2$$
$$Z_{20} = F_{20}\, Z_2$$
$$Z_1 = Z_2/s$$
$$Z_{16} = B(Z_1-Z_2)$$

and $$Z_4 = (X_{16}-X_2)(Z_1-Z_2)/(X_{16}-X_4).$$

Z_{12}, Z_{11} and T_{11} are now calculated from the mass and species balances for lines 7, 14, 8, 11, 12 and the enthalpy balance of the return process: let $h_{11} = h_{10}$ (for a first guess, to be corrected),

$$a = Z_{13} - Z_{10}\ ,$$
$$b = Z_{13}h_{13} - Z_{10}h_{10}\ ,$$
$$c = Z_{13}X_{13} - Z_{10}X_{10}\ ,$$

and $$d = b - ah_{12}\ .$$

Then:

$$Z_{11} = d/(h_{12} - h_{11})\ ,$$
$$Z_{12} = a + Z_{11}\ ,$$
$$X_{11} = (Z_{12}X_{12} - C)/Z_{11}\ ,$$
$$T_{11} = \text{Table }(X_{11},\ P_M)\ ,$$
$$h_{11} = [\text{Table }(X_{11},\ T_{11}) + 0.6\ h_{11}]/1.6\ .$$

With this corrected value of h_{11}, recalculations can be made for Z_{11}, Z_{12}, T_{11}, and h_{11}. The convergence of T_{11} should be obtained in less than seven iterations.

The computer program for this system should be simple, as shown in the following flow chart (Figure 4):

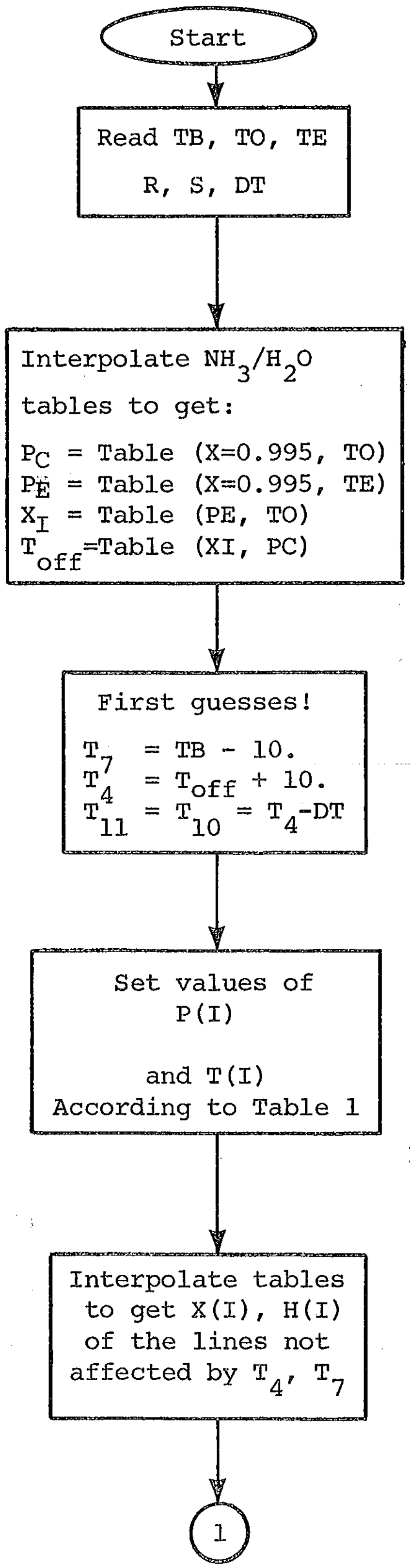
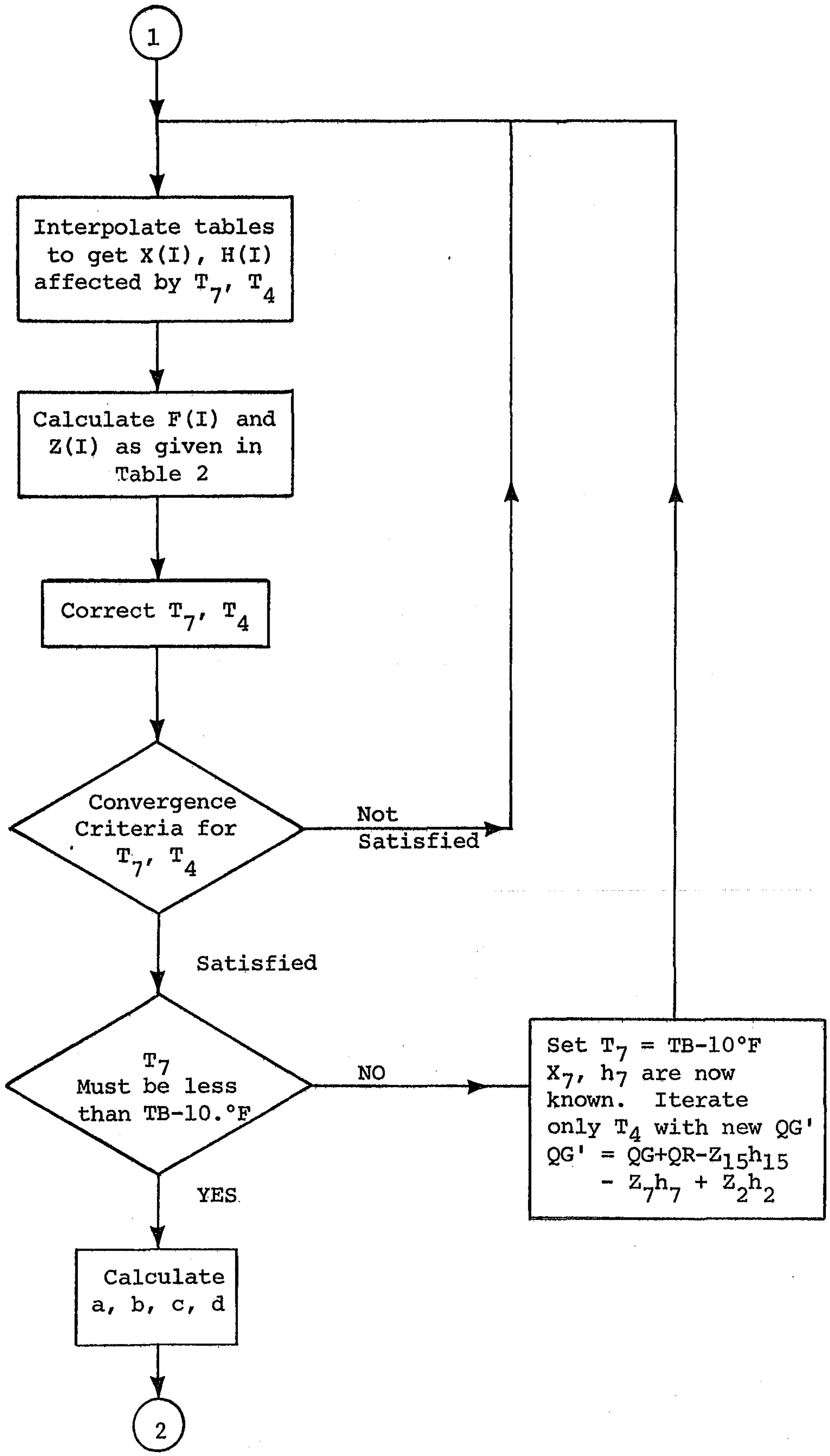
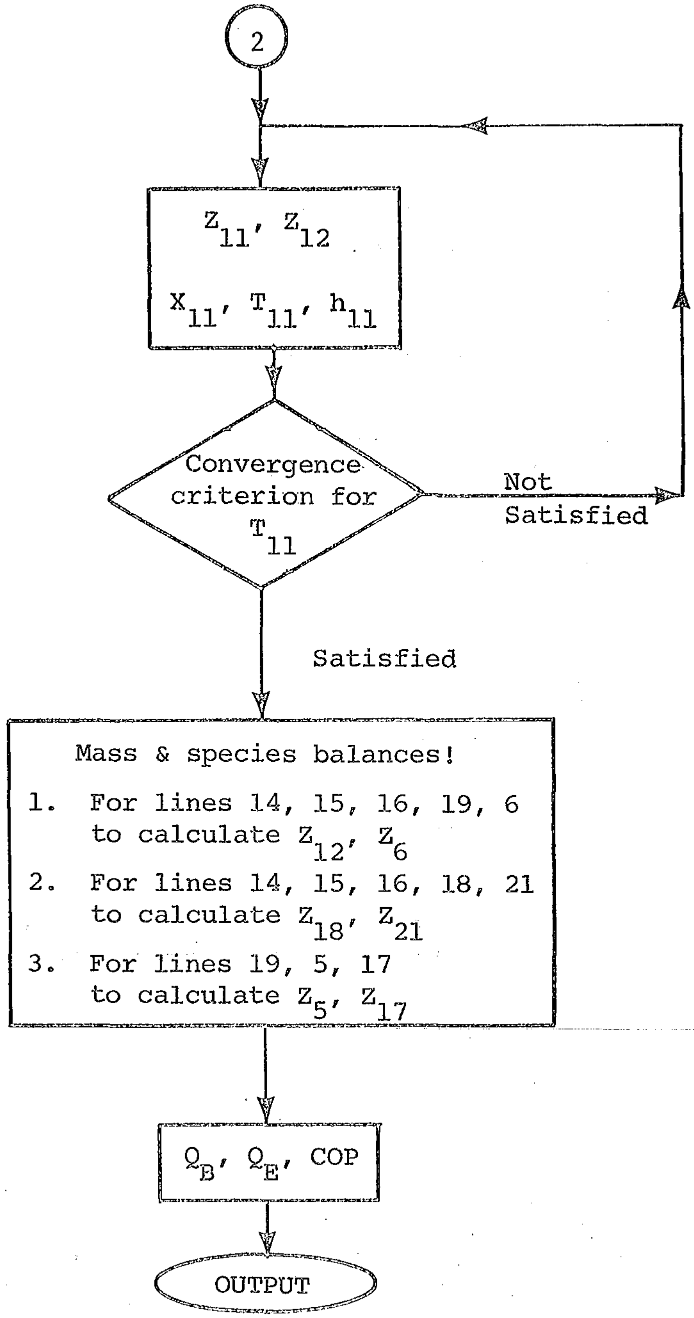


Figure 4. Flow chart of the computer program for estimating the performance of cycle 2R.


1
Interpolate tables to get X(I), H(I) affected by T_7, T_4
Calculate F(I) and Z(I) as given in Table 2
Correct T_7, T_4
Convergence Criteria for T_7, T_4
Not Satisfied
Satisfied
T_7 Must be less than TB-10.°F
NO
Set T_7 = TB-10°F
X_7, h_7 are now known. Iterate only T_4 with new QG'
$QG' = QG+QR-Z_{15}h_{15} - Z_7h_7 + Z_2h_2$
YES
Calculate a, b, c, d
2


2
Z_{11}, Z_{12}
X_{11}, T_{11}, h_{11}
Convergence criterion for T_{11}
Not Satisfied
Satisfied
Mass & species balances!
1. For lines 14, 15, 16, 19, 6 to calculate Z_{12}, Z_6
2. For lines 14, 15, 16, 18, 21 to calculate Z_{18}, Z_{21}
3. For lines 19, 5, 17 to calculate Z_5, Z_{17}
Q_B, Q_E, COP
OUTPUT

RESULTS

Calculated COP are plotted in Figures 5-11 versus some important parameters. The computer outputs are listed in Appendix I.

In figure 5, the COP of cycle 2R is compared to other cycles, namely, the common-condenser double-effect cycle, the cycle 1R, and the basic single-effect cycle. (A detailed description of cycle 1R can be found in Reference 1, of the basic single-effect cycle in Reference 2, and of the common condenser double-effect cycle in Appendix II.)

Figure 5 shows that cycle 2R performs as well as the single-effect cycle at low boiler temperatures and as well as the double-effect at high temperatures. The COP of cycle 2R increases continuously with boiler temperatures. While this is slightly less than the COP of cycle 1R, the configuration of cycle 2R is less complicated and only a careful cost analysis of the two systems can determine which one is better. The absence of cut-off temperatures is a feature of cycle 2R that makes it superior to double-effect cycles.

Figure 6 shows that at low condenser-absorber temperatures T_O, and high input temperatures T_B, the COP of cycle 2R can be substantially higher than double-effect cycles.

Figure 7 shows that cycle 2R can be used as heat pump for heating purposes since it has an acceptable COP at T_E of about 10°F.

Figures 8-10 show the small influence of r, s and DT on the performance of cycle 2R.

The influence of the size of the preheater (or preheater effectiveness) is shown in Figure 11. It seems that the preheater effectiveness must be greater than 0.85 for good system performance.

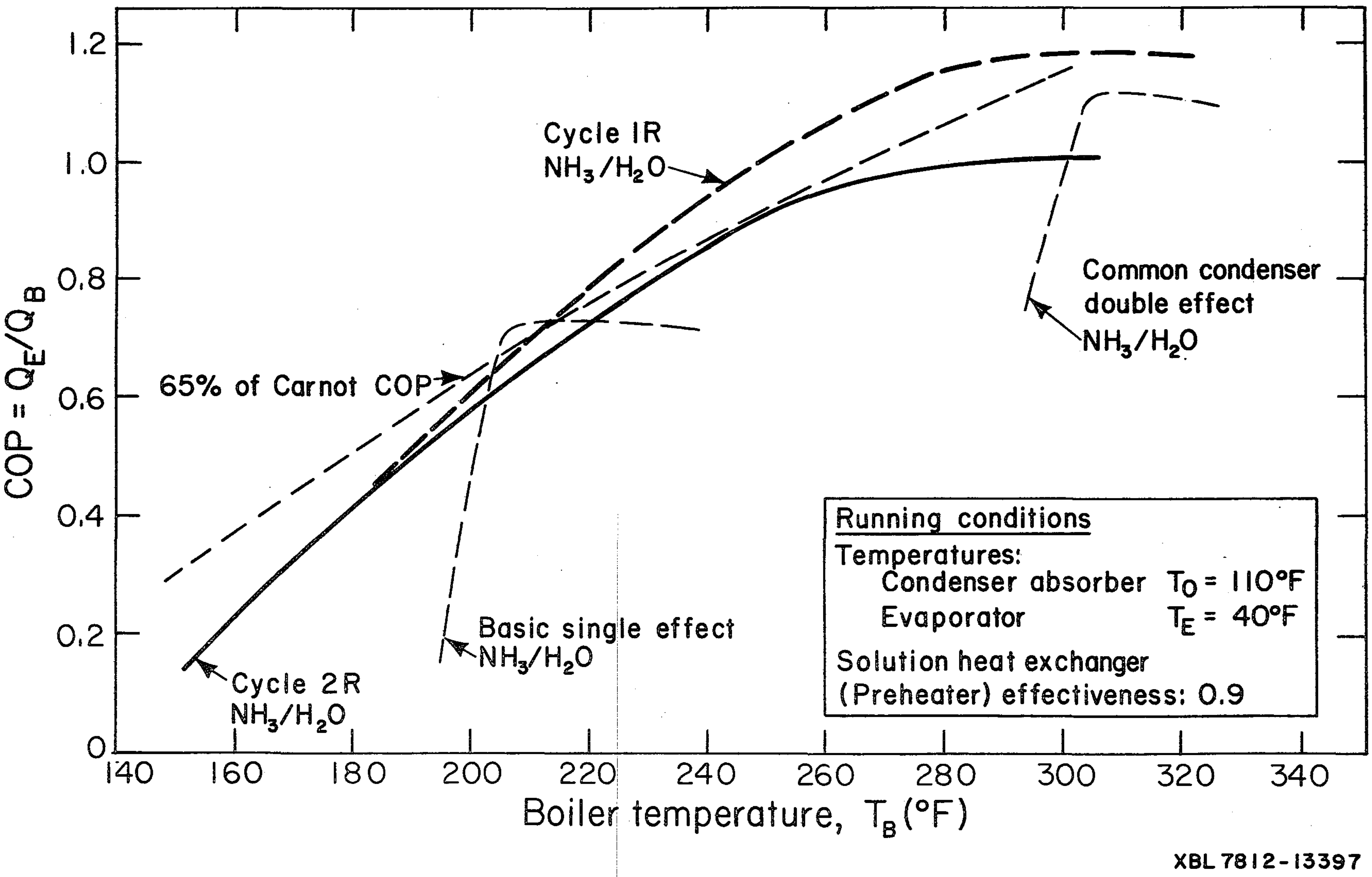
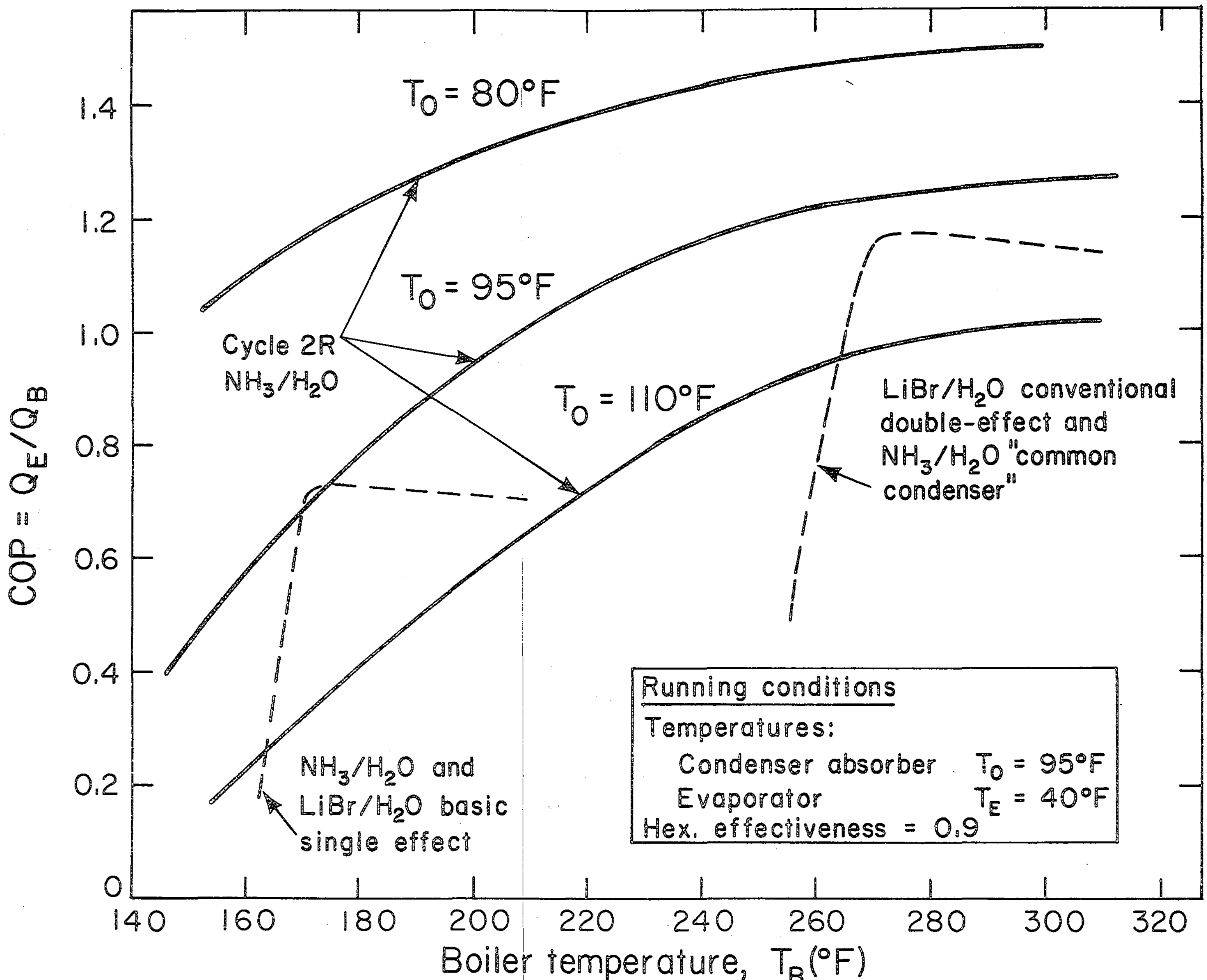
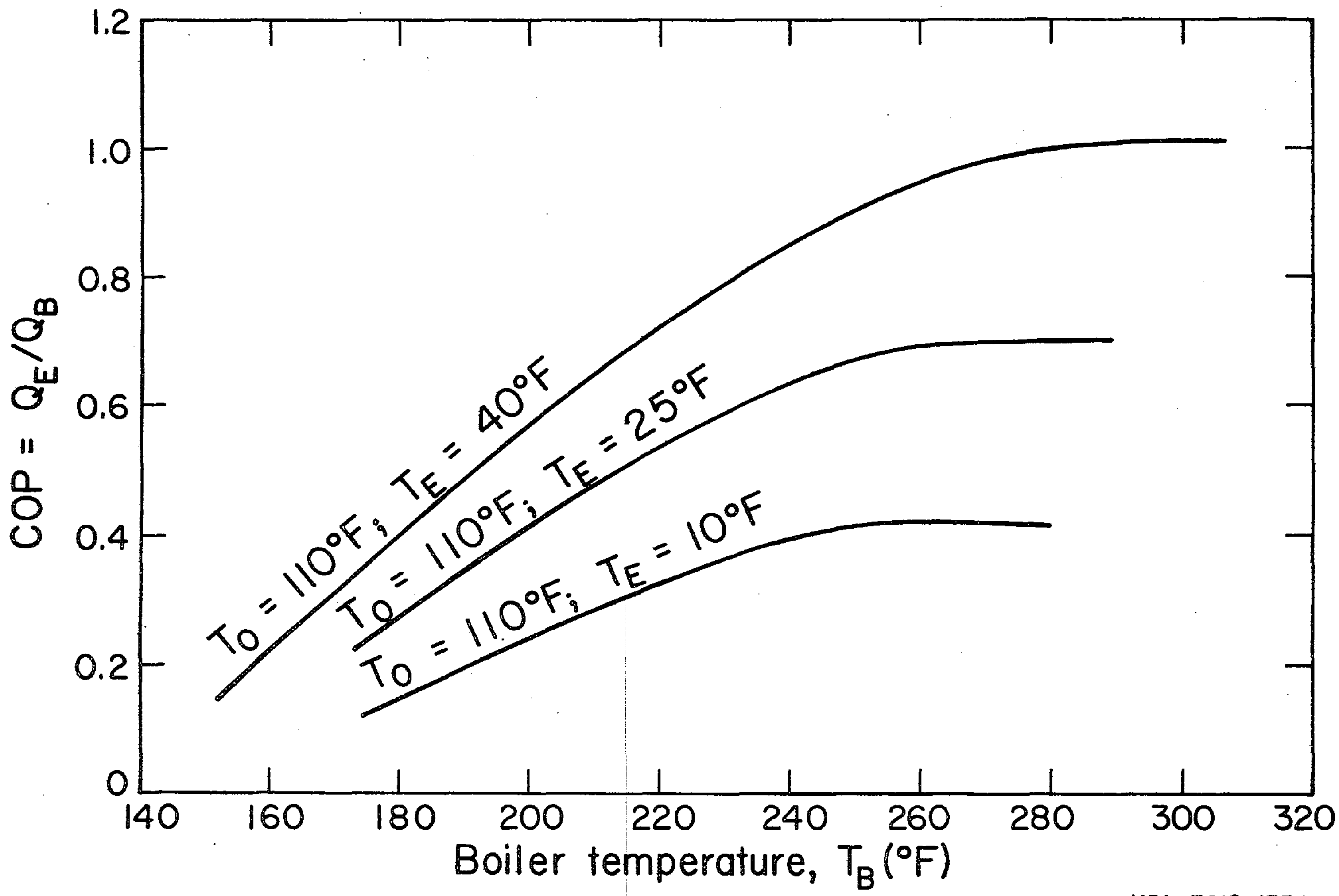


Figure 5. Calculated performance of cycle 2R using NH_3/H_2O mixtures. Carnot COP = $(T_B-T_O)/(T_B+460) \times (T_E+460)/(T_O-T_E)$.



XBL 7812-13396

Figure 6. Calculated performance of cycle 2R using NH_3/H_2O mixtures.



XBL 7812-13391

Figure 7. Calculated performance of cycle 2R using NH_3/H_2O mixtures.

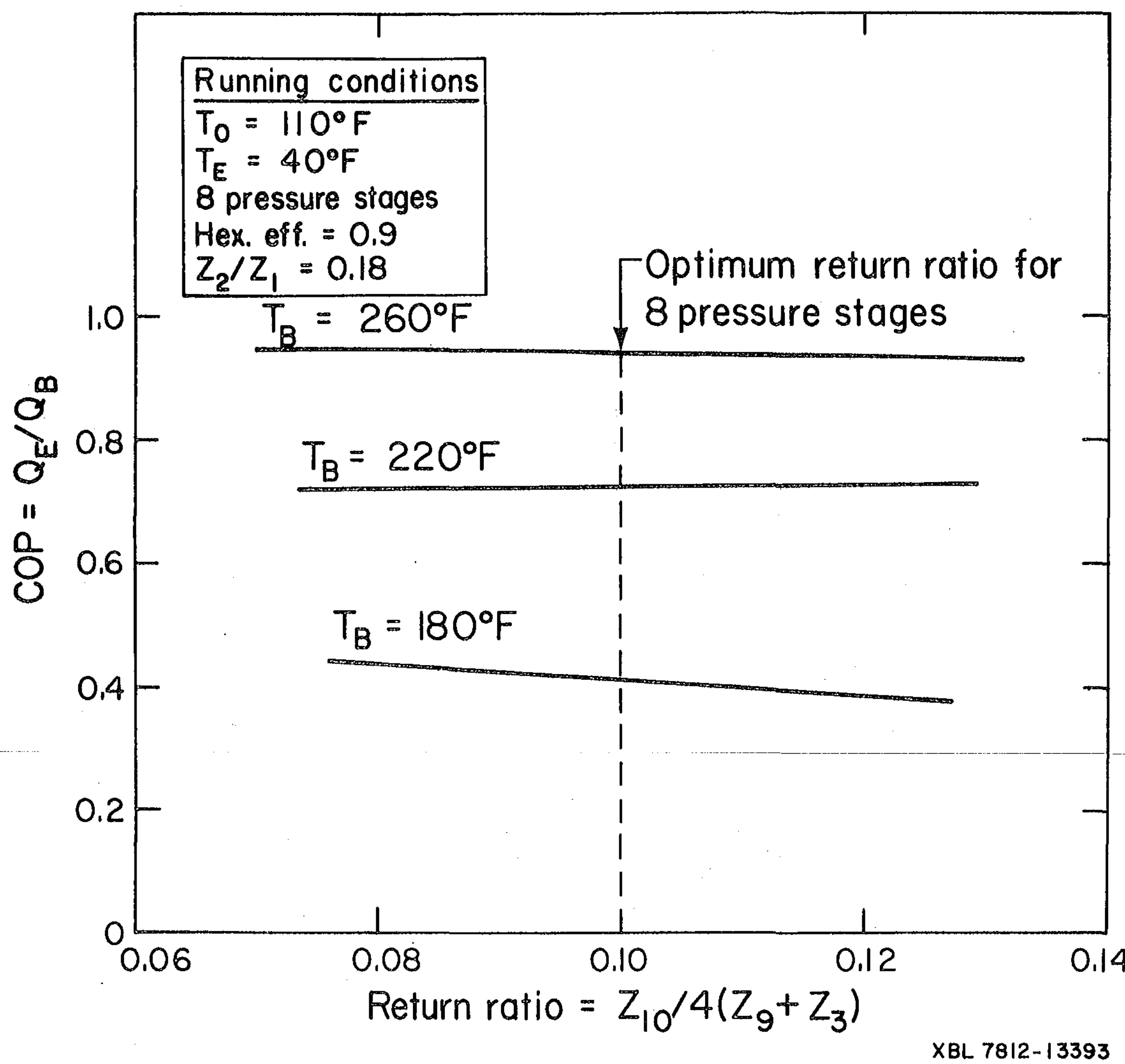


Figure 8. Small influence of the return ratio r on the COP of cycle 2R.

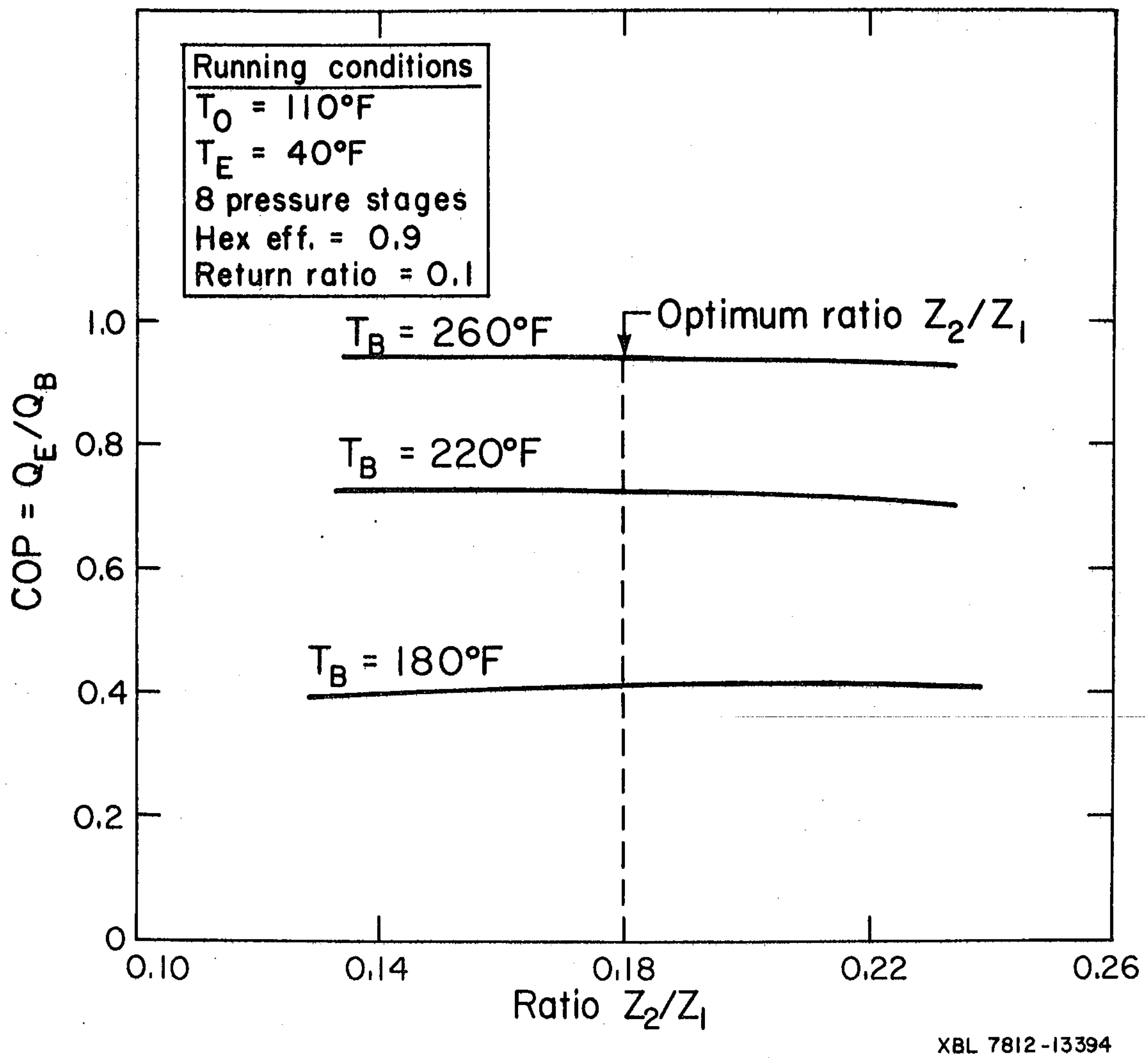


Figure 9. Small influence of the splitting ratios = Z_2/Z_1 on the COP of cycle 2R.

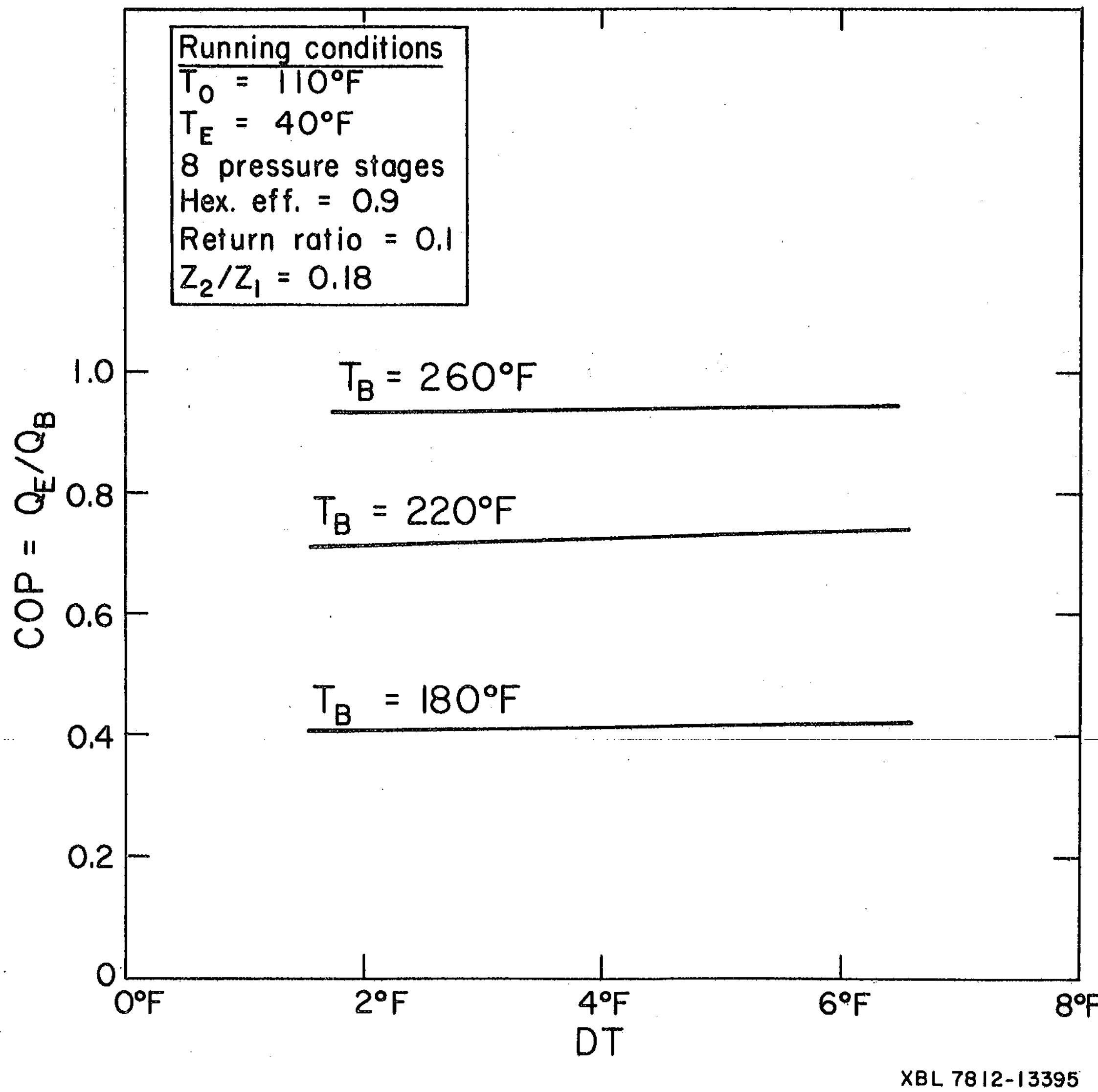


Figure 10. Small influence of DT on the COP of cycle 2R.

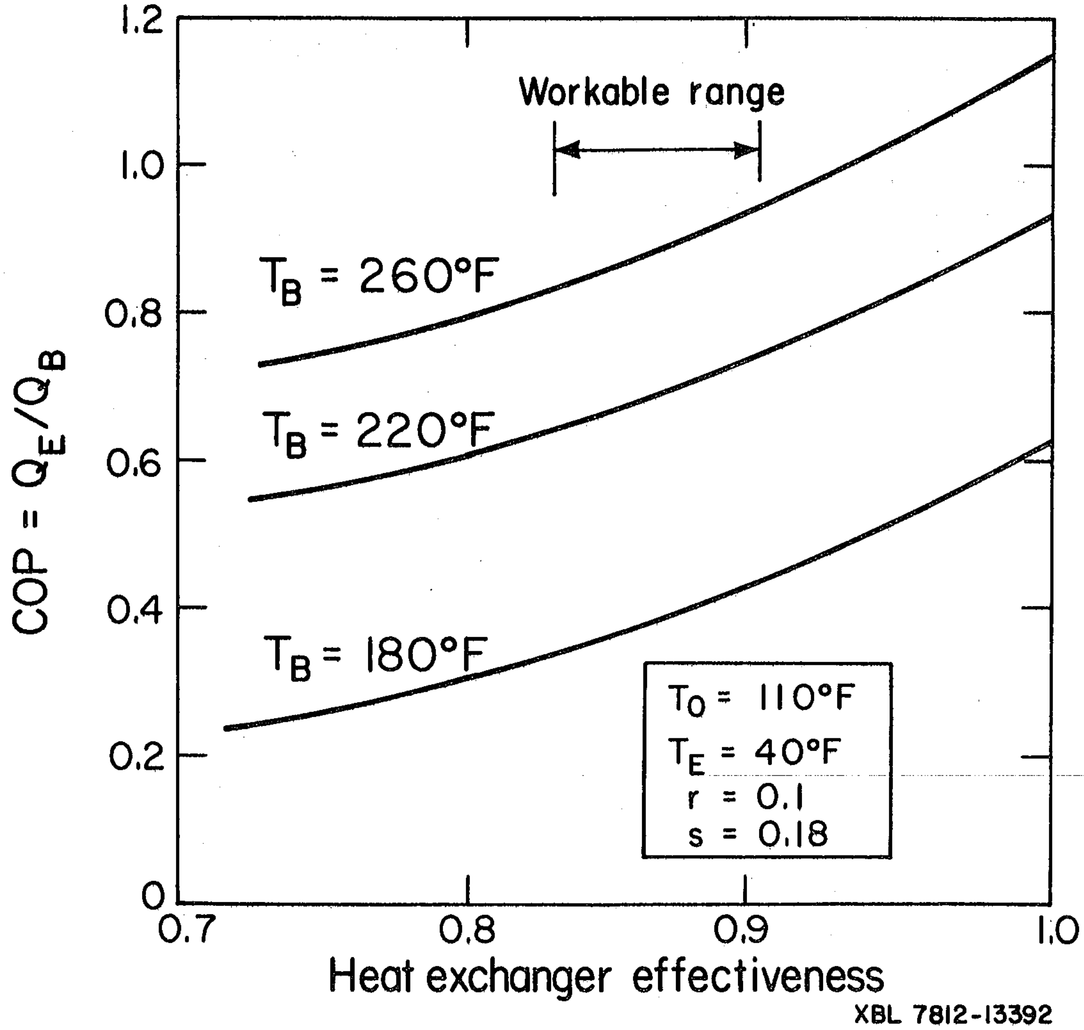


Figure 11. Estimated influence of preheater effectiveness on the COP of cycle 2R.

REFERENCES

1. Kim Dao, A New Absorption Cycle: The Single-effect Regenerative Absorption Refrigeration Cycle, Lawrence Berkeley Laboratory, Report LBL-6879, Feb. 1978.

2. Kim Dao, Mel Simmons, Richard Wolgast and Michael Wahlig, Performance of an Experimental Solar-Driven Absorption Air-Conditioner, Lawrence Berkeley Laboratory, Report LBL-5911, Jan. 1977.

APPENDIX I. OTHER DOUBLE-EFFECT CYCLES

The "common condenser" double-effect cycle (Fig. A) is an alternative to the conventional double-effect cycle which cannot be used with NH_3/H_2O mixtures because the pressure in the generator of the first effect would be too high (about 900 psia). In the conventional double-effect cycle, the condensation of the refrigerant vapor generated from the first-effect generator releases heat to boil out refrigerant in the second-effect generator. In the "common condenser" cycle the refrigerant vapors generated by both generators are at the same pressure; they are subsequently rectified and condensed in the same condenser.

The "common condenser" cycle is essentially the coupling of two conventional single-effect cycles. The first single-effect cycle operates at high generator temperature to boil out refrigerant vapor at the common condenser pressure and absorbs refrigerant vapor at the common evaporator pressure (the evaporator is common to both coupled cycles). This absorption of vapor releases heat at a temperature high enough to boil out refrigerant in the generator of the second single-effect cycle.

The conventional double-effect cycle is also essentially the coupling of two single-effect cycles. The difference between the conventional and "common-condenser" cycles consists in the mode of coupling: For the conventional double-effect cycle, the coupling is between the first-effect condensing process and the second-effect generating process; for the "common condenser" cycle the coupling is between the first-effect absorption process and the second-effect generating process.

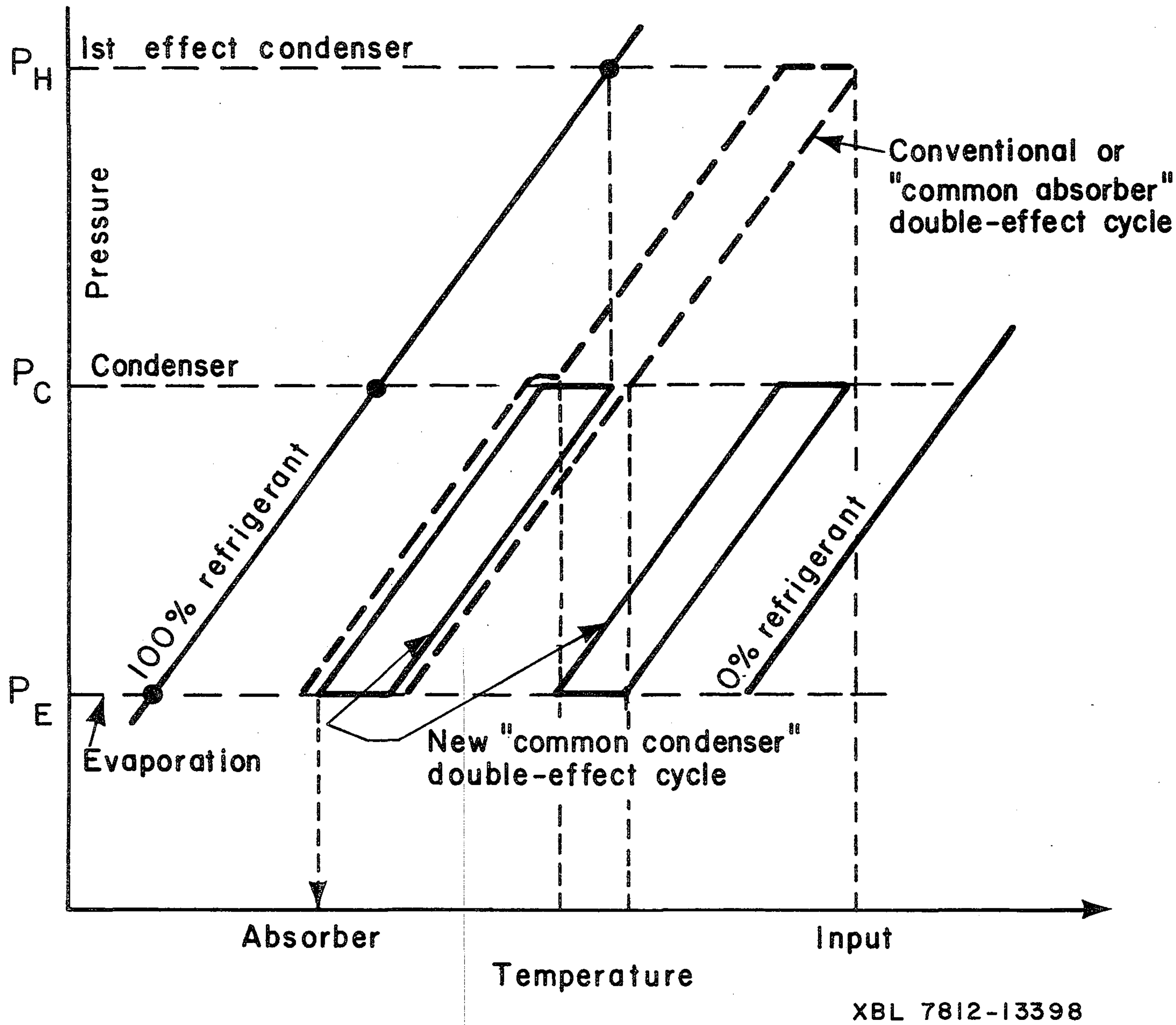


Figure A. Two possible configurations of double-effect absorption cycles. Both cycles have high, sharp cut-off temperatures.

APPENDIX II

CALCULATED MASS FLOW RATES

AND OTHER RESULTS

TR= 160.0F TC= 110.0F TE= 40.0F RETURN RATIO=.100 Z2/Z1=.180 DT= 4.0 COP= .147 FRACTION OF CARNOT=.255
MAX RECOVERABLE HEAT IN PREHEATER= 654.7 PREHEATER EFF. USED= .829 COP WITH PREH. EFF. OF 0.9= .232
COOLING PER LB OF TOTAL VAP. GENERATED= 458.7 HEAT TO GENERATOR PER LB OF VAP.= 684.5 4 5

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	73.0	.4715	-23.5	5.5556	12	160.0	109.0	.9712	623.2	.3808
2	196.9	260.9	.4715	74.2	1.0000	13	206.4	109.0	.9075	683.3	.3728
3	202.4	245.9	.4402	80.2	.8670	14	206.4	245.9	.9608	640.3	.2913
4	206.4	245.9	.4277	84.8	4.1816	15	206.4	245.9	.9608	640.3	-.5492
5	120.0	245.9	.8667	58.2	.0054	16	206.4	245.9	.9608	640.3	.3740
6	158.2	245.9	.5975	-3.7	.0092	17	120.0	245.9	.9989	89.6	.1014
7	148.8	245.9	.6451	38.0	1.5492	18	100.0	73.0	.9956	583.3	.1078
8	160.0	87.6	.3538	39.2	1.7926	19	158.2	245.9	.9922	596.1	.1068
9	202.4	73.0	.2116	115.1	1.4016	20	202.4	73.0	.8637	706.6	-.3910
10	202.4	109.0	.2790	99.8	.9074	21	100.0	73.0	.5069	-33.6	.0082
11	190.1	109.0	.3110	79.9	.9154	22	196.9	260.9	.4715	74.2	4.5556

TR= 180.0F TC= 110.0F TE= 40.0F RETURN RATIO=.100 Z2/Z1=.180 DT= 4.0 COP= .348 FRACTION OF CARNOT=.445
MAX RECOVERABLE HEAT IN PREHEATER= 639.7 PREHEATER EFF. USED= .849 COP WITH PREH. EFF. OF 0.9= .411
COOLING PER LB OF TOTAL VAP. GENERATED= 458.2 HEAT TO GENERATOR PER LB OF VAP.= 687.0 6 5

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	73.0	.4715	-23.5	5.5556	12	180.0	109.0	.9514	644.2	.3889
2	196.9	260.9	.4715	74.2	1.0000	13	206.9	109.0	.9065	684.1	.3842
3	202.9	245.9	.4389	80.7	.8945	14	206.9	245.9	.9603	640.8	.1750
4	206.9	245.9	.4264	85.3	4.1710	15	206.9	245.9	.9603	640.8	-.2978
5	120.0	245.9	.8667	58.2	.0124	16	206.9	245.9	.9603	640.8	.3846
6	158.4	245.9	.5965	-3.8	.0210	17	120.0	245.9	.9989	89.6	.2284
7	161.4	245.9	.5836	41.9	1.2978	18	100.0	73.0	.9956	583.3	.2429
8	180.0	87.6	.2993	70.8	1.6750	19	158.4	245.9	.9921	596.3	.2408
9	202.9	73.0	.2105	115.9	1.4468	20	202.9	73.0	.8621	707.6	-.2283
10	202.9	109.0	.2779	100.6	.9365	21	100.0	73.0	.5069	-33.6	.0189
11	194.5	109.0	.2995	86.9	.9411	22	196.9	260.9	.4715	74.2	4.5556

TR= 200.0F TC= 110.0F TE= 40.0F RETURN RATIO=.100 Z2/Z1=.180 DT= 4.0 COP= .532 FRACTION OF CARNOT=.546
MAX RECOVERABLE HEAT IN PREHEATER= 626.9 PREHEATER EFF. USED= .866 COP WITH PREH. EFF. OF 0.9= .574
COOLING PER LB OF TOTAL VAP. GENERATED= 457.7 HEAT TO GENERATOR PER LB OF VAP.= 689.1 6 4

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	73.0	.4715	-23.5	5.5556	12	200.0	109.0	.9207	672.6	.3950
2	196.9	260.9	.4715	74.2	1.0000	13	207.2	109.0	.9056	684.8	.3939
3	203.2	245.9	.4378	81.1	.9179	14	207.2	245.9	.9599	641.2	.0867
4	207.2	245.9	.4253	85.8	4.1621	15	207.2	245.9	.9599	641.2	-.0967
5	120.0	245.9	.8667	58.2	.0182	16	207.2	245.9	.9599	641.2	.3935
6	158.6	245.9	.5956	-3.9	.0311	17	120.0	245.9	.9989	89.6	.3341
7	179.4	245.9	.5145	56.2	1.0967	18	100.0	73.0	.9956	583.3	.3554
8	200.0	87.6	.2476	103.9	1.5774	19	158.6	245.9	.9921	596.4	.3523
9	203.2	73.0	.2096	116.5	1.4852	20	203.2	73.0	.8608	708.3	-.0921
10	203.2	109.0	.2769	101.2	.9613	21	100.0	73.0	.5069	-33.6	.0280
11	200.6	109.0	.2838	96.8	.9623	22	196.9	260.9	.4715	74.2	4.5556

TR= 220.0F TC= 110.0F TE= 40.0F RETURN RATIO=.100 Z2/Z1=.180 DT= 4.0 COP= .699 FRACTION OF CARNOT=.605
MAX RECOVERABLE HEAT IN PREHEATER= 621.6 PREHEATER EFF. USED= .882 COP WITH PREH. EFF. OF 0.9= .723
COOLING PER LB OF TOTAL VAP. GENERATED= 457.4 HEAT TO GENERATOR PER LB OF VAP.= 690.7 6 4

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	73.0	.4715	-23.5	5.5556	12	220.0	109.0	.8726	708.5	.4012
2	196.9	260.9	.4715	74.2	1.0000	13	207.6	109.0	.9049	685.3	.4019
3	203.6	245.9	.4368	81.5	.9371	14	207.6	245.9	.9595	641.6	.0196
4	207.6	245.9	.4244	86.1	4.1548	15	207.6	245.9	.9595	641.6	.0655
5	120.0	245.9	.8667	58.2	.0232	16	207.6	245.9	.9595	641.6	.4008
6	158.8	245.9	.5949	-4.0	.0397	17	120.0	245.9	.9989	89.6	.4229
7	203.2	245.9	.4373	81.0	.9345	18	100.0	73.0	.9956	583.3	.4501
8	220.0	87.6	.1988	137.6	1.4945	19	158.8	245.9	.9920	596.5	.4461
9	203.6	73.0	.2088	117.1	1.5168	20	197.6	73.0	.8796	696.8	.0222
10	203.6	109.0	.2761	101.7	.9815	21	100.0	73.0	.5069	-33.6	.0358
11	209.1	109.0	.2624	110.7	.9808	22	196.9	260.9	.4715	74.2	4.5556

TR= 240.0F TC= 110.0F TE= 40.0F RETURN RATIO=.100 Z2/Z1=.180 DT= 4.0 COP= .842 FRACTION OF CARNOT=.635
MAX RECOVERABLE HEAT IN PREHEATER= 639.0 PREHEATER EFF. USED= .891 COP WITH PREH. EFF. OF 0.9= .854
COOLING PER LB OF TOTAL VAP. GENERATED= 456.7 HEAT TO GENERATOR PER LB OF VAP.= 693.5 11 4

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	73.0	.4715	-23.5	5.5556	12	240.0	109.0	.8000	746.3	.4105
2	196.9	260.9	.4715	74.2	1.0000	13	208.1	109.0	.9038	686.2	.4066
3	204.1	245.9	.4353	82.1	.9492	14	208.1	245.9	.9589	642.1	-.0124
4	208.1	245.9	.4229	86.8	4.1426	15	208.1	245.9	.9589	642.1	.1820
5	120.0	245.9	.8667	58.2	.0281	16	208.1	245.9	.9589	642.1	.4132
6	159.0	245.9	.5938	-4.1	.0483	17	120.0	245.9	.9989	89.6	.5063
7	230.0	245.9	.3630	136.9	.8180	18	100.0	73.0	.9956	583.3	.5391
8	240.0	87.6	.1514	171.1	1.4184	19	159.0	245.9	.9919	596.7	.5345
9	204.1	73.0	.2075	118.0	1.5372	20	198.1	73.0	.8780	697.9	.1188
10	204.1	109.0	.2748	102.5	.9946	21	100.0	73.0	.5069	-33.6	.0437
11	220.5	109.0	.2346	129.5	.9985	22	196.9	260.9	.4715	74.2	4.5556

TR= 260.0F TC= 110.0F TE= 40.0F RETURN RATIO=.100 Z2/Z1=.180 DT= 4.0 COP= .927 FRACTION OF CARNOT=.623
MAX RECOVERABLE HEAT IN PREHEATER= 659.4 PREHEATER EFF. USED= .889 COP WITH PREH. EFF. OF 0.9= .940
COOLING PER LB OF TOTAL VAP. GENERATED= 455.2 HEAT TO GENERATOR PER LB OF VAP.= 699.5 12 4

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	73.0	.4715	-23.5	5.5556	12	260.0	109.0	.7012	799.6	.4184
2	196.9	260.9	.4715	74.2	1.0000	13	209.3	109.0	.9009	688.4	.4076
3	205.3	245.9	.4316	83.5	.9543	14	209.3	245.9	.9574	643.5	-.0105
4	209.3	245.9	.4193	88.2	4.1137	15	209.3	245.9	.9574	643.5	.2468
5	120.0	245.9	.8667	58.2	.0335	16	209.3	245.9	.9574	643.5	.4416
6	159.7	245.9	.5910	-4.5	.0580	17	120.0	245.9	.9989	89.6	.5864
7	250.0	245.9	.3123	147.4	.7532	18	100.0	73.0	.9956	583.3	.6250
8	260.0	87.6	.1104	202.4	1.3567	19	159.7	245.9	.9918	597.2	.6199
9	205.3	73.0	.2045	120.1	1.5473	20	199.3	73.0	.8740	700.3	.1906
10	205.3	109.0	.2717	104.6	1.0007	21	100.0	73.0	.5069	-33.6	.0529
11	236.9	109.0	.1958	156.8	1.0115	22	196.9	260.9	.4715	74.2	4.5556

TR= 280.0F TC= 110.0F TE= 40.0F RETURN RATIO=.100 Z2/Z1=.180 DT= 4.0 COP= .990 FRACTION OF CARNOT=.603
MAX RECOVERABLE HEAT IN PREHEATER= 678.5 PREHEATER EFF. USED= .887 COP WITH PREH. EFF. OF 0.9=1.006
COOLING PER LB OF TOTAL VAP. GENERATED= 453.7 HEAT TO GENERATOR PER LB OF VAP.= 704.8 13 6

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	73.0	.4715	-23.5	5.5556	12	280.0	109.0	.5693	883.0	.4252
2	196.9	260.9	.4715	74.2	1.0000	13	210.5	109.0	.8981	690.5	.4085
3	206.5	245.9	.4281	84.9	.9588	14	210.5	245.9	.9560	644.8	-.0052
4	210.5	245.9	.4159	89.6	4.0867	15	210.5	245.9	.9560	644.8	.2990
5	120.0	245.9	.8667	58.2	.0385	16	210.5	245.9	.9560	644.8	.4692
6	160.2	245.9	.5884	-4.8	.0673	17	120.0	245.9	.9989	89.6	.6573
7	270.0	245.9	.2648	178.5	.7010	18	100.0	73.0	.9956	583.3	.7013
8	280.0	87.6	.0721	232.6	1.3037	19	160.2	245.9	.9916	597.6	.6958
9	206.5	73.0	.2017	122.1	1.5564	20	200.5	73.0	.8702	702.7	.2527
10	206.5	109.0	.2687	106.5	1.0061	21	100.0	73.0	.5069	-33.6	.0617
11	261.1	109.0	.1423	196.0	1.0228	22	196.9	260.9	.4715	74.2	4.5556

TR= 290.0F TC= 110.0F TE= 40.0F RETURN RATIO=.100 Z2/Z1=.180 DT= 4.0 COP= 1.015 FRACTION OF CARNOT=.592
MAX RECOVERABLE HEAT IN PREHEATER= 688.0 PREHEATER EFF. USED= .886 COP WITH PREH. EFF. OF 0.9=1.032
COOLING PER LB OF TOTAL VAP. GENERATED= 452.9 HEAT TO GENERATOR PER LB OF VAP.= 707.4 13 6

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	73.0	.4715	-23.5	5.5556	12	290.0	109.0	.4887	932.3	.4303
2	196.9	260.9	.4715	74.2	1.0000	13	211.1	109.0	.8966	691.6	.4088
3	207.1	245.9	.4263	85.6	.9609	14	211.1	245.9	.9553	645.5	-.0008
4	211.1	245.9	.4141	90.4	4.0729	15	211.1	245.9	.9553	645.5	.3214
5	120.0	245.9	.8667	58.2	.0410	16	211.1	245.9	.9553	645.5	.4831
6	160.6	245.9	.5870	-4.9	.0720	17	120.0	245.9	.9989	89.6	.6907
7	280.0	245.9	.2424	194.1	.6786	18	100.0	73.0	.9956	583.3	.7374
8	290.0	87.6	.0533	247.4	1.2792	19	160.6	245.9	.9915	597.9	.7317
9	207.1	73.0	.2002	123.1	1.5607	20	201.1	73.0	.8682	703.9	.2815
10	207.1	109.0	.2672	107.5	1.0086	21	100.0	73.0	.5069	-33.6	.0663
11	276.6	109.0	.1099	220.2	1.0301	22	196.9	260.9	.4715	74.2	4.5556

TR= 300.0F TC= 110.0F TE= 40.0F RETURN RATIO=.100 Z2/Z1=.180 DT= 4.0 COP= 1.036 FRACTION OF CARNOT=.580
MAX RECOVERABLE HEAT IN PREHEATER= 697.5 PREHEATER EFF. USED= .884 COP WITH PREH. EFF. OF 0.9=1.055
COOLING PER LB OF TOTAL VAP. GENERATED= 452.1 HEAT TO GENERATOR PER LB OF VAP.= 709.9 14 7

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	73.0	.4715	-23.5	5.5556	12	300.0	109.0	.3974	985.4	.4383
2	196.9	260.9	.4715	74.2	1.0000	13	211.7	109.0	.8950	692.8	.4095
3	207.7	245.9	.4244	86.3	.9626	14	211.7	245.9	.9545	646.2	.0040
4	211.7	245.9	.4124	91.1	4.0585	15	211.7	245.9	.9545	646.2	.3417
5	120.0	245.9	.8667	58.2	.0435	16	211.7	245.9	.9545	646.2	.4967
6	160.9	245.9	.5857	-5.1	.0766	17	120.0	245.9	.9989	89.6	.7223
7	290.0	245.9	.2208	209.7	.6583	18	100.0	73.0	.9956	583.3	.7716
8	300.0	87.6	.0345	262.0	1.2552	19	160.9	245.9	.9914	598.1	.7698
9	207.7	73.0	.1985	124.3	1.5635	20	201.7	73.0	.8660	705.2	.3083
10	207.7	109.0	.2656	108.5	1.0104	21	100.0	73.0	.5069	-33.6	.0708
11	295.0	109.0	.0731	248.1	1.0392	22	196.9	260.9	.4715	74.2	4.5556

TR= 180.0F TC= 95.0F TE= 40.0F RETURN RATIO=.100 Z2/Z1=.180 DT= 4.0 COP= .826 FRACTION OF CARNOT=.684
MAX RECOVERABLE HEAT IN PREHEATER= 464.8 PREHEATER EFF. USED= .936 COP WITH PREH. EFF. OF 0.9= .778
COOLING PER LB OF TOTAL VAP. GENERATED= 484.5 HEAT TO GENERATOR PER LB OF VAP.= 629.8 6 4

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	95.0	73.0	.5260	-38.2	5.5556	12	180.0	101.0	.9473	647.7	.3658
2	164.2	210.0	.5260	39.6	1.0000	13	170.4	101.0	.9588	636.0	.3681
3	166.4	195.0	.4985	40.6	.9448	14	170.4	195.0	.9828	614.2	.0126
4	170.4	195.0	.4849	44.6	4.1795	15	170.4	195.0	.9828	614.2	.0695
5	105.0	195.0	.8580	38.1	.0106	16	170.4	195.0	.9828	614.2	.3761
6	132.7	195.0	.6411	-13.6	.0167	17	105.0	195.0	.9991	71.8	.4310
7	168.4	195.0	.4919	42.6	.9305	18	85.0	73.0	.9979	574.1	.4422
8	180.0	84.6	.2933	72.0	1.5641	19	132.7	195.0	.9957	585.8	.4416
9	166.4	73.0	.3045	54.7	1.5910	20	160.4	73.0	.9554	636.8	.0270
10	166.4	101.0	.3613	45.3	1.0143	21	85.0	73.0	.5680	-46.1	.0161
11	168.3	101.0	.3558	48.2	1.0121	22	164.2	210.0	.5260	39.6	4.5556

TR= 220.0F TC= 95.0F TE= 40.0F RETURN RATIO=.100 Z2/Z1=.180 DT= 4.0 COP= 1.099 FRACTION OF CARNOT=.657
MAX RECOVERABLE HEAT IN PREHEATER= 496.1 PREHEATER EFF. USED= .918 COP WITH PREH. EFF. OF 0.9=1.077
COOLING PER LB OF TOTAL VAP. GENERATED= 482.6 HEAT TO GENERATOR PER LB OF VAP.= 645.6 11 5

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	95.0	73.0	.5260	-38.2	5.5556	12	220.0	101.0	.8602	715.1	.3541
2	164.2	210.0	.5260	39.6	1.0000	13	172.8	101.0	.9562	638.7	.3622
3	168.8	195.0	.4906	42.9	.9408	14	172.8	195.0	.9813	616.4	.0232
4	172.8	195.0	.4771	47.0	4.1132	15	172.8	195.0	.9813	616.4	.2573
5	105.0	195.0	.8580	38.1	.0175	16	172.8	195.0	.9813	616.4	.4420
6	133.9	195.0	.6347	-14.7	.0285	17	105.0	195.0	.9991	71.8	.6764
7	210.0	195.0	.3683	93.4	.7427	18	85.0	73.0	.9979	574.1	.6946
8	220.0	84.6	.1925	139.2	1.3703	19	133.9	195.0	.9955	586.5	.6939
9	168.8	73.0	.2981	58.6	1.5916	20	162.8	73.0	.9523	639.8	.2213
10	168.8	101.0	.3547	48.9	1.0130	21	85.0	73.0	.5680	-46.1	.0279
11	183.0	101.0	.3160	71.1	1.0049	22	164.2	210.0	.5260	39.6	4.5556

TR= 260.0F TC= 95.0F TE= 40.0F RETURN RATIO=.100 Z2/Z1=.180 DT= 4.0 COP= 1.217 FRACTION OF CARNOT=.584
MAX RECOVERABLE HEAT IN PREHEATER= 522.3 PREHEATER EFF. USED= .902 COP WITH PREH. EFF. OF 0.9=1.215
COOLING PER LB OF TOTAL VAP. GENERATED= 480.8 HEAT TO GENERATOR PER LB OF VAP.= 657.0 10 6

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	95.0	73.0	.5260	-38.2	5.5556	12	260.0	101.0	.6750	815.1	.3559
2	164.2	210.0	.5260	39.6	1.0000	13	174.9	101.0	.9537	641.3	.3566
3	170.9	195.0	.4835	45.1	.9359	14	174.9	195.0	.9798	618.4	.0531
4	174.9	195.0	.4701	49.3	4.0557	15	174.9	195.0	.9798	618.4	.3629
5	105.0	195.0	.8580	38.1	.0232	16	174.9	195.0	.9798	618.4	.4993
6	135.0	195.0	.6290	-15.6	.0388	17	105.0	195.0	.9991	71.8	.8533
7	250.0	195.0	.2675	155.4	.6371	18	85.0	73.0	.9979	574.1	.8769
8	260.0	84.6	.1056	203.6	1.2375	19	135.0	195.0	.9954	587.2	.8765
9	170.9	73.0	.2924	62.1	1.5894	20	164.9	73.0	.9494	642.7	.3519
10	170.9	101.0	.3488	52.2	1.0101	21	85.0	73.0	.5680	-46.1	.0384
11	208.8	101.0	.2501	113.0	1.0093	22	164.2	210.0	.5260	39.6	4.5556

TH= 180.0F TC= 80.0F TE= 40.0F RETURN RATIO=.100 Z2/Z1=.180 DT= 4.0 COP= 1.326 FRACTION OF CARNOT=.679
MAX RECOVERABLE HEAT IN PREHEATER= 343.5 PREHEATER EFF. USED= .974 COP WITH PREH. EFF. OF 0.9=1.252
COOLING PER LB OF TOTAL VAP. GENERATED= 502.8 HEAT TO GENERATOR PER LB OF VAP.= 585.6 12 5

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	80.0	73.0	.5917	-49.2	5.5556	12	180.0	93.1	.9425	651.6	.3256
2	131.8	167.5	.5917	9.0	1.0000	13	135.9	93.1	.9852	605.8	.3379
3	131.9	152.5	.5628	6.0	.9377	14	135.9	152.5	.9933	593.7	.0444
4	135.9	152.5	.5470	9.1	4.0996	15	135.9	152.5	.9933	593.7	.2861
5	90.0	152.5	.8491	18.4	.0078	16	135.9	152.5	.9933	593.7	.4565
6	108.0	152.5	.6889	-21.7	.0115	17	90.0	152.5	.9993	54.2	.7678
7	170.0	152.5	.4308	43.6	.7139	18	70.0	73.0	.9990	565.7	.7742
8	180.0	81.5	.2870	73.2	1.3565	19	108.0	152.5	.9978	576.0	.7756
9	131.9	73.0	.4023	1.9	1.6247	20	125.9	73.0	.9856	602.8	.2682
10	131.9	93.1	.4477	.8	1.0250	21	70.0	73.0	.6486	-51.8	.0128
11	138.3	93.1	.4274	8.1	1.0126	22	131.8	167.5	.5917	9.0	4.5556

TH= 220.0F TC= 80.0F TE= 40.0F RETURN RATIO=.100 Z2/Z1=.180 DT= 4.0 COP= 1.442 FRACTION OF CARNOT=.561
MAX RECOVERABLE HEAT IN PREHEATER= 362.3 PREHEATER EFF. USED= .946 COP WITH PREH. EFF. OF 0.9=1.404
COOLING PER LB OF TOTAL VAP. GENERATED= 501.9 HEAT TO GENERATOR PER LB OF VAP.= 600.1 12 6

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	80.0	73.0	.5917	-49.2	5.5556	12	220.0	93.1	.8455	722.4	.3046
2	131.8	167.5	.5917	9.0	1.0000	13	138.0	93.1	.9839	607.6	.3253
3	134.0	152.5	.5541	7.6	.9224	14	138.0	152.5	.9927	595.3	.0979
4	138.0	152.5	.5386	10.9	4.0236	15	138.0	152.5	.9927	595.3	.4035
5	90.0	152.5	.8491	18.4	.0110	16	138.0	152.5	.9927	595.3	.5324
6	109.0	152.5	.6821	-23.1	.0164	17	90.0	152.5	.9993	54.2	1.0065
7	210.0	152.5	.3205	100.7	.5965	18	70.0	73.0	.9990	565.7	1.0152
8	220.0	81.5	.1860	140.8	1.1862	19	109.0	152.5	.9977	576.6	1.0175
9	134.0	73.0	.3961	4.8	1.6100	20	128.0	73.0	.9842	604.6	.4238
10	134.0	93.1	.4410	3.2	1.0129	21	70.0	73.0	.6486	-51.8	.0186
11	152.0	93.1	.3872	25.8	.9922	22	131.8	167.5	.5917	9.0	4.5556

TH= 260.0F TC= 80.0F TE= 40.0F RETURN RATIO=.100 Z2/Z1=.180 DT= 4.0 COP= 1.494 FRACTION OF CARNOT=.478
MAX RECOVERABLE HEAT IN PREHEATER= 376.5 PREHEATER EFF. USED= .927 COP WITH PREH. EFF. OF 0.9=1.473
COOLING PER LB OF TOTAL VAP. GENERATED= 501.2 HEAT TO GENERATOR PER LB OF VAP.= 608.8 11 7

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	80.0	73.0	.5917	-49.2	5.5556	12	260.0	93.1	.6447	833.7	.2972
2	131.8	167.5	.5917	9.0	1.0000	13	139.6	93.1	.9828	609.0	.3168
3	135.6	152.5	.5477	8.8	.9118	14	139.6	152.5	.9922	596.4	.1363
4	139.6	152.5	.5326	12.2	3.9696	15	139.6	152.5	.9922	596.4	.4792
5	90.0	152.5	.8491	18.4	.0134	16	139.6	152.5	.9922	596.4	.5855
6	109.8	152.5	.6771	-24.1	.0202	17	90.0	152.5	.9993	54.2	1.1674
7	250.0	152.5	.2232	164.7	.5208	18	70.0	73.0	.9990	565.7	1.1778
8	260.0	81.5	.1004	204.8	1.0722	19	109.8	152.5	.9976	577.1	1.1809
9	135.6	73.0	.3914	7.0	1.5997	20	129.6	73.0	.9831	606.0	.5274
10	135.6	93.1	.4361	5.0	1.0046	21	70.0	73.0	.6486	-51.8	.0233
11	175.0	93.1	.3232	60.8	.9851	22	131.8	167.5	.5917	9.0	4.5556

TR= 180.0F TC= 110.0F TE= 25.0F RETURN RATIO=.100 Z2/Z1=.180 DT= 4.0 COP= .206 FRACTION OF CARNOT=.331
MAX RECOVERABLE HEAT IN PREHEATER= 878.5 PREHEATER EFF. USED= .749 COP WITH PREH. EFF. OF 0.9= .372
COOLING PER LB OF TOTAL VAP. GENERATED= 448.7 HEAT TO GENERATOR PER LB OF VAP.= 768.4 8 6

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	53.5	.4145	-22.9	5.5556	12	180.0	88.5	.9391	654.3	.3772
2	215.7	260.9	.4145	95.6	1.0000	13	227.2	88.5	.8057	736.0	.3808
3	223.2	245.9	.3809	106.8	.7694	14	227.2	245.9	.9367	663.2	.3556
4	227.2	245.9	.3698	112.8	4.1965	15	227.2	245.9	.9367	663.2	-.4998
5	120.0	245.9	.8667	58.2	.0146	16	227.2	245.9	.9367	663.2	.3590
6	168.6	245.9	.5539	-8.3	.0256	17	120.0	245.9	.9989	89.6	.1745
7	160.3	245.9	.5885	41.2	1.4998	18	100.0	53.5	.9926	588.1	.1928
8	180.0	67.3	.2548	80.1	1.5354	19	168.6	245.9	.9887	604.2	.1891
9	223.2	53.5	.1160	162.0	1.1606	20	223.2	53.5	.6843	801.2	-.3749
10	223.2	88.5	.1922	142.7	.7720	21	100.0	53.5	.4461	-34.6	.0220
11	197.9	88.5	.2549	99.9	.7684	22	215.7	260.9	.4145	95.6	4.5556

TR= 220.0F TC= 110.0F TE= 25.0F RETURN RATIO=.100 Z2/Z1=.180 DT= 4.0 COP= .448 FRACTION OF CARNOT=.485
MAX RECOVERABLE HEAT IN PREHEATER= 811.0 PREHEATER EFF. USED= .812 COP WITH PREH. EFF. OF 0.9= .547
COOLING PER LB OF TOTAL VAP. GENERATED= 446.1 HEAT TO GENERATOR PER LB OF VAP.= 780.7 7 5

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	53.5	.4145	-22.9	5.5556	12	220.0	88.5	.8354	727.1	.4283
2	215.7	260.9	.4145	95.6	1.0000	13	229.4	88.5	.7965	740.1	.4339
3	225.4	245.9	.3752	110.0	.8773	14	229.4	245.9	.9340	665.8	.1288
4	229.4	245.9	.3641	116.0	4.1526	15	229.4	245.9	.9340	665.8	-.1168
5	120.0	245.9	.8667	58.2	.0294	16	229.4	245.9	.9340	665.8	.4030
6	169.7	245.9	.5497	-8.6	.0513	17	120.0	245.9	.9989	89.6	.3343
7	193.0	245.9	.4688	69.8	1.1168	18	100.0	53.5	.9926	588.1	.3705
8	220.0	67.3	.1548	148.7	1.4345	19	169.7	245.9	.9882	605.1	.3637
9	225.4	53.5	.1117	165.4	1.3238	20	225.4	53.5	.6698	811.2	-.1107
10	225.4	88.5	.1868	146.5	.8804	21	100.0	53.5	.4461	-34.6	.0445
11	219.5	88.5	.2019	136.3	.8747	22	215.7	260.9	.4145	95.6	4.5556

TR= 260.0F TC= 110.0F TE= 25.0F RETURN RATIO=.100 Z2/Z1=.180 DT= 4.0 COP= .661 FRACTION OF CARNOT=.556
MAX RECOVERABLE HEAT IN PREHEATER= 799.8 PREHEATER EFF. USED= .869 COP WITH PREH. EFF. OF 0.9= .698
COOLING PER LB OF TOTAL VAP. GENERATED= 444.2 HEAT TO GENERATOR PER LB OF VAP.= 788.4 7 4

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	53.5	.4145	-22.9	5.5556	12	260.0	88.5	.6245	846.4	.4819
2	215.7	260.9	.4145	95.6	1.0000	13	231.0	88.5	.7894	743.5	.4723
3	227.0	245.9	.3710	112.4	.9548	14	231.0	245.9	.9319	667.8	-.0084
4	231.0	245.9	.3599	118.4	4.1209	15	231.0	245.9	.9319	667.8	.1316
5	120.0	245.9	.8667	58.2	.0406	16	231.0	245.9	.9319	667.8	.4347
6	170.5	245.9	.5466	-8.9	.0707	17	120.0	245.9	.9989	89.6	.4466
7	240.3	245.9	.3361	132.5	.8684	18	100.0	53.5	.9926	588.1	.4960
8	260.0	67.3	.0748	211.0	1.3627	19	170.5	245.9	.9879	605.7	.4872
9	227.0	53.5	.1086	167.9	1.4407	20	221.0	53.5	.6988	791.1	.0780
10	227.0	88.5	.1828	149.2	.9582	21	100.0	53.5	.4461	-34.6	.0619
11	262.8	88.5	.1067	206.3	.9678	22	215.7	260.9	.4145	95.6	4.5556

TB= 180.0F TC= 110.0F TE= 10.0F RETURN RATIO=.100 Z2/Z1=.180 DT= 4.0 COP= .159 FRACTION OF CARNOT=.309
MAX RECOVERABLE HEAT IN PREHEATER=1321.6 PREHEATER EFF. USED= .593 COP WITH PREH. EFF. OF 0.9= .483
COOLING PER LB OF TOTAL VAP. GENERATED= 444.1 HEAT TO GENERATOR PER LB OF VAP.= 797.4 30 5

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	38.3	.3596	-17.1	5.5556	12	180.0	70.8	.9209	667.1	.2467
2	235.9	260.9	.3596	124.0	1.0000	13	243.7	70.8	.6498	828.0	.2533
3	239.7	245.9	.3380	131.5	.4216	14	243.7	245.9	.9130	685.3	.7645
4	243.4	245.9	.3282	137.6	4.3064	15	243.7	245.9	.9130	685.3	-.7592
5	120.0	245.9	.8667	58.2	.0223	16	243.7	245.9	.9130	685.3	.2442
6	176.8	245.9	.5232	-10.5	.0389	17	120.0	245.9	.9989	89.6	.1885
7	157.9	245.9	.5990	39.8	1.7592	18	100.0	38.3	.9873	593.1	.2184
8	180.0	50.7	.2095	91.2	1.1347	19	176.8	245.9	.9849	611.2	.2106
9	239.7	38.3	.0453	197.0	.5616	20	239.7	38.3	.3703	993.8	-.5731
10	239.7	70.8	.1208	178.3	.3933	21	100.0	38.3	.3901	-32.1	.0311
11	171.9	70.8	.2848	64.6	.3867	22	235.9	260.9	.3596	124.0	4.5556

TB= 220.0F TC= 110.0F TE= 10.0F RETURN RATIO=.100 Z2/Z1=.180 DT= 4.0 COP= .289 FRACTION OF CARNOT=.380
MAX RECOVERABLE HEAT IN PREHEATER=1224.7 PREHEATER EFF. USED= .640 COP WITH PREH. EFF. OF 0.9= .552
COOLING PER LB OF TOTAL VAP. GENERATED= 434.5 HEAT TO GENERATOR PER LB OF VAP.= 840.3 30 4

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	38.3	.3596	-17.1	5.5556	12	220.0	70.8	.7850	739.3	.3544
2	235.9	260.9	.3596	124.0	1.0000	13	249.9	70.8	.6048	857.6	.3585
3	245.9	245.9	.3224	141.0	.5737	14	249.9	245.9	.9019	694.9	.4659
4	248.1	245.9	.3167	146.4	4.1905	15	249.9	245.9	.9019	694.9	-.3830
5	120.0	245.9	.8667	58.2	.0409	16	249.9	245.9	.9019	694.9	.3338
6	179.9	245.9	.5124	-11.1	.0720	17	120.0	245.9	.9989	89.6	.3037
7	178.0	245.9	.5195	56.7	1.3830	18	100.0	38.3	.9873	593.1	.3570
8	220.0	50.7	.1154	158.7	1.0846	19	179.9	245.9	.9832	613.9	.3447
9	245.9	38.3	.0341	206.1	.7412	20	245.9	38.3	.2908	1035.3	-.3434
10	245.9	70.8	.1086	187.9	.5260	21	100.0	38.3	.3901	-32.1	.0596
11	194.2	70.8	.2271	102.3	.5218	22	235.9	260.9	.3596	124.0	4.5556

TB= 260.0F TC= 110.0F TE= 10.0F RETURN RATIO=.100 Z2/Z1=.180 DT= 4.0 COP= .419 FRACTION OF CARNOT=.428
MAX RECOVERABLE HEAT IN PREHEATER=1091.5 PREHEATER EFF. USED= .719 COP WITH PREH. EFF. OF 0.9= .583
COOLING PER LB OF TOTAL VAP. GENERATED= 423.4 HEAT TO GENERATOR PER LB OF VAP.= 861.6 30 5

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	38.3	.3596	-17.1	5.5556	12	260.0	70.8	.5218	909.9	.5189
2	235.9	260.9	.3596	124.0	1.0000	13	256.3	70.8	.5537	890.1	.5165
3	252.3	245.9	.3067	150.9	.7840	14	256.3	245.9	.8890	705.5	.1991
4	256.1	245.9	.2976	157.0	4.0741	15	256.3	245.9	.8890	705.5	-.0890
5	120.0	245.9	.8667	58.2	.0633	16	256.3	245.9	.8890	705.5	.4778
6	183.1	245.9	.5014	-11.6	.1131	17	120.0	245.9	.9989	89.6	.4116
7	214.2	245.9	.4054	94.9	1.0890	18	100.0	38.3	.9873	593.1	.4911
8	260.0	50.7	.0401	219.3	1.0743	19	183.1	245.9	.9813	616.8	.4748
9	252.3	38.3	.0225	215.5	.9684	20	252.3	38.3	.2007	1079.4	-.1059
10	252.3	70.8	.0962	197.7	.7009	21	100.0	38.3	.3901	-32.1	.0968
11	263.3	70.8	.0741	214.6	.7033	22	235.9	260.9	.3596	124.0	4.5556

TB= 180.0F TC= 110.0F TE= 40.0F RETURN RATIO=.080 Z2/Z1=.180 DT= 4.0 COP= .388 FRACTION OF CARNOT=.497
MAX RECOVERABLE HEAT IN PREHEATER= 628.3 PREHEATER EFF. USED= .864 COP WITH PREH. EFF. OF 0.9= .436
COOLING PER LB OF TOTAL VAP. GENERATED= 459.2 HEAT TO GENERATOR PER LB OF VAP.= 682.1 5 5

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	73.0	.4715	-23.5	5.5556	12	180.0	109.0	.9514	644.2	.3689
2	196.9	260.9	.4715	74.2	1.0000	13	206.1	109.0	.9083	682.7	.3646
3	202.1	245.9	.4414	79.8	.9072	14	206.1	245.9	.9612	639.9	.1460
4	206.1	245.9	.4288	84.4	4.1904	15	206.1	245.9	.9612	639.9	-.2412
5	120.0	245.9	.8667	58.2	.0126	16	206.1	245.9	.9612	639.9	.3652
6	158.0	245.9	.5983	-3.6	.0212	17	120.0	245.9	.9989	89.6	.2362
7	165.6	245.9	.5660	44.8	1.2412	18	100.0	73.0	.9956	583.3	.2510
8	180.0	87.6	.2993	70.8	1.4129	19	158.0	245.9	.9922	596.0	.2487
9	202.1	73.0	.2125	114.5	1.2249	20	202.1	73.0	.8649	705.9	-.1880
10	202.1	109.0	.2799	99.2	.6823	21	100.0	73.0	.5069	-33.6	.0190
11	191.5	109.0	.3071	82.2	.6866	22	196.9	260.9	.4715	74.2	4.5556

TB= 220.0F TC= 110.0F TE= 40.0F RETURN RATIO=.080 Z2/Z1=.180 DT= 4.0 COP= .710 FRACTION OF CARNOT=.614
MAX RECOVERABLE HEAT IN PREHEATER= 614.0 PREHEATER EFF. USED= .892 COP WITH PREH. EFF. OF 0.9= .720
COOLING PER LB OF TOTAL VAP. GENERATED= 458.5 HEAT TO GENERATOR PER LB OF VAP.= 685.3 5 5

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	73.0	.4715	-23.5	5.5556	12	220.0	109.0	.8726	708.5	.3775
2	196.9	260.9	.4715	74.2	1.0000	13	206.6	109.0	.9071	683.6	.3783
3	202.6	245.9	.4398	80.4	.9425	14	206.6	245.9	.9607	640.5	.0183
4	206.6	245.9	.4273	85.0	4.1779	15	206.6	245.9	.9607	640.5	.0621
5	120.0	245.9	.8667	58.2	.0215	16	206.6	245.9	.9607	640.5	.3777
6	158.3	245.9	.5971	-3.7	.0365	17	120.0	245.9	.9989	89.6	.4001
7	202.6	245.9	.4390	80.4	.9379	18	100.0	73.0	.9956	583.3	.4254
8	220.0	87.6	.1988	137.6	1.2504	19	158.3	245.9	.9921	596.2	.4216
9	202.6	73.0	.2112	115.4	1.2734	20	196.6	73.0	.8825	694.9	.0230
10	202.6	109.0	.2786	100.1	.7091	21	100.0	73.0	.5069	-33.6	.0327
11	210.3	109.0	.2595	112.7	.7083	22	196.9	260.9	.4715	74.2	4.5556

TB= 260.0F TC= 110.0F TE= 40.0F RETURN RATIO=.080 Z2/Z1=.180 DT= 4.0 COP= .958 FRACTION OF CARNOT=.644
MAX RECOVERABLE HEAT IN PREHEATER= 636.0 PREHEATER EFF. USED= .911 COP WITH PREH. EFF. OF 0.9= .941
COOLING PER LB OF TOTAL VAP. GENERATED= 458.2 HEAT TO GENERATOR PER LB OF VAP.= 687.0 5 4

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	73.0	.4715	-23.5	5.5556	12	260.0	109.0	.7012	799.6	.3966
2	196.9	260.9	.4715	74.2	1.0000	13	206.9	109.0	.9065	684.1	.3861
3	202.9	245.9	.4389	80.7	.9629	14	206.9	245.9	.9603	640.8	-.0414
4	206.9	245.9	.4264	85.4	4.1707	15	206.9	245.9	.9603	640.8	.2473
5	120.0	245.9	.8667	58.2	.0279	16	206.9	245.9	.9603	640.8	.3849
6	158.4	245.9	.5964	-3.8	.0475	17	120.0	245.9	.9989	89.6	.5154
7	250.5	245.9	.3109	148.2	.7527	18	100.0	73.0	.9956	583.3	.5481
8	260.0	87.6	.1104	202.4	1.1325	19	158.4	245.9	.9921	596.3	.5433
9	202.9	73.0	.2104	115.9	1.3012	20	196.9	73.0	.8816	695.5	.1687
10	202.9	109.0	.2778	100.6	.7245	21	100.0	73.0	.5069	-33.6	.0426
11	245.7	109.0	.1760	171.2	.7349	22	196.9	260.9	.4715	74.2	4.5556

TR= 180.0F TC= 110.0F TE= 40.0F RETURN RATIO=.120 Z2/Z1=.180 DT= 4.0 COP= .303 FRACTION OF CARNOT=.387
MAX RECOVERABLE HEAT IN PREHEATER= 654.2 PREHEATER EFF. USED= .830 COP WITH PREH. EFF. OF 0.9= .383
COOLING PER LB OF TOTAL VAP. GENERATED= 457.0 HEAT TO GENERATOR PER LB OF VAP.= 692.3 6 5

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	73.0	.4715	-23.5	5.5556	12	180.0	109.0	.9514	644.2	.4128
2	196.9	260.9	.4715	74.2	1.0000	13	207.9	109.0	.9043	685.8	.4078
3	203.9	245.9	.4359	81.8	.8783	14	207.9	245.9	.9592	641.9	.2144
4	207.9	245.9	.4236	86.5	4.1477	15	207.9	245.9	.9592	641.9	-.3724
5	120.0	245.9	.8667	58.2	.0120	16	207.9	245.9	.9592	641.9	.4078
6	158.9	245.9	.5942	-4.1	.0206	17	120.0	245.9	.9989	89.6	.2172
7	156.9	245.9	.6038	39.5	1.3724	18	100.0	73.0	.9956	583.3	.2312
8	180.0	87.6	.2993	70.8	1.9953	19	158.9	245.9	.9920	596.7	.2292
9	203.9	73.0	.2081	117.6	1.7155	20	203.9	73.0	.8586	709.6	-.2797
10	203.9	109.0	.2754	102.2	1.2450	21	100.0	73.0	.5069	-33.6	.0186
11	196.8	109.0	.2934	90.7	1.2500	22	196.9	260.9	.4715	74.2	4.5556

TR= 220.0F TC= 110.0F TE= 40.0F RETURN RATIO=.120 Z2/Z1=.180 DT= 4.0 COP= .683 FRACTION OF CARNOT=.591
MAX RECOVERABLE HEAT IN PREHEATER= 630.8 PREHEATER EFF. USED= .868 COP WITH PREH. EFF. OF 0.9= .721
COOLING PER LB OF TOTAL VAP. GENERATED= 455.9 HEAT TO GENERATOR PER LB OF VAP.= 696.9 6 4

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	73.0	.4715	-23.5	5.5556	12	220.0	109.0	.8726	708.5	.4304
2	196.9	260.9	.4715	74.2	1.0000	13	208.8	109.0	.9022	687.4	.4310
3	204.8	245.9	.4332	82.9	.9300	14	208.8	245.9	.9581	642.9	.0226
4	208.8	245.9	.4209	87.6	4.1264	15	208.8	245.9	.9581	642.9	.0662
5	120.0	245.9	.8667	58.2	.0253	16	208.8	245.9	.9581	642.9	.4291
6	159.4	245.9	.5922	-4.3	.0437	17	120.0	245.9	.9989	89.6	.4489
7	203.3	245.9	.4370	81.1	.9338	18	100.0	73.0	.9956	583.3	.4783
8	220.0	87.6	.1988	137.6	1.7994	19	159.4	245.9	.9918	597.0	.4742
9	204.8	73.0	.2059	119.2	1.8182	20	198.8	73.0	.8758	699.2	.0188
10	204.8	109.0	.2730	103.7	1.3191	21	100.0	73.0	.5069	-33.6	.0397
11	208.8	109.0	.2631	110.3	1.3185	22	196.9	260.9	.4715	74.2	4.5556

TR= 260.0F TC= 110.0F TE= 40.0F RETURN RATIO=.120 Z2/Z1=.180 DT= 4.0 COP= .896 FRACTION OF CARNOT=.602
MAX RECOVERABLE HEAT IN PREHEATER= 686.9 PREHEATER EFF. USED= .866 COP WITH PREH. EFF. OF 0.9= .934
COOLING PER LB OF TOTAL VAP. GENERATED= 451.6 HEAT TO GENERATOR PER LB OF VAP.= 711.4 22 5

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	73.0	.4715	-23.5	5.5556	12	260.0	109.0	.7012	799.6	.4475
2	196.9	260.9	.4715	74.2	1.0000	13	212.1	109.0	.8941	693.5	.4359
3	208.1	245.9	.4233	86.8	.9451	14	212.1	245.9	.9540	646.6	.0204
4	212.1	245.9	.4114	91.6	4.0502	15	212.1	245.9	.9540	646.6	.2481
5	120.0	245.9	.8667	58.2	.0402	16	212.1	245.9	.9540	646.6	.5049
6	161.1	245.9	.5849	-5.2	.0710	17	120.0	245.9	.9989	89.6	.6623
7	250.0	245.9	.3123	147.4	.7519	18	100.0	73.0	.9956	583.3	.7077
8	260.0	87.6	.1104	202.4	1.6382	19	161.1	245.9	.9913	598.2	.7024
9	208.1	73.0	.1975	125.0	1.8518	20	202.1	73.0	.8648	706.0	.2136
10	208.1	109.0	.2646	109.1	1.3425	21	100.0	73.0	.5069	-33.6	.0658
11	232.4	109.0	.2063	149.3	1.3542	22	196.9	260.9	.4715	74.2	4.5556

TR= 180.0F TC= 110.0F TE= 40.0F RETURN RATIO=.100 Z2/Z1=.140 DT= 4.0 COP= .391 FRACTION OF CARNOT=.500
MAX RECOVERABLE HEAT IN PREHEATER= 778.8 PREHEATER EFF. USED= .896 COP WITH PREH. EFF. OF 0.9= .397
COOLING PER LB OF TOTAL VAP. GENERATED= 462.1 HEAT TO GENERATOR PER LB OF VAP.= 664.0 5 5

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	73.0	.4715	-23.5	7.1429	12	180.0	109.0	.9514	644.2	.4030
2	196.9	260.9	.4715	74.2	1.0000	13	203.5	109.0	.9137	678.4	.3985
3	199.5	245.9	.4491	76.9	.9199	14	203.5	245.9	.9641	637.2	.1388
4	203.5	245.9	.4364	81.4	5.7341	15	203.5	245.9	.9641	637.2	-.2667
5	120.0	245.9	.8667	58.2	.0118	16	203.5	245.9	.9641	637.2	.4089
6	156.8	245.9	.6045	-2.6	.0209	17	120.0	245.9	.9989	89.6	.2484
7	163.5	245.9	.5752	43.3	1.2667	18	100.0	73.0	.9956	583.3	.2630
8	180.0	87.6	.2993	70.8	1.6901	19	156.8	245.9	.9929	595.1	.2602
9	199.5	73.0	.2187	110.1	1.4822	20	199.5	73.0	.8734	700.7	-.2079
10	199.5	109.0	.2865	95.1	.9608	21	100.0	73.0	.5069	-33.6	.0181
11	192.3	109.0	.3051	83.5	.9653	22	196.9	260.9	.4715	74.2	6.1429

TR= 220.0F TC= 110.0F TE= 40.0F RETURN RATIO=.100 Z2/Z1=.140 DT= 4.0 COP= .762 FRACTION OF CARNOT=.659
MAX RECOVERABLE HEAT IN PREHEATER= 766.2 PREHEATER EFF. USED= .922 COP WITH PREH. EFF. OF 0.9= .723
COOLING PER LB OF TOTAL VAP. GENERATED= 461.6 HEAT TO GENERATOR PER LB OF VAP.= 667.6 7 4

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	73.0	.4715	-23.5	7.1429	12	220.0	109.0	.8726	708.5	.4139
2	196.9	260.9	.4715	74.2	1.0000	13	204.0	109.0	.9127	679.2	.4153
3	200.0	245.9	.4477	77.4	.9598	14	204.0	245.9	.9635	637.7	-.0106
4	204.0	245.9	.4350	82.0	5.7185	15	204.0	245.9	.9635	637.7	.0928
5	120.0	245.9	.8667	58.2	.0214	16	204.0	245.9	.9635	637.7	.4244
6	157.0	245.9	.6033	-2.8	.0381	17	120.0	245.9	.9989	89.6	.4470
7	208.7	245.9	.4211	87.5	.9072	18	100.0	73.0	.9956	583.3	.4734
8	220.0	87.6	.1988	137.6	1.5054	19	157.0	245.9	.9928	595.3	.4684
9	200.0	73.0	.2176	110.9	1.5473	20	194.0	73.0	.8902	689.9	.0420
10	200.0	109.0	.2853	95.8	1.0028	21	100.0	73.0	.5069	-33.6	.0332
11	207.0	109.0	.2678	107.2	1.0015	22	196.9	260.9	.4715	74.2	6.1429

TR= 260.0F TC= 110.0F TE= 40.0F RETURN RATIO=.100 Z2/Z1=.140 DT= 4.0 COP= .969 FRACTION OF CARNOT=.651
MAX RECOVERABLE HEAT IN PREHEATER= 808.4 PREHEATER EFF. USED= .918 COP WITH PREH. EFF. OF 0.9= .941
COOLING PER LB OF TOTAL VAP. GENERATED= 459.3 HEAT TO GENERATOR PER LB OF VAP.= 681.6 6 4

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	73.0	.4715	-23.5	7.1429	12	260.0	109.0	.7012	799.6	.4293
2	196.9	260.9	.4715	74.2	1.0000	13	206.0	109.0	.9085	682.5	.4190
3	202.0	245.9	.4416	79.7	.9733	14	206.0	245.9	.9613	639.8	-.0108
4	206.0	245.9	.4290	84.3	5.6534	15	206.0	245.9	.9613	639.8	.2453
5	120.0	245.9	.8667	58.2	.0336	16	206.0	245.9	.9613	639.8	.4901
6	158.0	245.9	.5985	-3.6	.0568	17	120.0	245.9	.9989	89.6	.6341
7	250.0	245.9	.3123	147.4	.7547	18	100.0	73.0	.9956	583.3	.6739
8	260.0	87.6	.1104	202.4	1.3649	19	158.0	245.9	.9922	596.0	.6678
9	202.0	73.0	.2127	114.4	1.5727	20	196.0	73.0	.8844	693.7	.2078
10	202.0	109.0	.2802	99.1	1.0184	21	100.0	73.0	.5069	-33.6	.0507
11	235.1	109.0	.2000	153.8	1.0287	22	196.9	260.9	.4715	74.2	6.1429

TR= 180.0F TC= 110.0F TE= 40.0F RETURN RATIO=.100 Z2/Z1=.220 DT= 4.0 COP= .312 FRACTION OF CARNOT=.400
MAX RECOVERABLE HEAT IN PREHEATER= 555.9 PREHEATER EFF. USED= .799 COP WITH PREH. EFF. OF 0.9= .413
COOLING PER LB OF TOTAL VAP. GENERATED= 453.7 HEAT TO GENERATOR PER LB OF VAP.= 704.6 6 5

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	73.0	.4715	-23.5	4.5455	12	180.0	109.0	.9514	644.2	.3743
2	196.9	260.9	.4715	74.2	1.0000	13	210.5	109.0	.8982	690.5	.3696
3	206.5	245.9	.4282	84.8	.8674	14	210.5	245.9	.9561	644.7	.2133
4	210.5	245.9	.4160	89.6	3.1813	15	210.5	245.9	.9561	644.7	-.3304
5	120.0	245.9	.8667	58.2	.0125	16	210.5	245.9	.9561	644.7	.3641
6	160.2	245.9	.5885	-4.8	.0218	17	120.0	245.9	.9989	89.6	.2128
7	159.5	245.9	.5918	40.7	1.3304	18	100.0	73.0	.9956	583.3	.2271
8	180.0	87.6	.2993	70.8	1.6575	19	160.2	245.9	.9916	597.6	.2253
9	206.5	73.0	.2018	122.0	1.4078	20	206.5	73.0	.8491	715.1	-.2497
10	206.5	109.0	.2688	106.4	.9101	21	100.0	73.0	.5069	-33.6	.0200
11	196.7	109.0	.2938	90.5	.9148	22	196.9	260.9	.4715	74.2	3.5455

TR= 220.0F TC= 110.0F TE= 40.0F RETURN RATIO=.100 Z2/Z1=.220 DT= 4.0 COP= .643 FRACTION OF CARNOT=.556
MAX RECOVERABLE HEAT IN PREHEATER= 531.0 PREHEATER EFF. USED= .837 COP WITH PREH. EFF. OF 0.9= .707
COOLING PER LB OF TOTAL VAP. GENERATED= 452.5 HEAT TO GENERATOR PER LB OF VAP.= 708.7 6 4

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	73.0	.4715	-23.5	4.5455	12	220.0	109.0	.8726	708.5	.3882
2	196.9	260.9	.4715	74.2	1.0000	13	211.4	109.0	.8958	692.2	.3884
3	207.4	245.9	.4253	86.0	.9129	14	211.4	245.9	.9549	645.8	.0523
4	211.4	245.9	.4132	90.8	3.1640	15	211.4	245.9	.9549	645.8	.0358
5	120.0	245.9	.8667	58.2	.0241	16	211.4	245.9	.9549	645.8	.3815
6	160.7	245.9	.5863	-5.0	.0424	17	120.0	245.9	.9989	89.6	.4031
7	197.9	245.9	.4536	75.0	.9642	18	100.0	73.0	.9956	583.3	.4305
8	220.0	87.6	.1988	137.6	1.4817	19	160.7	245.9	.9914	598.0	.4272
9	207.4	73.0	.1993	123.7	1.4828	20	201.4	73.0	.8670	704.6	.0011
10	207.4	109.0	.2663	108.0	.9583	21	100.0	73.0	.5069	-33.6	.0391
11	211.4	109.0	.2568	114.5	.9581	22	196.9	260.9	.4715	74.2	3.5455

TR= 260.0F TC= 110.0F TE= 40.0F RETURN RATIO=.100 Z2/Z1=.220 DT= 4.0 COP= .889 FRACTION OF CARNOT=.597
MAX RECOVERABLE HEAT IN PREHEATER= 563.9 PREHEATER EFF. USED= .863 COP WITH PREH. EFF. OF 0.9= .930
COOLING PER LB OF TOTAL VAP. GENERATED= 451.1 HEAT TO GENERATOR PER LB OF VAP.= 712.9 30 4

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	73.0	.4715	-23.5	4.5455	12	260.0	109.0	.7012	799.6	.4096
2	196.9	260.9	.4715	74.2	1.0000	13	212.5	109.0	.8931	694.2	.3984
3	208.5	245.9	.4221	87.3	.9365	14	212.5	245.9	.9535	647.0	-.0113
4	212.5	245.9	.4102	92.1	3.1451	15	212.5	245.9	.9535	647.0	.2483
5	120.0	245.9	.8667	58.2	.0333	16	212.5	245.9	.9535	647.0	.4001
6	161.3	245.9	.5840	-5.3	.0591	17	120.0	245.9	.9989	89.6	.5447
7	250.0	245.9	.3123	147.4	.7517	18	100.0	73.0	.9956	583.3	.5823
8	260.0	87.6	.1104	202.4	1.3477	19	161.3	245.9	.9913	598.4	.5781
9	208.5	73.0	.1964	125.7	1.5212	20	202.5	73.0	.8634	706.8	.1736
10	208.5	109.0	.2636	109.8	.9831	21	100.0	73.0	.5069	-33.6	.0548
11	238.7	109.0	.1917	159.8	.9943	22	196.9	260.9	.4715	74.2	3.5455

TR= 180.0F TC= 110.0F TE= 40.0F RETURN RATIO=.100 Z2/Z1=.180 DT= 6.0 COP= .359 FRACTION OF CARNOT=.459
MAX RECOVERABLE HEAT IN PREHEATER= 636.4 PREHEATER EFF. USED= .853 COP WITH PREH. EFF. OF 0.9= .417
COOLING PER LB OF TOTAL VAP. GENERATED= 457.8 HEAT TO GENERATOR PER LB OF VAP.= 688.9 6 5

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	73.0	.4715	-23.5	5.5556	12	180.0	109.0	.9514	644.2	.3987
2	196.9	260.9	.4715	74.2	1.0000	13	207.2	109.0	.9057	684.7	.3938
3	201.2	245.9	.4439	78.8	.9076	14	207.2	245.9	.9599	641.2	.1597
4	207.2	245.9	.4254	85.7	4.1627	15	207.2	245.9	.9599	641.2	-.2812
5	120.0	245.9	.8667	58.2	.0127	16	207.2	245.9	.9599	641.2	.3928
6	158.6	245.9	.5957	-3.9	.0217	17	120.0	245.9	.9989	89.6	.2330
7	162.6	245.9	.5787	42.7	1.2812	18	100.0	73.0	.9956	583.3	.2478
8	180.0	87.6	.2993	70.8	1.6793	19	158.6	245.9	.9921	596.4	.2457
9	201.2	73.0	.2145	113.1	1.4614	20	201.2	73.0	.8678	704.2	-.2179
10	201.2	109.0	.2821	97.9	.9476	21	100.0	73.0	.5069	-33.6	.0195
11	192.6	109.0	.3044	83.9	.9525	22	196.9	260.9	.4715	74.2	4.5556

TR= 220.0F TC= 110.0F TE= 40.0F RETURN RATIO=.100 Z2/Z1=.180 DT= 6.0 COP= .713 FRACTION OF CARNOT=.617
MAX RECOVERABLE HEAT IN PREHEATER= 622.9 PREHEATER EFF. USED= .883 COP WITH PREH. EFF. OF 0.9= .735
COOLING PER LB OF TOTAL VAP. GENERATED= 457.0 HEAT TO GENERATOR PER LB OF VAP.= 692.4 6 4

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	73.0	.4715	-23.5	5.5556	12	220.0	109.0	.8726	708.5	.4098
2	196.9	260.9	.4715	74.2	1.0000	13	207.9	109.0	.9042	685.9	.4106
3	201.9	245.9	.4419	79.6	.9477	14	207.9	245.9	.9592	641.9	.0055
4	207.9	245.9	.4235	86.5	4.1474	15	207.9	245.9	.9592	641.9	.0784
5	120.0	245.9	.8667	58.2	.0237	16	207.9	245.9	.9592	641.9	.4082
6	158.9	245.9	.5942	-4.1	.0406	17	120.0	245.9	.9989	89.6	.4279
7	205.7	245.9	.4300	83.9	.9216	18	100.0	73.0	.9956	583.3	.4554
8	220.0	87.6	.1988	137.6	1.4955	19	158.9	245.9	.9920	596.7	.4515
9	201.9	73.0	.2129	114.2	1.5271	20	197.9	73.0	.8786	697.5	.0316
10	201.9	109.0	.2804	98.9	.9899	21	100.0	73.0	.5069	-33.6	.0367
11	207.4	109.0	.2668	107.8	.9891	22	196.9	260.9	.4715	74.2	4.5556

TR= 260.0F TC= 110.0F TE= 40.0F RETURN RATIO=.100 Z2/Z1=.180 DT= 6.0 COP= .929 FRACTION OF CARNOT=.624
MAX RECOVERABLE HEAT IN PREHEATER= 664.1 PREHEATER EFF. USED= .887 COP WITH PREH. EFF. OF 0.9= .946
COOLING PER LB OF TOTAL VAP. GENERATED= 454.3 HEAT TO GENERATOR PER LB OF VAP.= 702.8 13 4

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	73.0	.4715	-23.5	5.5556	12	260.0	109.0	.7012	799.6	.4260
2	196.9	260.9	.4715	74.2	1.0000	13	210.0	109.0	.8992	689.7	.4152
3	204.0	245.9	.4354	82.0	.9631	14	210.0	245.9	.9566	644.3	-.0116
4	210.0	245.9	.4172	89.1	4.0973	15	210.0	245.9	.9566	644.3	.2471
5	120.0	245.9	.8667	58.2	.0347	16	210.0	245.9	.9566	644.3	.4586
6	160.0	245.9	.5894	-4.7	.0605	17	120.0	245.9	.9989	89.6	.5988
7	250.0	245.9	.3123	147.4	.7529	18	100.0	73.0	.9956	583.3	.6387
8	260.0	87.6	.1104	202.4	1.3567	19	160.0	245.9	.9916	597.5	.6335
9	204.0	73.0	.2077	117.9	1.5553	20	200.0	73.0	.8717	701.8	.1986
10	204.0	109.0	.2749	102.5	1.0074	21	100.0	73.0	.5069	-33.6	.0554
11	235.6	109.0	.1987	154.7	1.0182	22	196.9	260.9	.4715	74.2	4.5556

TB= 180.0F TC= 110.0F TE= 40.0F RETURN RATIO=.100 Z2/Z1=.180 DT= 2.0 COP= .337 FRACTION OF CARNOT=.431
MAX RECOVERABLE HEAT IN PREHEATER= 643.3 PREHEATER EFF. USED= .844 COP WITH PREH. EFF. OF 0.9= .405
COOLING PER LB OF TOTAL VAP. GENERATED= 458.6 HEAT TO GENERATOR PER LB OF VAP.= 685.0 6 5

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	73.0	.4715	-23.5	5.5556	12	180.0	109.0	.9514	644.2	.3792
2	196.9	260.9	.4715	74.2	1.0000	13	206.5	109.0	.9072	683.5	.3748
3	204.5	245.9	.4339	82.6	.8813	14	206.5	245.9	.9607	640.5	.1945
4	206.5	245.9	.4274	84.9	4.1791	15	206.5	245.9	.9607	640.5	-.3145
5	120.0	245.9	.8667	58.2	.0120	16	206.5	245.9	.9607	640.5	.3765
6	158.3	245.9	.5973	-3.7	.0204	17	120.0	245.9	.9989	89.6	.2240
7	160.3	245.9	.5885	41.2	1.3145	18	100.0	73.0	.9956	583.3	.2381
8	180.0	87.6	.2993	70.8	1.6704	19	158.3	245.9	.9922	596.2	.2360
9	204.5	73.0	.2064	118.7	1.4317	20	204.5	73.0	.8562	711.0	-.2387
10	204.5	109.0	.2737	103.3	.9252	21	100.0	73.0	.5069	-33.6	.0183
11	196.4	109.0	.2947	90.0	.9296	22	196.9	260.9	.4715	74.2	4.5556

TB= 220.0F TC= 110.0F TE= 40.0F RETURN RATIO=.100 Z2/Z1=.180 DT= 2.0 COP= .685 FRACTION OF CARNOT=.593
MAX RECOVERABLE HEAT IN PREHEATER= 620.3 PREHEATER EFF. USED= .880 COP WITH PREH. EFF. OF 0.9= .711
COOLING PER LB OF TOTAL VAP. GENERATED= 457.7 HEAT TO GENERATOR PER LB OF VAP.= 689.1 6 5

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	73.0	.4715	-23.5	5.5556	12	220.0	109.0	.8726	708.5	.3928
2	196.9	260.9	.4715	74.2	1.0000	13	207.2	109.0	.9056	684.8	.3935
3	205.2	245.9	.4318	83.4	.9267	14	207.2	245.9	.9599	641.2	.0336
4	207.2	245.9	.4253	85.8	4.1620	15	207.2	245.9	.9599	641.2	.0526
5	120.0	245.9	.8667	58.2	.0228	16	207.2	245.9	.9599	641.2	.3936
6	158.6	245.9	.5956	-3.9	.0389	17	120.0	245.9	.9989	89.6	.4180
7	200.8	245.9	.4444	78.4	.9474	18	100.0	73.0	.9956	583.3	.4447
8	220.0	87.6	.1988	137.6	1.4937	19	158.6	245.9	.9921	596.4	.4408
9	205.2	73.0	.2047	120.0	1.5066	20	197.2	73.0	.8805	696.2	.0129
10	205.2	109.0	.2718	104.4	.9733	21	100.0	73.0	.5069	-33.6	.0350
11	210.9	109.0	.2580	113.6	.9726	22	196.9	260.9	.4715	74.2	4.5556

TB= 260.0F TC= 110.0F TE= 40.0F RETURN RATIO=.100 Z2/Z1=.180 DT= 2.0 COP= .925 FRACTION OF CARNOT=.621
MAX RECOVERABLE HEAT IN PREHEATER= 654.7 PREHEATER EFF. USED= .892 COP WITH PREH. EFF. OF 0.9= .935
COOLING PER LB OF TOTAL VAP. GENERATED= 456.1 HEAT TO GENERATOR PER LB OF VAP.= 696.1 11 4

LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW	LINE	TEMP	PRESS	CONC	ENTHALPY	MASS FLOW
1	110.0	73.0	.4715	-23.5	5.5556	12	260.0	109.0	.7012	799.6	.4112
2	196.9	260.9	.4715	74.2	1.0000	13	208.6	109.0	.9026	687.1	.4004
3	206.6	245.9	.4278	85.0	.9459	14	208.6	245.9	.9583	642.7	-.0094
4	208.6	245.9	.4214	87.4	4.1306	15	208.6	245.9	.9583	642.7	.2465
5	120.0	245.9	.8667	58.2	.0323	16	208.6	245.9	.9583	642.7	.4253
6	159.3	245.9	.5926	-4.3	.0556	17	120.0	245.9	.9989	89.6	.5744
7	250.0	245.9	.3123	147.4	.7535	18	100.0	73.0	.9956	583.3	.6119
8	260.0	87.6	.1104	202.4	1.3568	19	159.3	245.9	.9919	596.9	.6067
9	206.6	73.0	.2014	122.3	1.5398	20	198.6	73.0	.8763	698.9	.1830
10	206.6	109.0	.2684	106.6	.9943	21	100.0	73.0	.5069	-33.6	.0505
11	238.2	109.0	.1929	158.9	1.0051	22	196.9	260.9	.4715	74.2	4.5556

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