Utilization of Geopressured Resources in the Oxidation of Organic Waste in Supercritical Water
Phase I Final Report

by

Alexander F. Diaz
Howard J. Herzog
Jefferson W. Tester

Energy Laboratory
Massachusetts Institute of Technology
Cambridge, MA 02139

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for

Sandia National Laboratories
J. C. Dunn, Division 6252
P. O. Box 5800
Albuquerque, NM 87185

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Table of Contents

List of Figures

List of Tables

1. SUMMARY

Geopressured resources are geothermal reservoirs containing dissolved methane in hot brine at pressures well in excess of their *in situ* hydrostatic pressure. In the US, geopressured resources are primarily located in the Gulf (of Mexico) Coast. The wells in this area are characterized by typical bottomhole temperatures of 120-180°C (250-360°F) (Negus-de Wys, 1991a) and bottomhole pressures of 675-1275 bar (9,800-18,500 psia) (Negus-de Wys, 1991b). Supercritical water oxidation (SCWO) is an emerging technology for the destruction of hazardous organic waste in which oxidation is carried out in a water medium above the critical point of pure water (374°C/705°F, 221 bar/3208 psia) (Tester *et al.*, 1992). Geopressured resources are particularly suitable as an input stream to a SCWO waste treatment process due to the near critical conditions of their hot brine. By using a Rankine-type power cycle, electric power can be generated by capturing the available thermal and hydraulic energy from the geothermal resource and the chemical energy of the dissolved methane released by the oxidation process. In addition to oxidizing the methane to convert the chemical energy to thermal energy, auxiliary fuel in the form of an organic waste can be co-oxidized to increase the energy output to commercially sustainable levels. Coupling the treatment of geopressured brine with an organic waste in a SCWO process synergistically improves power production while providing a means for treating hazardous waste.

The objective of this study is to assess the feasibility of using geopressured resources to simultaneously detoxify hazardous waste and generate electric power. Our ultimate aim is to develop conceptual process designs for above-ground and fully or modified *in situ* approaches to co-processing organic waste with geopressured brine in supercritical water. As a preparatory step for investigating *in situ* approaches, a realistic above-ground conceptual design was developed in this study. In that concept, the waste, brine and oxidant (air or oxygen) are introduced into the SCWO reactor at the system pressure of 234 bar (3400 psia). The heat of oxidation raises the temperature of the system to about 600°C (1100°F). Due to the low solubility of inorganic salts in supercritical water (about 200 ppm or less) (Armellini and Tester, 1990, 1991a, 1991b), solid salt forms and falls to the lower section of the reactor, where it is cooled and quenched with water, creating a concentrated (organic-free) brine that would be mixed with brackish water and reinjected back to the geopressured well. Power is generated by the expansion of the products of the SCWO process through a series of multi-stage turboexpanders.

A processing capacity of 100,000 gallons per day (gpd) was initially taken as the design basis, following some investigations carried out at the Idaho National Engineering Laboratory (Propp *et al.*, 1990). The process was modeled using the ASPEN PLUS™ process flowsheet simulator and material and energy balances were determined. Both the cases of using air and oxygen as oxidant were investigated. Toluene was chosen as the model compound to represent the organic waste.

Turbine design calculations based on the volumetric flowrates obtained for a 100,000 gpd capacity resulted in unrealistically high rotor rotational speeds and small wheel pitch diameters to achieve optimum efficiencies. Higher SCWO effluent flowrates would lower rotor rotational speeds and increase wheel pitch diameters to more practical levels. Thus, a 42-fold larger design capacity of 100,000 barrels per day (bpd) was adopted as the basis for an above-ground base case. The results for the material and energy balances for a processing capacity of 100,000 bpd using air and oxygen as oxidant scale up linearly from the results for the 100,000 gpd case. The best case flowsheet corresponding to a 100,000 bpd case using oxygen as oxidant is given in Figure 1.

Our conceptual design study suggests that simultaneous detoxification of hazardous waste and production of power is possible by co-processing organic waste with geopressured brine. Net power outputs of about 140 MWe and 160 MWe have been estimated for a processing capacity of 100,000 bpd using air and oxygen as oxidant, respectively.

Further refinement of the model will be carried out in the next phase of this project. In particular, models for thermophysical properties of supercritical fluid mixtures using suitable equations of state (EOS) such as the one developed by Christoforakos, Heilig and Franck (CHFEOS) (Christoforakos and Franck, 1986; Heilig and Franck, 1990) will be developed for phase and chemical equilibrium calculations in multicomponent systems of salt, water, carbon dioxide, oxygen, nitrogen, and hydrocarbons. With these, the formation of solid salt in a reacting supercritical water stream will be modeled. In addition, well reinjection requirements (pressures and flowrates) will be reconsidered. Having established a realistic above-ground base case, equipment sizing and economic estimates for the process will be provided. Finally, conceptual process designs for an *in situ* approach to coupling oxidation and salt separation will be explored in future studies.

Figure 1. Process Flow Diagram for 100,000 bpd Case with Oxygen as Oxidant

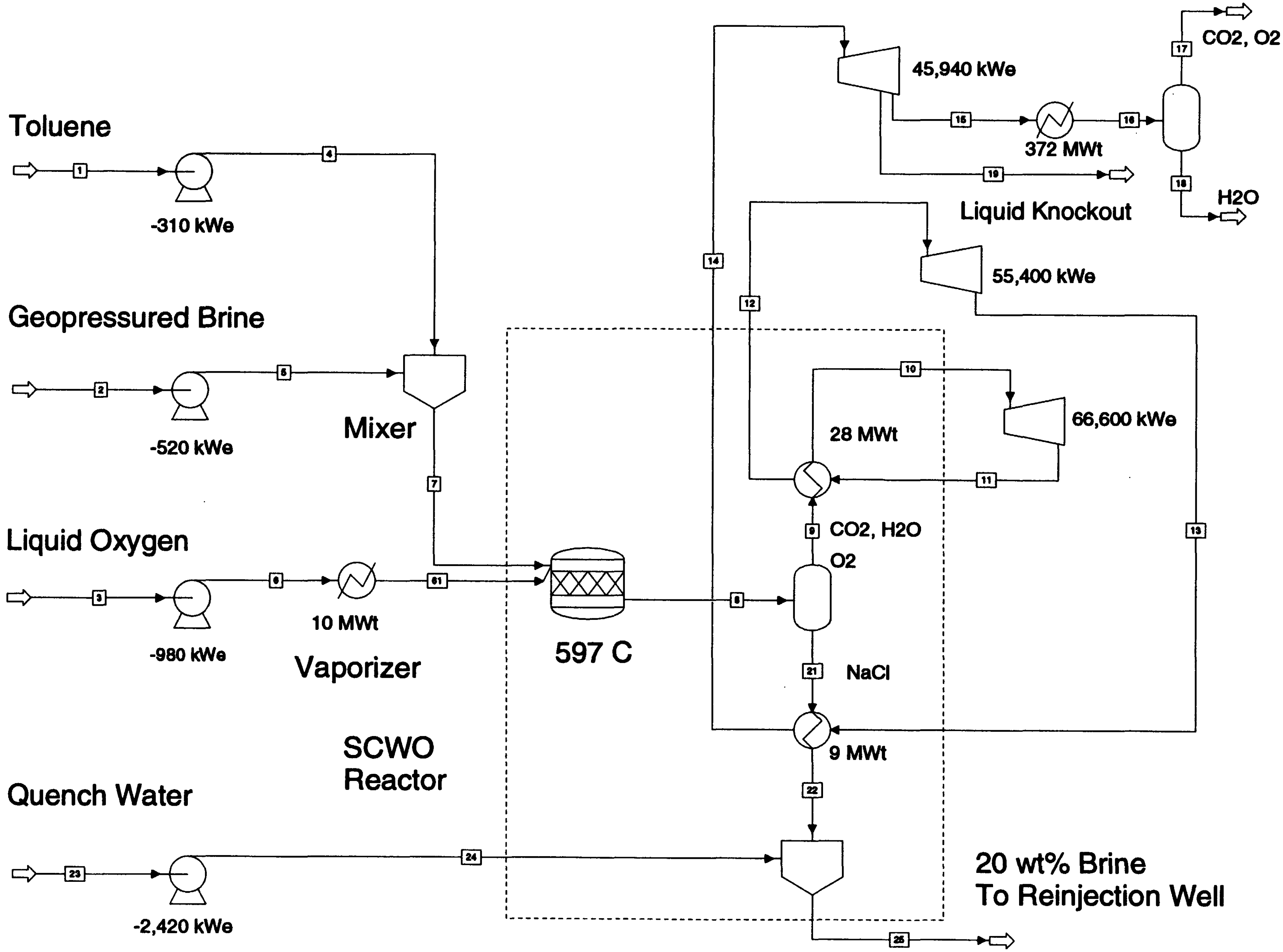


Figure 1 (Continued). Process Flow Diagram for 100,000 bpd Case with Oxygen as Oxidant

Stream ID		1	2	3	4	5	6	61	7	8	9	10	11
Pressure	BAR	1.0	206.8	10.1	234.4	234.4	234.4	234.4	234.4	234.4	234.4	234.4	39.4
Temperature	C	21	149	-153	26	150	-141	21	158	597	597	538	273
Mass Flow	KG/SEC	9.69	159.12	36.38	9.69	159.12	36.38	36.38	168.82	205.19	183.24	183.24	183.24
Stream ID		12	13	14	15	16	17	18	19	23	24	25	
Pressure	BAR	39.4	6.6	6.6	1.0	1.0	1.0	1.0	6.6	1.0	234.4	234.4	
Temperature	C	348	159	183	99	30	30	30	121	21	22	28	
Mass Flow	KG/SEC	183.24	183.24	183.24	176.07	176.07	38.21	137.86	7.17	87.82	87.82	109.78	
Stream ID		21	22										
Pressure	BAR	234.4	234.4										
Temperature	C	597	169										
Mass Flow	KG/SEC	21.96	21.96										

2. INTRODUCTION

2.1 Background

For the past year, the MIT Energy Laboratory has been investigating the feasibility of detoxifying hazardous waste by co-processing the waste with methane-containing geopressured brine. This report describes our progress in doing the first phase of the project. Our work follows initial investigations on this subject carried out at the Idaho National Engineering Laboratory (INEL) (Propp *et al.*, 1990).

Geopressured reservoirs are geothermal fields characterized by the presence of hot brine at pressures well in excess of their *in situ* hydrostatic pressure. In addition to dissolved salts ranging widely in concentration, methane is also present in solution, typically at or near saturation levels (6.0-8.9 x 10^{-3} m^3 CH_4/kg water; 40-50 SCF of CH_4/bbl water) (Tester and Grigsby, 1980). Three forms of energy are available from these resources: thermal, hydraulic and chemical. Of the three, methane is considered to be of greatest commercial value. The hydraulic energy content is potentially large, as the pressures in geopressured reservoirs are expected to approach lithostatic conditions. Thermal energy is probably the least valuable of the three because of the relatively low resource temperatures. The two resource conditions given in Table 1 represent the range of conditions anticipated for geopressured resources in the US. Thus, they are appropriate for our conceptual design study.

Table 1 Typical US Geopressured Brine Characteristics (Negus-DeWys, 1991a)

Property	Texas-Louisiana Gulf Coast Formations	Wilcox Formation South Texas
Temperature	121-182°C (250-360°F)	260°C (500°F)
Pressure	234 bar (3400 psi) (Wellhead)	1241 bar(18000 psi) (Bottom Hole)
Salt content TDS	54,000-194,000 ppm	3200 ppm
CH_4 concentration in brine	23-34 SCF/bbl	100-120 SCF/bbl
CO_2 in gas phase	8 to 11% by vol.	8 to 11% by vol.

Supercritical Water Oxidation (SCWO) is an emerging technology for the destruction of hazardous waste (Tester *et al.*, 1992) which would be coupled to a geopressured resource to increase its power production potential. Our efforts to evaluate this coupling builds on over ten years of research by the MIT Energy Laboratory and Chemical Engineering Department on understanding the fundamental aspects of supercritical water oxidation technology. Earlier in the mid-1970's, investigators in chemical engineering at MIT actually reduced the concept to practice in the first patent (Amin, Reid and Modell, 1978) which led to the establishment of a new company, MODAR, Inc. in 1980 and a series of additional patents on the process itself (Modell, 1982, 1985). Our research group was the first to actually measure kinetic rate constants for the oxidation of methane, carbon monoxide, ammonia, hydrogen, ethanol, and methanol in supercritical water (Helling and Tester, 1986, 1987, 1988; Webley and Tester, 1988, 1989, 1991; Webley *et al.*, 1990, 1991; Holgate and Tester, 1991; Holgate *et al.*, 1991) and the first to observe salt formation and separation in mixed supercritical water jets in an optically accessible cell (Armellini and Tester, 1990, 1991a, 1991b). A comprehensive review of the technology has been prepared in a collaborative effort of the MIT group, MODAR, and ABB Lummus Crest (Tester *et al.*, 1992).

Using a SCWO process, organic wastes are oxidized in a water medium above the critical point of pure water (374°C, 221 bar). Supercritical water behaves as a non-polar dense gas with a high solubility for organics and gases and a low solubility for inorganic salts. As such, a single homogeneous reaction system exists, eliminating the transport limitations associated with multi-phase reaction systems. In a typical SCWO reactor, water, organics and an oxidant such as oxygen are brought together at operating pressures of 234 bar (3400 psi) or higher. The heat of oxidation raises the mixture temperature to about 600°C (1100°F). At this temperature level, greater than 99.99% conversion of organics to carbon dioxide, water and molecular nitrogen is achieved for reactor residence times of 1 minute or less. Under these conditions, no NO_x compounds are produced. Heteroatoms, such as chlorine and sulfur, that might be present in the waste are oxidized to acids which are then neutralized by the addition of a base and precipitated as a salt.

Geopressured-geothermal resources are particularly suitable as an input stream to a SCWO waste treatment process by virtue of the near critical conditions of their hot brine. By using a Rankine-type power cycle, electric power can be generated by capturing the available thermal and hydraulic energy from the resource and the chemical energy of the dissolved methane released by the oxidation process. In addition to oxidizing the methane to convert its chemical energy to thermal energy, auxiliary fuel in the form of an organic waste can be co-oxidized to increase the energy output to commercially sustainable levels. The concept of coupling the treatment of geopressured resources with an organic waste in a supercritical water oxidation process synergistically improves power production while providing a means to destroy hazardous organic waste.

2.2 Project Objective and Approach

The objective of this study is to assess the feasibility of simultaneously generating power and detoxifying hazardous waste by co-processing organic waste with geopressured brine in supercritical water and to develop conceptual process designs for above-ground and modified or fully *in situ* approaches. Before *in situ* approaches can be seriously explored, however, a realistic above-ground base case must be established. This report covers the work done on the development of such a base case.

A review of the initial investigation by INEL (Propp *et al.*, 1990) served as the starting point for our work. We initially adopted the 100,000 gpd design processing capacity used in the INEL study and modeled our flowsheet using the ASPEN PLUS™ process flowsheet simulator. Toluene was chosen as the model compound to represent the organic waste. In modeling the process, practical consideration was given to critical engineering design and performance issues. The cases using air and oxygen as oxidant were both examined and material and energy balances for each case have been determined. A certain degree of heat integration was incorporated in the process but no optimization studies were done. Turbine design calculations based on the flowrates obtained were then performed. These yielded unrealistically high rotor rotational speed and small wheel pitch diameters for optimum efficiencies; thus, a 40-fold larger design capacity of 100,000 bpd was then adopted as the design capacity for the above-ground base case. Material and energy balances have likewise been determined for this design capacity for the cases using air and oxygen as oxidant. No economic analysis was performed in this phase of the project.

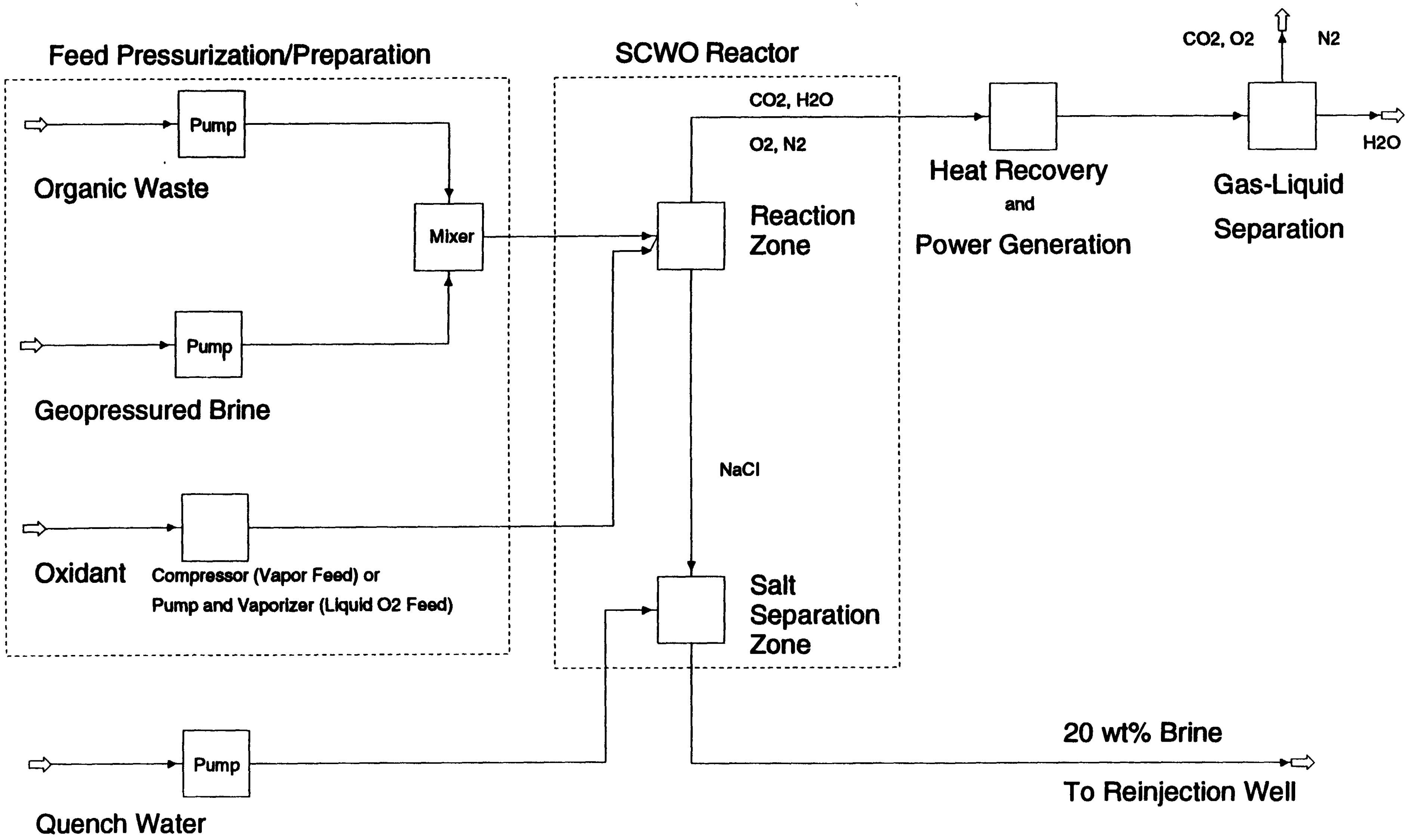
3. DESCRIPTION OF THE MODEL

3.1 Process Flow Description

A conceptual process design of an above-ground SCWO reactor for co-processing geopressured brine and organic waste is depicted in the flowsheet given in Figure 2. The general steps of the process are described below:

Feed Pressurization and Preparation. The geopressured brine and organic waste streams are individually pumped to the reaction system pressure of 234 bar, and then mixed to form an aqueous waste. From the mixer, the aqueous waste stream is introduced into the SCWO reactor. Air can be injected into the reaction vessel with a multi-stage compressor. Alternatively, liquid oxygen can be pumped to the required pressure and then vaporized. If heteroatoms such as Cl, F, P or S are present in the organic waste, caustic is added as part of the feed to neutralize the mineral acids formed upon oxidation.

Figure 2. Generalized Process Flow Diagram for Co-Processing Geopressured Brine with an Organic Waste in an Above-Ground SCWO Reactor



Reaction. Upon mixing with the oxidant in the reactor, the methane in the brine and and the organic waste are oxidized to carbon dioxide and water. The heat of oxidation raises the temperature of the reacting mixture to about 600°C, which accelerates reaction rates and reduces residence times for complete oxidation. The reaction temperature is sufficiently low that there is no formation of NO_x compounds or other toxic products of incomplete combustion. Heteroatoms that might be present in the waste are oxidized to mineral acids. These acids are then neutralized by the base added in the feed preparation step and precipitated as a salt.

Salt Formation and Separation. With its low solubility in supercritical water, inorganic salts such as NaCl precipitate and separate out of the reacting mixture under shock-like conditions (Tester *et al.*, 1992). Due to its higher density, solid salt falls to the lower section of the reaction vessel, where it is cooled and redissolved in quench water to create a concentrated (organic-free) brine. Maintaining the bottom of the reactor below 450°C (840°F) allows redissolution of the salt for ease of withdrawal from the reactor (Hong *et al.*, 1989). A small soluble fraction of the salt formed remains in the supercritical phase and is entrained with the overhead effluent from the reactor.

Heat Recovery and Power Generation. Power is generated from the process by direct expansion of the supercritical fluid effluent consisting of CO_2, H_2O, excess O_2, N_2, and possibly, a small amount of entrained salt through a series of turboexpanders. Heat is recovered from the process primarily by reheating the turbine exhaust streams with the reactor effluents.

There are a number of conceivable design configurations for this step of the process. The heat recovery and power generation scheme used in this study is depicted in Figure 1. A certain degree of heat integration has been incorporated into our process design. Power is generated by expansion of the supercritical fluid effluent through three sets of multi-stage turboexpanders (High, Medium and Low Pressure). The gaseous reaction products mixed with supercritical water leave the reactor as an overhead effluent at about 600°C. A key engineering consideration that arises is the inlet condition for which supercritical turbines are currently designed. A popular design base for a supercritical pressure cycle utilizes steam at an inlet temperature of 540°C (1000°F) and a pressure of 241 bar (3500 psia) (El-Wakil, 1984). Thus, before entering the first stage of the high pressure turboexpanders, the supercritical fluid effluent is first cooled to about 540°C by the exhaust from the last stage of the high pressure turbine. At the same time, the high pressure turbine exhaust is reheated prior to entering the medium pressure turbine. In like manner, exhaust from the last stage of the medium pressure turbine cools the bottom part of the reactor while it is reheated before finally entering the low pressure turbine.

Gas-Liquid Separation. High quality water is recovered from the process by cooling the atmospheric exhaust from the low pressure turbine to near ambient temperature in a water-cooled condenser. Noncondensable gases primarily composed of CO_2, excess O_2, and, in the case of using air as an oxidant, N_2, are finally removed in an atmospheric gas-liquid separator.

Brine Reinjection. A 20 wt% brine, formed by the addition of quench water, is withdrawn from the bottom of the reactor and is reinjected back into the geopressured well.

3.2 Design Basis

Two design capacities have been adopted in this phase of the study, corresponding to the processing of 100,000 gpd and 100,000 bpd of aqueous waste. The former basis was investigated for purposes of comparison with the INEL study (Propp *et al.*, 1990). The flowrates resulting from such a capacity however yielded unrealistic turbine sizes and require only a small fraction of the full capacity of a typical geopressured well system. Thus, we selected a significantly larger 100,000 bpd processing capacity for the base case of this study. In addition, for each processing capacity, the case of using air as an oxidant is compared to the case of using liquid oxygen. The amount of oxidant introduced is 10% above the stoichiometric requirement for oxidation of the methane and the organic waste.

Toluene has been chosen as the model compound for the organic waste, as this is a typical waste from chemical and oil refineries which are prevalent in the Gulf Coast area, where geopressured resources abound. The salt in the geopressured brine has been assumed to be sodium chloride. A key design parameter is the salinity of the brine. With the wide range of compositions observed, only the high salinity case was considered in this study as a worst-case approach. With this basis, we hope to address engineering issues related to salt separation and handling that would likewise be present, but to a lesser extent, in the low salinity case.

The conceptual design basis for this study is presented in Table 2. In addition, the following assumptions have been used to develop the model:

1. For the estimation of physical properties of all the streams except for the brine, the Redlich-Kwong-Soave equation of state has been used.

2. The sodium chloride is treated as an "inert solid." In the ASPEN PLUS™ simulator, an inert solid is accounted for in the heat balance calculations but is assumed to be inert in terms of phase and chemical equilibrium calculations. The Renon (NRTL) activity coefficient model is used to model liquid phase non-idealities, the Redlich-Kwong equation of state to predict the

properties of the vapor and supercritical phases, and Henry's law to estimate the solubility of noncondensable gases (CH_4 and CO_2) at subcritical conditions.

3. The SCWO reactor is modeled as an idealized stoichiometric reactor and a vapor-liquid separator with cooling of the top and bottom sections. Complete conversion of the organic waste and the methane to CO_2 and H_2O is assumed. Heat loss from the reactor is likewise assumed to be negligible. Quench water is injected to the bottom section of the reactor to redissolve the salts formed for withdrawal as a brine.

4. The supercritical fluid mixture leaving the top of the reactor is assumed to be salt-free, i.e. negligible salt solubility in the supercritical mixture (complete precipitation) and zero salt entrainment. Therefore, all the salt leaves the reactor at the bottom.

5. Pump efficiencies (fluid horsepower divided by brake horsepower) are taken to be 85%.

6. For the case with air as oxidant, a four-stage compressor is used, with each stage having an isentropic efficiency of 85% and a mechanical efficiency of 98%. In addition, intercooling to 49°C between stages is provided.

7. Extraction of power from the supercritical fluid is done by expansion through three, five-stage turbines, with each stage having a pressure ratio of 1.4, an isentropic dry stage efficiency of 85% and a mechanical efficiency of 100%. The stage pressure ratio specified has been chosen such that Mach numbers at the nozzle exit would not exceed 0.75 to 0.8 (Milora and Tester, 1976). The three pressure levels corresponding to the three sets of five-stage turbines are as follows:

High Pressure	234.4 to 39.4 bar
Medium Pressure	39.4 to 6.6 bar
Low Pressure	6.6 to 1.0 bar

Table 2 Conceptual Design Basis

Aqueous Waste Flow (Brine & Organic Waste)	**100,000 gpd**		**100,000 bpd**	
Oxidant	**Air**	**Oxygen**	**Air**	**Oxygen**
Flow	4.22 kg/s	0.87 kg/s	177.2 kg/s	36.4 kg/s
Temperature	21°C	-153°C (Saturation)	21°C	-153°C (Saturation)
Pressure	1.0 bar	10.1 bar	1.0 bar	10.1 bar
Organic Liquid Waste				
Flow	0.27 kg/s	0.23 kg/s	11.1 kg/s	9.7 kg/s
Temperature	21°C	21°C	21°C	21°C
Pressure	1.0 bar	1.0 bar	1.0 bar	1.0 bar
Brine				
Flow	3.75 kg/s	3.79 kg/s	157.6 kg/s	159.1 kg/s
Temperature	149°C	149°C	149°C	149°C
Pressure	206.8 bar	206.8 bar	206.8 bar	206.8 bar
Composition				
Dissolved Salt	127,000 mg NaCl/L	127,000 mg NaCl/L	127,000 mg NaCl/L	127,000 mg NaCl/L
Dissolved Gas	35 SCF/bbl (90% CH_4, 10% CO_2)	35 SCF/bbl (90% CH_4, 10% CO_2)	35 SCF/bbl (90% CH_4, 10% CO_2)	35 SCF/bbl (90% CH_4, 10% CO_2)

4. RESULTS

4.1 Mass and Energy Balances

The material balances for the 100,000 gpd case with air as oxidant and with liquid oxygen as oxidant are given in Figures 3 and 4, respectively. For purposes of comparison, the INEL flowsheet and mass balance for a 100,000 gpd processing capacity with air as oxidant are given in Figure 5.

Figures 6 and 1 give the mass balances for the 100,000 bpd case with air and liquid oxygen as oxidant, respectively. Detailed breakdown by component of the mass flows may be found in the ASPEN PLUS™ output files in the Appendix.

The energy balance for a 100,000 gpd processing capacity with air as oxidant is compared with that of the INEL study and is presented in Table 3. A similar comparison for the case with oxygen as oxidant is given in Table 4.

The energy balances for a processing capacity of 100,000 bpd are presented in Table 5 for the cases using air and oxygen as oxidant. Table 6 summarizes the net power output and net cooling requirement for all the cases considered. In addition, the results of the INEL study (Propp *et al.*, 1990) are also given in this table for purposes of comparison.

4.2 Turbine Design and Sizing

A Baljé (Milora and Tester, 1976) similarity analysis of turbine performance was carried out based on the volumetric flowrates of the supercritical fluid effluent obtained for 100,000 gpd and 100,000 bpd processing capacities. Table 7 gives the comparison of rotor rotational speeds, N_i, and wheel pitch diameters, D_i, of the turbines in the power production scheme of the 100,000 gpd and 100,000 bpd cases with air as oxidant. A similar comparison is given in Table 8 with oxygen as oxidant.

Figure 3. Process Flow Diagram for 100,000 gpd Case with Air as Oxidant

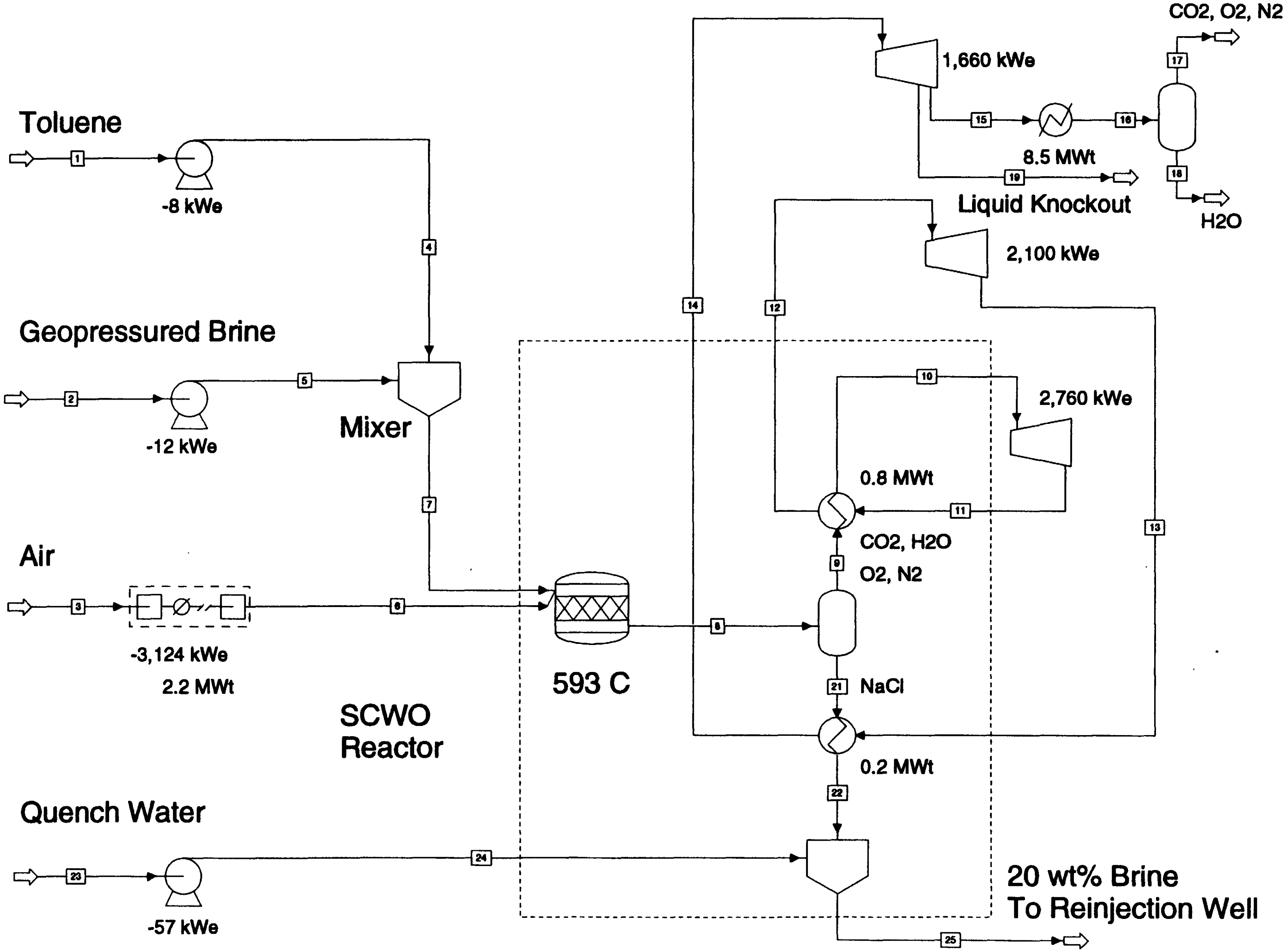


Figure 3 (Continued). Process Flow Diagram for 100,000 gpd Case with Air as Oxidant

Stream ID		1	2	3	4	5	6	7	8	9	10	11
Pressure	BAR	1.0	206.8	1.0	234.4	234.4	234.4	234.4	234.4	234.4	234.4	39.4
Temperature	C	21	149	21	26	150	224	157	593	593	538	283
Mass Flow	KG/SEC	0.27	3.75	4.22	0.27	3.75	4.22	4.02	8.24	7.72	7.72	7.72
Stream ID		12	13	14	15	16	17	18	19	23	24	25
Pressure	BAR	39.4	6.6	6.6	1.0	1.0	1.0	1.0	6.6	1.0	234.4	234.4
Temperature	C	346	150	170	87	30	30	30	107	21	22	28
Mass Flow	KG/SEC	7.72	7.72	7.72	7.46	7.46	4.34	3.12	0.26	2.07	2.07	2.59
Stream ID		21	22									
Pressure	BAR	234.4	234.4									
Temperature	C	593	160									
Mass Flow	KG/SEC	0.52	0.52									

Figure 4. Process Flow Diagram for 100,000 gpd Case with Oxygen as Oxidant

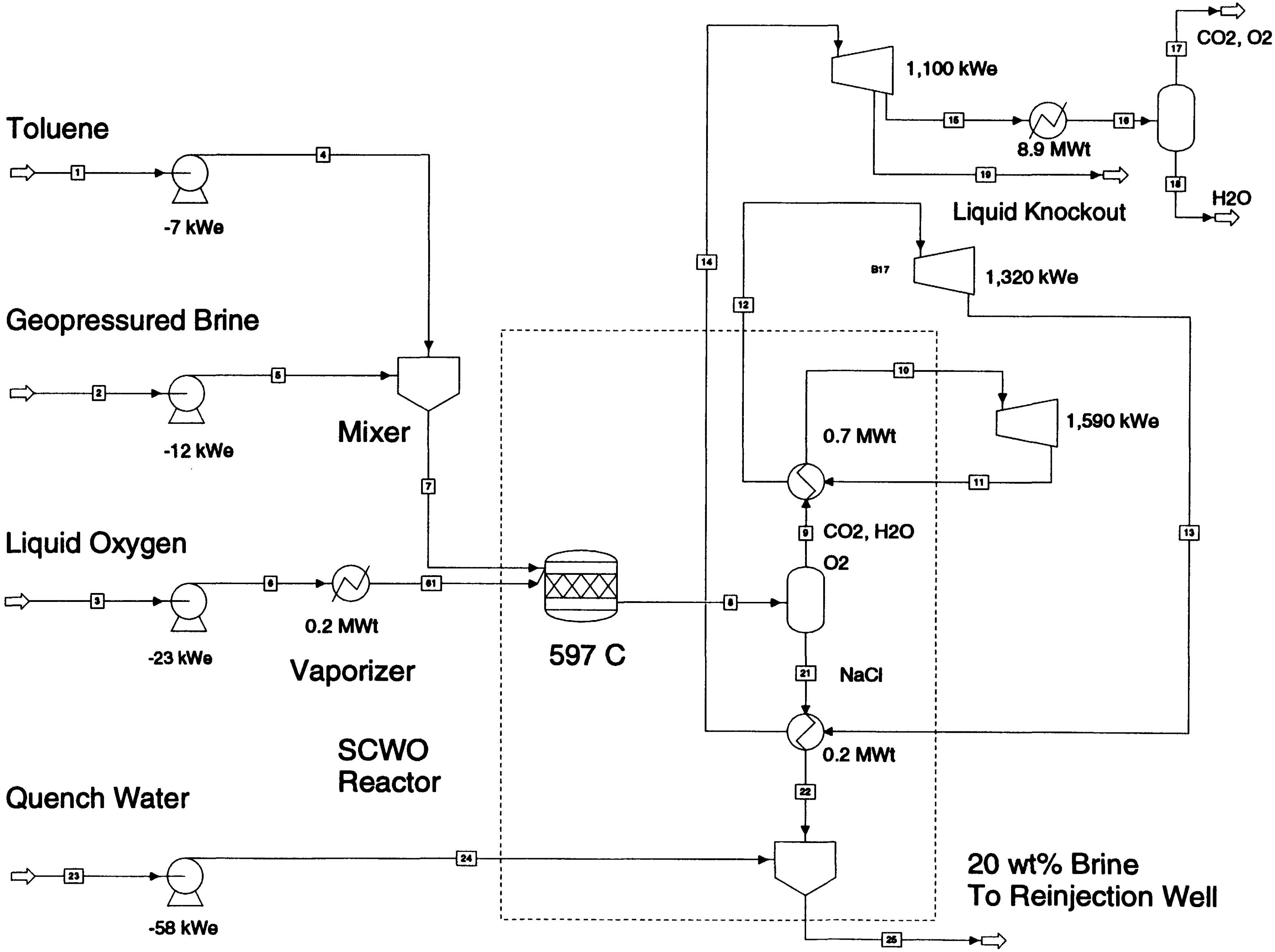
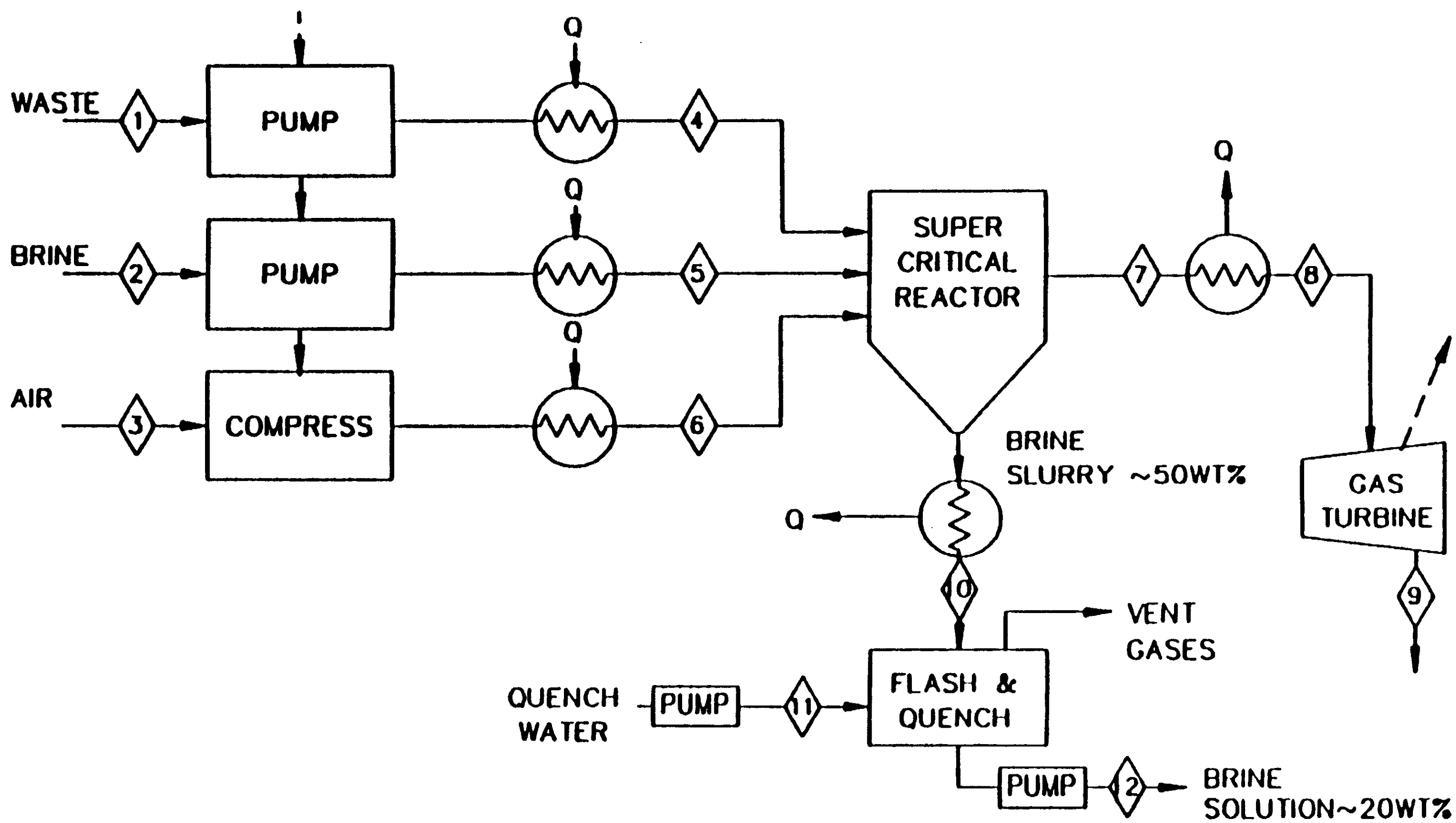


Figure 4 (Continued). Process Flow Diagram for 100,000 gpd Case with Oxygen as Oxidant

Stream ID		1	2	3	4	5	6	61	7	8	9	10	11
Pressure	BAR	1.0	206.8	10.1	234.4	234.4	234.4	234.4	234.4	234.4	234.4	234.4	39.4
Temperature	C	21	149	-153	26	150	-141	21	158	597	597	538	273
Mass Flow	KG/SEC	0.23	3.79	0.87	0.23	3.79	0.87	0.87	4.02	4.89	4.36	4.36	4.36
Stream ID		12	13	14	15	16	17	18	19	23	24	25	
Pressure	BAR	39.4	6.6	6.6	1.0	1.0	1.0	1.0	6.6	1.0	234.4	234.4	
Temperature	C	348	159	183	99	30	30	30	121	21	22	28	
Mass Flow	KG/SEC	4.36	4.36	4.36	4.19	4.19	0.91	3.28	0.17	2.09	2.09	2.61	
Stream ID		21	22										
Pressure	BAR	234.4	234.4										
Temperature	C	597	169										
Mass Flow	KG/SEC	0.52	0.52										

Figure 5. INEL Flow Diagram for 100,000 gpd Case with Air as Oxidant (Propp *et al.*, 1990)



STREAM NUMBER	1	2	3	4	5	6	7	8	9	10	11	12
PRESSURE (PSIA)	14.7	3000	14.7	3700	3700	3700	3700	3700	40	3600	3600	10000
TEMPERATURE (°F)	70	300	70	1100	1100	1100	2785	1200	270	300	70	145
FLOW (LB/HR)	3055	30100	46200	3055	30100	46200	75215	75215	75215	4140	14725	18865

Figure 6. Process Flow Diagram for 100,000 bpd Case with Air as Oxidant

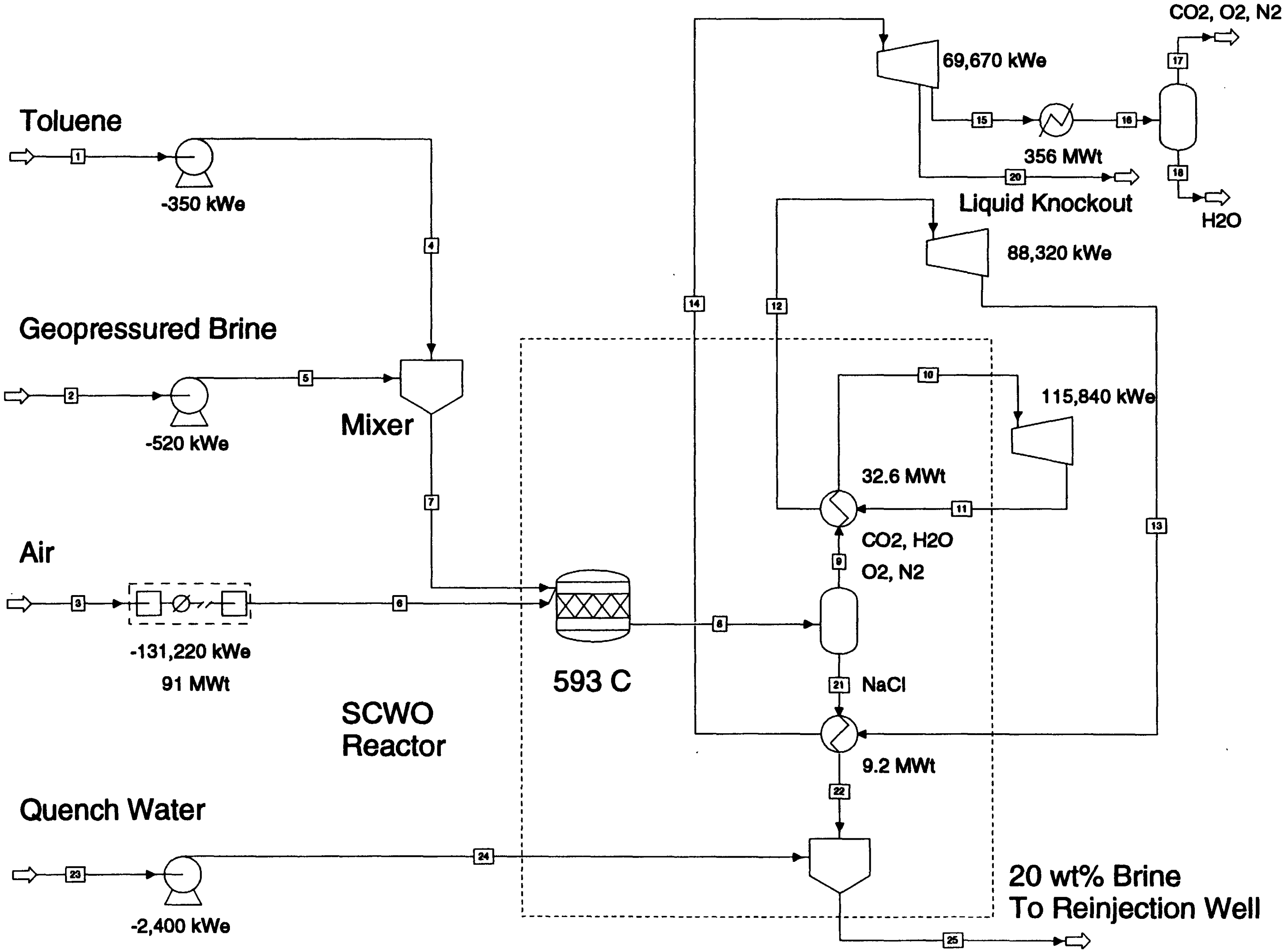


Figure 6 (Continued). Process Flow Diagram for 100,000 bpd Case with Air as Oxidant

Stream ID		1	2	3	4	5	6	7	8	9	10	11
Pressure	BAR	1.0	206.8	1.0	234.4	234.4	234.4	234.4	234.4	234.4	234.4	39.4
Temperature	C	21	149	21	26	150	224	157	593	593	538	283
Mass Flow	KG/SEC	11.13	157.60	177.23	11.13	157.60	177.23	168.73	345.96	324.22	324.22	324.22
Stream ID		12	13	14	15	16	17	18	19	23	24	25
Pressure	BAR	39.4	6.6	6.6	1.0	1.0	1.0	1.0	6.6	1.0	234.4	234.4
Temperature	C	346	150	170	87	30	30	30	107	21	22	28
Mass Flow	KG/SEC	324.22	324.22	324.22	313.48	313.48	182.36	131.13	10.74	86.98	86.98	108.72
Stream ID		21	22									
Pressure	BAR	234.4	234.4									
Temperature	C	593	160									
Mass Flow	KG/SEC	21.74	21.74									

Table 3 Energy Balance Comparison for 100,000 gpd Case with Air as Oxidant between the MIT (this study) and the INEL (Propp *et al.*, 1990) Study

Energy Input

	Power, kWe		Heat Rate, MWt	
	MIT	INEL*	MIT	INEL*
Waste (pump, heater)	8	13	-	0.6
Air (compressor, heater)	3124	5294	-	2.7
Brine (pump, heater)	12	25	-	11.4
Quench Water (pump)	57	54	-	-
Brine Return (pump)	-	132	-	-
	3201	5518	-	14.7

Energy Output

	Power, kWe		Cooling Rate, MWt	
	MIT	INEL*	MIT	INEL*
Hot Exhaust (turbine, cooler)	6520	7550	8.5	14.6
Slurry (cooler)	-	-	-	1.6
Air (compressor intercooler)	-	-	2.2	-
	6520	7550	10.7	16.2

* Results of INEL Study (Propp *et al.*, 1990) converted from English units (hp and MMBtu/hr)

Table 4 Energy Balance Comparison for 100,000 gpd with Oxygen as Oxidant between the MIT (this study) and the INEL (Propp *et al.*, 1990) Study

Energy Input

	Power, kWe		Heat Rate, MWt	
	MIT	INEL*	MIT	INEL*
Waste (pump, heater)	7	13	-	0.6
Oxygen (pump/compress, heater)	23	1119	0.2	0.6
Brine (pump, heater)	12	25	-	11.4
Quench Water (pump)	58	54	-	-
Brine Return (pump)	-	132	-	-
	100	1343	0.2	12.6

Energy Output

	Power, kWe		Cooling Rate, MWt	
	MIT	INEL*	MIT	INEL*
Hot Exhaust (turbine, cooler)	4000	5060	8.9	14.2
Slurry (cooler)	-	-	-	2.8
	4000	5056	8.9	17.0

* Results of INEL Study (Propp *et al.*, 1990) converted from English units (hp and MMBtu/hr)

Table 5 Energy Balance for 100,000 bpd Case

Energy Input

	Power, kWe		Heat Rate, MWt	
Oxidant	Air	O_2	Air	O_2
Waste (pump)	350	310	-	-
Air/Oxygen (compressor/pump)	131,220	980	-	10
Brine (pump)	520	520	-	-
Quench Water (pump)	2,400	2,420	-	-
	134,490	4,230	-	10

Energy Output

	Power, kWe		Cooling Rate, MWt	
Oxidant	Air	O_2	Air	O_2
Hot Exhaust (turbine, cooler)	273,820	167,950	356	372
Slurry (cooler)	-	-	91	-
	273,820	167,950	447	372

Table 6 Summary of Net Power Output and Net Cooling Requirement

Case	Net Power Output, MWe (Oxidant) Air	Net Power Output, MWe (Oxidant) O_2	Net Cooling Requirement, MWt (Oxidant) Air	Net Cooling Requirement, MWt (Oxidant) O_2
100,000 gpd (INEL)	2.0	3.7	1.5	4.4
100,000 gpd	3.3	3.9	10.6	8.7
100,000 bpd	139	164	450	370

Table 7 Comparison of Rotor Rotational Speed, N_i and Wheel Pitch Diameter, D_i between 100,000 gpd and 100,000 bpd Cases with Air as Oxidant

Turboexpander Unit	Stage, i	100,000 gpd Case N_i, rpm	100,000 gpd Case D_i, m	100,000 bpd Case N_i, rpm	100,000 bpd Case D_i, m
High Pressure	1	105,000	0.05	16,200	0.31
	2	86,000	0.06	13,200	0.36
	3	70,000	0.07	10,900	0.42
	4	58,000	0.08	8,900	0.50
	5	47,000	0.09	7,300	0.58
Medium Pressure	1	40,000	0.11	6,200	0.70
	2	33,000	0.13	5,100	0.82
	3	27,000	0.15	4,200	0.97
	4	22,000	0.18	3,400	1.13
	5	18,000	0.21	2,800	1.33
Low Pressure	1	16,000	0.24	2,400	1.57
	2	13,000	0.29	1,900	1.74
	3	10,000	0.34	1,600	2.23
	4	9,000	0.41	1,300	2.66
	5	7,000	0.49	1,100	3.17

Table 8 Comparison of Rotor Rotational Speed, N_i and Wheel Pitch Diameter, D_i between 100,000 gpd and 100,000 bpd Cases with Oxygen as Oxidant

		100,000 gpd Case		100,000 bpd Case	
Turboexpander Unit	Stage, i	N_i, rpm	D_i, m	N_i, rpm	D_i, m
High Pressure	1	140,000	0.04	21,600	0.23
	2	115,000	0.04	17,700	0.27
	3	94,000	0.05	14,500	0.32
	4	77,000	0.06	11,900	0.38
	5	63,000	0.07	9,800	0.44
Medium Pressure	1	54,000	0.08	8,400	0.54
	2	45,000	0.10	6,900	0.64
	3	37,000	0.12	5,700	0.75
	4	30,000	0.14	4,700	0.88
	5	25,000	0.16	3,800	1.03
Low Pressure	1	21,000	0.19	3,300	1.23
	2	17,000	0.23	2,700	1.47
	3	14,000	0.27	2,200	1.75
	4	12,000	0.32	1,800	2.08
	5	10,000	0.38	1,500	2.47

5. DISCUSSION

5.1 Comparison with the INEL Study

As seen in Tables 3 and 4, there are a number of significant differences between the results of this study for the 100,000 gpd case and those of the INEL study (Propp *et al.*, 1990). The reasons for these differences are explained below:

Adherence to a Maximum Reactor Temperature Process Constraint. A process contraint of maintaining a maximum reactor temperature of 600°C was used in this study. A critical engineering issue is the mechanical design and choice of materials of construction for the reaction vessel. The high pressure and high temperature conditions of SCWO, coupled with the corrosive nature of salts formed during oxidation, require the use of high-strength nickel superalloys such as Inconel 625 (in wt%: 55-68 Ni, 20-23 Cr, 8-10 Mo, 3-4 Nb and <5 Fe) or Hastelloy C276 (Tester *et al.*, 1992). Practical SCWO systems would operate at temperatures at or near 600°C, as the strength of the materials used for the reactor would be significantly reduced at higher temperatures. High strength is needed for containment under normal SCWO operating pressures of 234 to 250 bar.

This operation constraint limits the amount of organic waste that can be co-processed with the brine. While the INEL flowsheet has an aqueous waste (geopressured brine and organic waste) containing about 10% organics with a heating value of 4,200 kJ/kg (1,800 Btu/lb) aqueous waste, the aqueous waste in this study contains only about 7% and 6% organics with heating values of 2,900 kJ/kg (1,250 Btu/lb) and 2,600 kJ/kg (1,100 Btu/lb) aqueous waste for the cases using air and oxygen as oxidant, respectively. The decrease in the amount of organics mainly account for the lower waste pumping requirement and lower power output from the turbines in this study.

Reduction in Reaction System Pressure. The reaction system pressure was lowered to 234 bar (3400 psi) in this study, as opposed to 255 bar (3700 psi) in the INEL study, because of the successful demonstration of SCWO of hazardous wastes at this pressure by MODAR, Inc. (Hong, 1992). This lower pressure reduces the head to be added to the input streams and partly explains the difference in pumping/compression power requirements. For example, the pumping head for the geopressured brine, which is available at 207 bar (3000 psi), has been decreased by half. Thus, the power required to bring the brine to the system pressure is only 12 kWe, about half the power requirement of 25 kWe in the INEL study.

Decrease in Amount of Oxidant Used. As a result of the lower heating value of the aqueous waste, the amount of air used is about 30% lower than that in the INEL study. This largely explains the compression power requirement of 3,124 kWe, which is about 40% lower than the result of the INEL study. In addition, the air compressor has been modeled in this study as a four-stage unit with intercooling between stages. The INEL study gives no details on its assumptions for the calculation of the air compressor power requirement.

Omission of Feed Preheaters. In the INEL study, the feed streams to the SCWO reactor are preheated to 600°C. Upon reaction, the system temperature increases drastically to 1530°C, for the case with air as oxidant. Because of the maximum reactor temperature process contraint, the input stream preheaters are not needed and have been omitted in this study. The effect of this change is a much larger net cooling utility requirement relative to the INEL results. In an actual plant, the aqueous waste is preheated to obtain faster kinetics. However, preheating is done only to temperatures below which pyrolysis of the organic waste may occur and not to the reaction system temperature of 600°C, since the heat of oxidation further raises the system temperature. For purposes of determining the overall energy balance, omitting the preheat will have no effect, unless a heat source external to the process is used.

Reduction in Pressure Range of Turbine Operation. For the power production scheme of this study, the effluent from the SCWO reactor is expanded from 234 bar to a saturated vapor at 1 bar (14.5 psi), as opposed to an expansion from 255 bar to 2.8 bar (40 psi) in the INEL study. The total power generated is 6520 kWe, about 15% lower than the result of the INEL study. Aside from the difference in the pressure range, the reduced mass flow of the supercritical fluid effluent due to the lower amount of organics and oxidant accounts for the difference in power production. The turboexpander has been modeled as multi-stage, multi-unit equipment with liquid extraction. As with the air compressor, the INEL study does not give its assumptions for modeling the turboexpander.

Use of Liquid Oxygen as Oxidant. For the case with oxygen, saturated liquid oxygen at 10 bar (145 psi) is utilized as oxidant source, making the use of a pump possible, instead of a compressor. A vaporizer with the atmospheric air as heat source is then installed after the pump. The pump/vaporizer set-up reduces the power requirement substantially, compared to the oxygen compressor set-up of the INEL study.

Omission of Reinjection Pump. The reinjection pump is omitted because of overpressure in the system. Assuming a downhole pressure of 690 bar (10,000 psi) at a depth of about 5,200 m (17,000 ft) (Negus-deWys, 1991b), the system pressure of 234 bar plus the head of a column of 20 wt% brine is sufficient for reinjection. Of greater concern, however, is the amount of reinjected brine. The mass of geopressured brine withdrawn from the well is about 30% greater than the mass of

20 wt% brine returned to the well. Clearly, this difference has to be made up, either with seawater or brackish water from a source near the plant. The INEL study does not address this concern.

Decrease in Concentration of Brine from Reactor. Solid salt, which is cooled by the exhaust from the medium pressure turboexpander, is quenched with water in the lower section of the reactor to form a 20 wt% brine. This is opposed to a 50 wt% slurry from the reactor in the INEL study. Withdrawal of a 20 wt% brine from the SCWO reactor is much easier than withdrawal of a slurry. This is recognized in the INEL study as the slurry is further diluted to a 20 wt% brine prior to reinjection.

5.2 Development of the 100,000 bpd Base Case

A Baljé similarity analysis of turbine performance (Milora and Tester, 1976) based on the volumetric flowrates obtained for a 100,000 gpd processing capacity has resulted in unrealistically large rotor rotational speeds, N_i , and small wheel pitch diameters, D_i, of the turbines in the power production scheme. Considering that a flowrate of 100,000 gpd (70 gpm) is but a small fraction of maximum flowrates typical of geopressured reservoirs 15,000 to 40,000 bpd (450 to 1200 gpm) (Negus-de Wys, 1991b), a significantly higher flowrate of 100,000 bpd (2900 gpm) has been taken as an alternative design basis. Because this exceeds the maximum flowrate from a single geopressured well, an underlying assumption for using this design capacity is to co-process geopressured brine from and to reinject brine back into multiple wells. A similar analysis based on flowrates for a scaled-up process with a 100,000 bpd capacity has given more reasonable values for N_i and D_i. Because a realistic turbine design results for a 100,000 bpd case, this capacity has been taken to be the design basis for our base case. The mass and energy balance results scale up linearly from the results for the 100,000 gpd case.

6. CONCLUSIONS

This conceptual design study suggests that simultaneous detoxification of hazardous waste and production of power is possible by co-processing organic waste with geopressured brine. Our best case flowsheet, presented in Figure 1, shows that, for a processing capacity of 100,000 bpd using oxygen as oxidant, a net power output of 160 MWe is attainable by expanding the supercritical fluid effluent from the SCWO reactor through three sets of multi-stage turboexpanders. With air as oxidant, the net power output is 140 MWe for the same design capacity.

7. FUTURE MODELING STUDIES

Further investigation into the utilization of geopressured resources in the oxidation of organic waste in supercritical water will be pursued in Phase II of our study by completing a realistic, above-ground base case heat and material balance, and developing several conceptual process designs for *in situ* approaches. Specific sub-tasks for this phase of our research are:

Improve Supercritical Fluid Models. Refine the model by calculating thermophysical properties of supercritical fluid mixtures using a more accurate equation of state (EOS) such as the three-parameter Martin equation or the one developed by Christoforakos, Heilig and Franck (CHFEOS) (Christoforakos and Franck, 1986; Heilig and Franck, 1990). These equations of state more correctly describe and predict phase equilibria and critical phenomena of multicomponent fluid systems, particularly in the region of elevated temperatures and pressures in which our reactor will be operating. The CHFEOS utilizes an additive perturbation attraction term based on a square well potential and a modified hard sphere repulsion term, while the Martin EOS introduces a volume translation parameter to more correctly fit the critical compressibility of each component.

Incorporate Electrolyte Thermodynamic Property Models. We intend to use the ASPEN PLUS™ electrolyte system to include a salt component in the phase and chemical equilibrium calculations. In addition, we plan to develop models for the precipitation of salt in a reacting supercritical water stream using data obtained by our research group (Armellini and Tester, 1990, 1991a, 1991b). Salt separation is a key engineering design consideration in the operation of the SCWO process (Hong *et al.*, 1989).

Investigate Other Power Production Schemes. The amount of salt dissolved in the supercritical fluid effluent is a critical parameter in turbine design. Should we determine the amount of dissolved salt to exceed the specification levels of modern geothermal steam turbines, we will consider an alternative power generation scheme such as a binary fluid Rankine cycle. This will require high pressure steam to be generated on one side of a heat exchanger and the supercritical fluid to be cooled and, possibly, condensed on the other side. Such a set-up would, of course, have a lower efficiency due to the inability to recover the hydraulic energy of the supercritical fluid.

Reconsider Reinjection Requirements. Pressures and flowrates of the brine reinjection stream will be evaluated more closely in the light of reinjection requirements. Multiple well configurations will be considered. Since essentially pure water will be produced from the process and can be put to better use, another source of water, possibly seawater or brackish water, would be considered for reinjection.

Develop Conceptual Process Designs for an In Situ Approach. The MIT Energy Laboratory's expertise in process simulation and modeling using advanced simulators such as ASPEN PLUS™ and Advent would be utilized in conjunction with accumulated data and technical experience with SCWO and geothermal technology (Milora and Tester, 1976; Tester and Grigsby, 1980; Murphy *et al.*, 1981; Tester, 1982; Armstead and Tester, 1987; Tester *et al.*, 1989) to investigate new design options for processing both low and high salinity brines. Fully *in situ* and modified *in situ* approaches would be examined with conceptual process designs, equipment sizing and economic estimates provided. *In situ* methods of treating wastes would take advantage of the sensitivity of solubility to pressure and temperature around the critical point. For some conceptual design cases, downhole reactor and salt handling volumes would consist of large cavities mined in deep pockets of rock or salt (Rauenzahn and Tester, 1989, 1990a, 1990b). More conventional, multi-annuli downhole tubular reactor and separator concepts confined to large diameter sections of a drilled well would also be examined as possible *in situ* approaches (Rappe, 1984; Kaufmann and Peterscheck, 1986).

Perform an Economic Analysis. Equipment sizing and economic estimates will be provided to assess the feasibility of commercial operation.

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Appendix A.1 ASPEN PLUS™ Output File for 100,000 gpd Case with Air as Oxidant

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AAAAA   SSSSS   PPPPP   EEEEE   N   N N   PPPPP   L       U   U   SSSSS
A   A       S   P       E       N    NN   P       L       U   U       S
A   A   SSSSS   P       EEEEE   N     N   P       LLLLL   UUUUU   SSSSS
```

ASPEN PLUS IS A TRADEMARK OF
ASPEN TECHNOLOGY, INC.
251 VASSAR STREET
CAMBRIDGE, MASSACHUSETTS 02139
617/497-9010

HOTLINE:
U.S.A. 617/497-9010
EUROPE (32) 2/732-6300

VERSION: PC-DOS
RELEASE: 8.5-3
INSTALLATION: MITELAB

NOVEMBER 11, 1992
WEDNESDAY
7:19:23 P.M.

TABLE OF CONTENTS

```
RUN CONTROL INFORMATION
-----------------------

THIS VERSION OF ASPEN PLUS LICENSED TO MIT ENERGY LAB
TYPE OF RUN: NEW

INPUT FILE NAME: TOL1.inp

OUTPUT PROBLEM DATA FILE NAME:  TOL1     VERSION NO.   1
LOCATED IN:                     G:\TOL1


PDF SIZE USED FOR INPUT TRANSLATION:
  NUMBER OF FILE RECORDS (PSIZE) = 99999
  NUMBER OF IN-CORE RECORDS      =   400
PSIZE NEEDED FOR SIMULATION    =   300

CALLING PROGRAM NAME:            apmod
LOCATED IN:                     d:\ap85b\xeq\apmod

SIMULATION REQUESTED FOR ENTIRE FLOWSHEET

BLOCK STATUS
------------

****************************************************************************
*                                                                          *
* ALL UNIT OPERATION BLOCKS WERE COMPLETED NORMALLY                        *
*                                                                          *
* ALL CONVERGENCE BLOCKS WERE COMPLETED NORMALLY                           *
*                                                                          *
****************************************************************************
```

INPUT FILE(S)

```
>>ORIGINAL RUN                                NOVEMBER 11, 1992
  7:18:34 P.M.                                WEDNESDAY
  INPUT FILE: TOL1.inp
  OUTPUT PDF: TOL1      VERSION:  1
  LOCATED IN: G:\TOL1
      ;
      ;Input file created by ModelManager Rel. 3.3-3 on Wed Nov 11 19:17:58
      ;Directory G:\  Runid TOL1
      ;



      TITLE "FLOWSHEET"

      IN-UNITS SI PRESSURE=BAR TEMPERATURE=C DELTA-T=C

      DEF-STREAMS MIXCISLD ALL

      DATABANKS ASPENPCD / SOLIDS / BINARY

      PROP-SOURCES ASPENPCD / SOLIDS / BINARY

      COMPONENTS
          TOL C7H8 TOL /
          H2O H2O H2O /
          NACL NACL NACL /
          CH4 CH4 CH4 /
          CO2 CO2 CO2 /
          N2 N2 N2 /
          O2 O2 O2

      HENRY-COMPS GASES CH4 CO2

      FLOWSHEET
          BLOCK B1 IN=1 OUT=4
          BLOCK B2 IN=2 OUT=5
          BLOCK B3 IN=3 OUT=6
          BLOCK B5 IN=6 7 OUT=8
          BLOCK B4 IN=4 5 OUT=7
          BLOCK B13 IN=21 13 OUT=22 14
          BLOCK B14 IN=24 22 OUT=25
          BLOCK B15 IN=23 OUT=24
          BLOCK B11 IN=15 OUT=16
          BLOCK B6 IN=8 OUT=9 21
          BLOCK B8 IN=10 OUT=11
          BLOCK B9 IN=12 OUT=13
          BLOCK B10 IN=14 OUT=15 19
          BLOCK B12 IN=16 OUT=17 18
          BLOCK B7 IN=9 11 OUT=10 12

      PROPERTIES SYSOP3 HENRY-COMPS=GASES
          PROPERTIES SYSOP10A / SYSOP15S
```

INPUT FILE(S) (CONTINUED)

```
PROP-REPLACE SYSOP15S SYSOP15S
    PROP VLMX VLMX01

PROP-REPLACE SYSOP3 SYSOP3
    PROP VLMX VLMX01
    PROP VL VL01

STREAM 1
    SUBSTREAM MIXED TEMP=21.11111 PRES=1.013530
    MASS-FLOW TOL .2651000

STREAM 2
    SUBSTREAM MIXED TEMP=148.8889 PRES=206.8430
    MASS-FLOW H2O 3.216474 / CH4 .0163545 / CO2 1.81437E-3
    SUBSTREAM CISOLID TEMP=148.8889 PRES=206.8430
    MASS-FLOW NACL .5177253

STREAM 23
    SUBSTREAM MIXED TEMP=21.11111 PRES=1.013530
    MASS-FLOW H2O 2.070901

STREAM 3
    SUBSTREAM MIXED TEMP=21.11111 PRES=1.013530
    MASS-FLOW N2 3.236507 / O2 .9832874

BLOCK B14 MIXER
    IN-UNITS SI

BLOCK B4 MIXER

BLOCK B6 SEP
    FRAC STREAM=9 SUBSTREAM=MIXED COMPS=H2O CO2 N2 O2  &
        FRACS=1 1 1 1
    FRAC STREAM=21 SUBSTREAM=CISOLID COMPS=NACL FRACS=1

BLOCK B11 HEATER
    PARAM TEMP=30.00000 PRES=1.013529

BLOCK B12 FLASH2
    PARAM PRES=1.013529 DUTY=0

BLOCK B13 HEATX
    PARAM DELT-HOT=10 <K>
    FEEDS HOT=21 COLD=13
    PRODUCTS HOT=22 COLD=14

BLOCK B7 HEATX
    PARAM T-HOT=1000 <F>
    FEEDS HOT=9 COLD=11
    PRODUCTS HOT=10 COLD=12

BLOCK B5 RSTOIC
    PARAM PRES=234.4220 DUTY=0.0
```

INPUT FILE(S) (CONTINUED)

```
        STOIC 1 MIXED TOL -1 / O2 -9 / CO2 7 / H2O 4
        STOIC 2 MIXED CH4 -1 / O2 -2 / CO2 1 / H2O 2
        CONV 1 MIXED TOL 1
        CONV 2 MIXED CH4 1

    BLOCK B1 PUMP
        PARAM PRES=234.4218 EFF=0.85

    BLOCK B15 PUMP
        PARAM PRES=234.4220 EFF=0.85

    BLOCK B2 PUMP
        PARAM PRES=234.4220 EFF=0.85
        PROPERTIES SYSOP10A HENRY-COMPS=GASES

    BLOCK B10 MCOMPR
        PARAM NSTAGE=5 TYPE=ISENTROPIC PRES=1.013529 COMPR-NPHASE=2
        FEEDS 14 1
        PRODUCTS 15 5 / 19 GLOBAL L
        COMPR-SPECS 1 SEFF=0.85 MEFF=1 / 2 SEFF=0.85 MEFF=1 / 3  &
            SEFF=0.85 MEFF=1 / 4 SEFF=0.85 MEFF=1 / 5 SEFF=0.85  &
            MEFF=1
        COOLER-SPECS 1 DUTY=0.0 / 2 DUTY=0.0 / 3 DUTY=0.0 / 4  &
            DUTY=0.0 / 5 DUTY=0.0

    BLOCK B3 MCOMPR
        PARAM NSTAGE=4 TYPE=ISENTROPIC PRES=234.4220 COMPR-NPHASE=2
        FEEDS 3 1
        PRODUCTS 6 4
        COMPR-SPECS 1 SEFF=0.85 MEFF=0.98 / 2 SEFF=0.85 MEFF=0.98  &
            / 3 SEFF=0.85 MEFF=0.98 / 4 SEFF=0.85 MEFF=0.98
        COOLER-SPECS 1 TEMP=48.88891 / 2 TEMP=48.88891 / 3  &
            TEMP=48.88891 / 4 DUTY=0.0

    BLOCK B8 MCOMPR
        PARAM NSTAGE=5 TYPE=ISENTROPIC PRES=39.36907 COMPR-NPHASE=2
        FEEDS 10 1
        PRODUCTS 11 5
        COMPR-SPECS 1 SEFF=0.85 MEFF=1 / 2 SEFF=0.85 MEFF=1 / 3  &
            SEFF=0.85 MEFF=1 / 4 SEFF=0.85 MEFF=1 / 5 SEFF=0.85  &
            MEFF=1
        COOLER-SPECS 1 DUTY=0.0 / 2 DUTY=0.0 / 3 DUTY=0.0 / 4  &
            DUTY=0.0 / 5 DUTY=0.0

    BLOCK B9 MCOMPR
        PARAM NSTAGE=5 TYPE=ISENTROPIC PRES=6.618967 COMPR-NPHASE=2
        FEEDS 12 1
        PRODUCTS 13 5
        COMPR-SPECS 1 SEFF=0.85 MEFF=1 / 2 SEFF=0.85 MEFF=1 / 3  &
            SEFF=0.85 MEFF=1 / 4 SEFF=0.85 MEFF=1 / 5 SEFF=0.85  &
            MEFF=1
        COOLER-SPECS 1 DUTY=0.0 / 2 DUTY=0.0 / 3 DUTY=0.0 / 4  &
            DUTY=0.0 / 5 DUTY=0.0
```

INPUT FILE(S) (CONTINUED)

```
CONVERGENCE $OLVER01 WEGSTEIN
    TEAR 11

REPORT INPUT NOFLOWSHEET NOPROPERTIES

BLOCK-REPORT NEWPAGE NOSORT INCL-BLOCKS=B1 B2 B3 B5 B6 B7 B8  &
        B9 B10 B11 B12 B13 B15

STREAM-REPOR NOSORT NOZEROFLOW MOLEFLOW NOVOLFLOW INCL-STREAMS=1  &
        2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18  &
        19 21 22 23 24 25
;
;
;
;
;
```

SIMULATION STARTED MODULE USED: apmod CREATION: 02/14/92 11:21:55
LOCATED IN:d:\ap85b\xeq\apmod
SIMULATION COMPLETED FOR ENTIRE FLOWSHEET

```
BLOCK:  B1        MODEL: PUMP
----------------------------
  INLET STREAM:             1
  OUTLET STREAM:            4
  PROPERTY OPTION SET:      SYSOP3    REDLICH-KWONG-SOAVE EQUATION OF STATE
  HENRY-COMPS ID:           GASES

                        ***  MASS AND ENERGY BALANCE  ***
                                       IN              OUT          RELATIVE DIFF.
   TOTAL BALANCE
      MOLE(KMOL/SEC)              0.287711E-02    0.287711E-02    0.000000E+00
      MASS(KG/SEC   )             0.265100        0.265100        0.000000E+00
      ENTHALPY(WATT     )          33451.3         41859.1        -0.200858

                            ***  INPUT DATA  ***
   OUTLET PRESSURE (BAR      )                                  234.422
   PUMP EFFICIENCY                                                0.85000
   DRIVER EFFICIENCY                                              1.00000

   FLASH SPECIFICATIONS:
   LIQUID PHASE CALCULATION
   NO FLASH PERFORMED
   MAXIMUM NUMBER OF ITERATIONS                                   30
   TOLERANCE                                                      0.000100000

                             ***  RESULTS  ***
   VOLUMETRIC FLOW RATE (CUM/SEC )                                0.00030618
   PRESSURE CHANGE (BAR      )                                  233.408
   FLUID POWER (WATT     )                                    7,146.56
   BRAKE POWER (WATT     )                                    8,407.72
   ELECTRICITY (WATT     )                                    8,407.72
   PUMP EFFICIENCY USED                                           0.85000
   NET WORK (WATT     )                                      -8,407.72
```

```
BLOCK:  B2       MODEL: PUMP
----------------------------
  INLET STREAM:           2
  OUTLET STREAM:          5
  PROPERTY OPTION SET:    SYSOP10A  RENON (NRTL) / REDLICH-KWONG
  HENRY-COMPS ID:         GASES

                          ***  MASS AND ENERGY BALANCE  ***
                                    IN              OUT          RELATIVE DIFF.
   TOTAL BALANCE
      MOLE(KMOL/SEC)             0.188463         0.188463        0.000000E+00
      MASS(KG/SEC   )             3.75237          3.75237        0.000000E+00
      ENTHALPY(WATT     )      -0.529704E+08    -0.529581E+08   -0.231775E-03

                              ***  INPUT DATA  ***
   OUTLET PRESSURE (BAR      )                              234.422
   PUMP EFFICIENCY                                            0.85000
   DRIVER EFFICIENCY                                          1.00000

   FLASH SPECIFICATIONS:
   LIQUID PHASE CALCULATION
   NO FLASH PERFORMED
   MAXIMUM NUMBER OF ITERATIONS                               30
   TOLERANCE                                                  0.000100000

                               ***  RESULTS  ***
   VOLUMETRIC FLOW RATE (CUM/SEC )                            0.0037839
   PRESSURE CHANGE (BAR      )                               27.5790
   FLUID POWER (WATT     )                               10,435.6
   BRAKE POWER (WATT     )                               12,277.2
   ELECTRICITY (WATT     )                               12,277.2
   PUMP EFFICIENCY USED                                       0.85000
   NET WORK (WATT     )                                 -12,277.2
```

BLOCK: B3 MODEL: MCOMPR

INLET STREAMS: 3 TO STAGE 1
OUTLET STREAMS: 6 FROM STAGE 4
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	0.146265	0.146265	0.000000E+00
MASS(KG/SEC)	4.21979	4.21979	0.000000E+00
ENTHALPY(WATT)	-17610.7	877693.	-1.02006

*** INPUT DATA ***

ISENTROPIC CENTRIFUGAL COMPRESSOR

NUMBER OF STAGES	4
FINAL PRESSURE, BAR	234.422

COMPRESSOR SPECIFICATIONS PER STAGE

STAGE NUMBER	MECHANICAL EFFICIENCY	ISENTROPIC EFFICIENCY
1	0.9800	0.8500
2	0.9800	0.8500
3	0.9800	0.8500
4	0.9800	0.8500

COOLER SPECIFICATIONS PER STAGE

STAGE NUMBER	PRESSURE DROP BAR	TEMPERATURE C
1	0.0000E+00	48.89
2	0.0000E+00	48.89
3	0.0000E+00	48.89

*** RESULTS ***

FINAL PRESSURE, BAR	234.422
TOTAL WORK REQUIRED, WATT	3,124,240.

BLOCK: B3 MODEL: MCOMPR (CONTINUED)

*** PROFILE ***

COMPRESSOR PROFILE

STAGE NUMBER	OUTLET PRESSURE BAR	PRESSURE RATIO	OUTLET TEMPERATURE C
1	3.953	3.900	183.7
2	15.41	3.900	225.9
3	60.11	3.900	225.7
4	234.4	3.900	224.1

STAGE NUMBER	INDICATED HORSEPOWER WATT	BRAKE HORSEPOWER WATT
1	0.7000E+06	0.7143E+06
2	0.7680E+06	0.7837E+06
3	0.7772E+06	0.7931E+06
4	0.8165E+06	0.8331E+06

COOLER PROFILE

STAGE NUMBER	OUTLET TEMPERATURE C	OUTLET PRESSURE BAR	COOLING LOAD WATT	VAPOR FRACTION
1	48.89	3.953	-.5833E+06	1.000
2	48.89	15.41	-.7764E+06	1.000
3	48.89	60.11	-.8068E+06	1.000

FLOWSHEET
U-O-S BLOCK SECTION

BLOCK: B5 MODEL: RSTOIC

INLET STREAMS: 6 7
OUTLET STREAM: 8
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	GENERATION	RELATIVE DIFF.
TOTAL BALANCE				
MOLE(KMOL/SEC)	0.337605	0.340482	0.287711E-02	-0.815184E-16
MASS(KG/SEC)	8.23726	8.23726		0.822317E-06
ENTHALPY(WATT)	-0.520386E+08	-0.520386E+08		0.112521E-05

*** INPUT DATA ***

SIMULTANEOUS REACTIONS
STOICHIOMETRY MATRIX:

REACTION # 1:
SUBSTREAM MIXED :

TOL	-1.00	H2O	4.00	CO2	7.00	O2	-9.00

SUBSTREAM CISOLID :
NO PARTICIPATING COMPONENTS

REACTION # 2:
SUBSTREAM MIXED :

H2O	2.00	CH4	-1.00	CO2	1.00	O2	-2.00

SUBSTREAM CISOLID :
NO PARTICIPATING COMPONENTS

REACTION CONVERSION SPECS: NUMBER= 2
REACTION # 1:
SUBSTREAM:MIXED KEY COMP:TOL CONV FRAC: 1.000
REACTION # 2:
SUBSTREAM:MIXED KEY COMP:CH4 CONV FRAC: 1.000

TWO PHASE PQ FLASH

SPECIFIED PRESSURE BAR	234.422
SPECIFIED HEAT DUTY WATT	0.0
MAXIMUM NO. ITERATIONS	30
CONVERGENCE TOLERANCE	0.000100000

BLOCK: B5 MODEL: RSTOIC (CONTINUED)

*** RESULTS ***

OUTLET TEMPERATURE	C	593.11
OUTLET PRESSURE	BAR	234.42
VAPOR FRACTION		1.0000

V-L PHASE EQUILIBRIUM :

COMP	F(I)	X(I)	Y(I)	K(I)
H2O	0.57925	0.98882	0.57925	2.5533
CO2	0.63929E-01	0.49054E-02	0.63929E-01	3.6210
N2	0.34839	0.59754E-02	0.34839	4.0210
O2	0.84308E-02	0.29555E-03	0.84308E-02	3.7604

```
BLOCK:  B6        MODEL: SEP
---------------------------
  INLET STREAM:            8
  OUTLET STREAMS:          9          21
  PROPERTY OPTION SET:     SYSOP3     REDLICH-KWONG-SOAVE EQUATION OF STATE
  HENRY-COMPS ID:          GASES

                    ***  MASS AND ENERGY BALANCE  ***
                                  IN               OUT             RELATIVE DIFF.
   TOTAL BALANCE
      MOLE(KMOL/SEC)          0.340482         0.340482          0.000000E+00
      MASS(KG/SEC  )           8.23726          8.23726          0.000000E+00
      ENTHALPY(WATT     )    -0.520386E+08    -0.520386E+08      0.000000E+00

                        ***  INPUT DATA  ***

  FLASH SPECS FOR STREAM 9
  TWO   PHASE  TP  FLASH
  PRESSURE DROP           BAR                                        0.0
  MAXIMUM NO. ITERATIONS                                            30
  CONVERGENCE TOLERANCE                                              0.000100000

  FLASH SPECS FOR STREAM 21
  TWO   PHASE  TP  FLASH
  PRESSURE DROP           BAR                                        0.0
  MAXIMUM NO. ITERATIONS                                            30
  CONVERGENCE TOLERANCE                                              0.000100000

  FRACTION OF FEED
    SUBSTREAM= MIXED
      STREAM= 9          CPT= H2O        FRACTION=            1.00000
                              CO2                              1.00000
                              N2                               1.00000
                              O2                               1.00000
    SUBSTREAM= CISOLID
      STREAM= 21         CPT= NACL       FRACTION=            1.00000

                         ***  RESULTS  ***

 COMPONENT = H2O
   STREAM     SUBSTREAM    SPLIT FRACTION
   9          MIXED               1.00000
```

BLOCK: B6 MODEL: SEP (CONTINUED)

COMPONENT = NACL

STREAM	SUBSTREAM	SPLIT FRACTION
21	CISOLID	1.00000

COMPONENT = CO2

STREAM	SUBSTREAM	SPLIT FRACTION
9	MIXED	1.00000

COMPONENT = N2

STREAM	SUBSTREAM	SPLIT FRACTION
9	MIXED	1.00000

COMPONENT = O2

STREAM	SUBSTREAM	SPLIT FRACTION
9	MIXED	1.00000

BLOCK: B7 MODEL: HEATX

HOT SIDE:

INLET STREAM: 9
OUTLET STREAM: 10
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

COLD SIDE:

INLET STREAM: 11
OUTLET STREAM: 12
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	0.663247	0.663247	0.000000E+00
MASS(KG/SEC)	15.4391	15.4391	0.000000E+00
ENTHALPY(WATT)	-0.100885E+09	-0.100885E+09	-0.439029E-06

*** INPUT DATA ***

FLASH SPECS FOR HOT SIDE:
TWO PHASE FLASH
MAXIMUM NO. ITERATIONS 30
CONVERGENCE TOLERANCE 0.000100000

FLASH SPECS FOR COLD SIDE:
TWO PHASE FLASH
MAXIMUM NO. ITERATIONS 30
CONVERGENCE TOLERANCE 0.000100000

FLOWSHEET
U-O-S BLOCK SECTION

BLOCK: B7 MODEL: HEATX (CONTINUED)

COUNTERCURRENT HEAT EXCHANGER WITH SPECIFIED HOT OUTLET TEMPERATURE

HOT STREAM OUTLET TEMPERATURE (C)	537.778
HOT STREAM PRESSURE DROP (BAR)	0.0
COLD STREAM PRESSURE DROP (BAR)	0.0

HEAT TRANSFER COEFFICIENTS (WATT/SQM-K):

HOT STREAM PHASE	COLD STREAM PHASE	
LIQUID	LIQUID	850.000
BOILING LIQUID	LIQUID	850.000
VAPOR	LIQUID	850.000
LIQUID	BOILING LIQUID	850.000
BOILING LIQUID	BOILING LIQUID	850.000
VAPOR	BOILING LIQUID	850.000
LIQUID	VAPOR	850.000
BOILING LIQUID	VAPOR	850.000
VAPOR	VAPOR	850.000

*** RESULTS ***

HOT STREAM INLET TEMPERATURE (C)	593.113
HOT STREAM OUTLET TEMPERATURE (C)	537.778
COLD STREAM INLET TEMPERATURE (C)	283.139
COLD STREAM OUTLET TEMPERATURE (C)	346.427
EXCHANGER HEAT DUTY (WATT)	776,561.
HEAT TRANSFER AREA (SQM)	3.64506

AREA CALCULATION RESULTS:

SECTION	CONDITIONS (HOT-COLD)	AREA (SQM)	HEAT DUTY (WATT)
1	V-V	3.64506	776,561.

SECTION	TEMPERATURE LEAVING SECTION HOT STREAM (C)	COLD STREAM (C)
1	537.778	346.427

```
           ------------------------------------------------------------
          |                                                            |
 9        |      VAP                                                   |  10
------>   |                                                            | ------>
 593.1    |                                                            |  537.8
          |                                                            |
 12       |      VAP                                                   |  11
<------   |                                                            | <------
 346.4    |                                                            |  283.1
          |                                                            |
           ------------------------------------------------------------
```

BLOCK: B8 MODEL: MCOMPR

INLET STREAMS: 10 TO STAGE 1
OUTLET STREAMS: 11 FROM STAGE 5
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	0.331624	0.331624	0.000000E+00
MASS(KG/SEC)	7.71953	7.71953	0.000000E+00
ENTHALPY(WATT)	-0.494519E+08	-0.522096E+08	0.528206E-01

*** INPUT DATA ***

ISENTROPIC CENTRIFUGAL COMPRESSOR
NUMBER OF STAGES 5
FINAL PRESSURE, BAR 39.3691

COMPRESSOR SPECIFICATIONS PER STAGE

STAGE NUMBER	MECHANICAL EFFICIENCY	ISENTROPIC EFFICIENCY
1	1.000	0.8500
2	1.000	0.8500
3	1.000	0.8500
4	1.000	0.8500
5	1.000	0.8500

*** RESULTS ***

FINAL PRESSURE, BAR 39.3691
TOTAL WORK REQUIRED, WATT -2,758,030.

*** PROFILE ***

COMPRESSOR PROFILE

STAGE NUMBER	OUTLET PRESSURE BAR	PRESSURE RATIO	OUTLET TEMPERATURE C
1	164.1	0.6999	480.4
2	114.8	0.6999	426.2
3	80.37	0.6999	375.1
4	56.25	0.6999	327.6
5	39.37	0.6999	283.1

BLOCK: B8 MODEL: MCOMPR (CONTINUED)

STAGE NUMBER	INDICATED HORSEPOWER WATT	BRAKE HORSEPOWER WATT
1	-.6491E+06	-.6491E+06
2	-.5941E+06	-.5941E+06
3	-.5460E+06	-.5460E+06
4	-.5035E+06	-.5035E+06
5	-.4654E+06	-.4654E+06

BLOCK: B9 MODEL: MCOMPR

INLET STREAMS: 12 TO STAGE 1
OUTLET STREAMS: 13 FROM STAGE 5
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	0.331624	0.331624	0.000000E+00
MASS(KG/SEC)	7.71953	7.71953	0.000000E+00
ENTHALPY(WATT)	-0.514330E+08	-0.535366E+08	0.392920E-01

*** INPUT DATA ***

ISENTROPIC CENTRIFUGAL COMPRESSOR
NUMBER OF STAGES 5
FINAL PRESSURE, BAR 6.61897

COMPRESSOR SPECIFICATIONS PER STAGE

STAGE NUMBER	MECHANICAL EFFICIENCY	ISENTROPIC EFFICIENCY
1	1.000	0.8500
2	1.000	0.8500
3	1.000	0.8500
4	1.000	0.8500
5	1.000	0.8500

*** RESULTS ***

FINAL PRESSURE, BAR 6.61897
TOTAL WORK REQUIRED, WATT -2,102,800.

*** PROFILE ***

COMPRESSOR PROFILE

STAGE NUMBER	OUTLET PRESSURE BAR	PRESSURE RATIO	OUTLET TEMPERATURE C
1	27.56	0.7000	301.7
2	19.29	0.7000	259.9
3	13.51	0.7000	220.8
4	9.455	0.7000	184.4
5	6.619	0.7000	150.4

BLOCK: B9 MODEL: MCOMPR (CONTINUED)

STAGE NUMBER	INDICATED HORSEPOWER WATT	BRAKE HORSEPOWER WATT
1	-.4863E+06	-.4863E+06
2	-.4509E+06	-.4509E+06
3	-.4182E+06	-.4182E+06
4	-.3878E+06	-.3878E+06
5	-.3595E+06	-.3595E+06

BLOCK: B10 MODEL: MCOMPR

INLET STREAMS: 14 TO STAGE 1
OUTLET STREAMS: 15 FROM STAGE 5
19 GLOBAL OUTLET
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	0.331624	0.331624	0.000000E+00
MASS(KG/SEC)	7.71953	7.71953	0.115056E-15
ENTHALPY(WATT)	-0.533187E+08	-0.549778E+08	0.301781E-01

*** INPUT DATA ***

ISENTROPIC CENTRIFUGAL COMPRESSOR
NUMBER OF STAGES 5
FINAL PRESSURE, BAR 1.01353

COMPRESSOR SPECIFICATIONS PER STAGE

STAGE NUMBER	MECHANICAL EFFICIENCY	ISENTROPIC EFFICIENCY
1	1.000	0.8500
2	1.000	0.8500
3	1.000	0.8500
4	1.000	0.8500
5	1.000	0.8500

*** RESULTS ***

FINAL PRESSURE, BAR 1.01353
TOTAL WORK REQUIRED, WATT -1,658,770.

*** PROFILE ***

COMPRESSOR PROFILE

STAGE NUMBER	OUTLET PRESSURE BAR	PRESSURE RATIO	OUTLET TEMPERATURE C
1	4.548	0.6871	135.3
2	3.125	0.6871	118.5
3	2.147	0.6871	107.4
4	1.475	0.6871	96.93
5	1.014	0.6871	87.14

BLOCK: B10 MODEL: MCOMPR (CONTINUED)

STAGE NUMBER	INDICATED HORSEPOWER WATT	BRAKE HORSEPOWER WATT
1	-.3668E+06	-.3668E+06
2	-.3438E+06	-.3438E+06
3	-.3292E+06	-.3292E+06
4	-.3158E+06	-.3158E+06
5	-.3032E+06	-.3032E+06

BLOCK: B11 MODEL: HEATER

INLET STREAM:	15
OUTLET STREAM:	16
PROPERTY OPTION SET:	SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID:	GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	0.317436	0.317436	0.000000E+00
MASS(KG/SEC)	7.46393	7.46393	0.000000E+00
ENTHALPY(WATT)	-0.509785E+08	-0.594529E+08	0.142540

*** INPUT DATA ***

TWO PHASE TP FLASH		
SPECIFIED TEMPERATURE	C	30.0000
SPECIFIED PRESSURE	BAR	1.01353
MAXIMUM NO. ITERATIONS		30
CONVERGENCE TOLERANCE		0.000100000

*** RESULTS ***

OUTLET TEMPERATURE	C	30.000
OUTLET PRESSURE	BAR	1.0135
HEAT DUTY	WATT	-0.84744E+07
VAPOR FRACTION		0.45406

V-L PHASE EQUILIBRIUM :

COMP	F(I)	X(I)	Y(I)	K(I)
H2O	0.56044	0.99999	0.31949E-01	0.31950E-01
CO2	0.66786E-01	0.96621E-05	0.14707	15222.
N2	0.36397	0.39158E-07	0.80158	0.20471E+08
O2	0.88076E-02	0.28292E-07	0.19397E-01	0.68561E+06

BLOCK: B12 MODEL: FLASH2

INLET STREAM: 16
OUTLET VAPOR STREAM: 17
OUTLET LIQUID STREAM: 18
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	0.317436	0.317436	0.000000E+00
MASS(KG/SEC)	7.46393	7.46393	-0.118996E-15
ENTHALPY(WATT)	-0.594529E+08	-0.594529E+08	-0.756587E-06

*** INPUT DATA ***

TWO PHASE PQ FLASH		
SPECIFIED PRESSURE	BAR	1.01353
SPECIFIED HEAT DUTY	WATT	0.0
MAXIMUM NO. ITERATIONS		30
CONVERGENCE TOLERANCE		0.000100000

*** RESULTS ***

OUTLET TEMPERATURE	C	30.001
OUTLET PRESSURE	BAR	1.0135
VAPOR FRACTION		0.45406

V-L PHASE EQUILIBRIUM :

COMP	F(I)	X(I)	Y(I)	K(I)
H2O	0.56044	0.99999	0.31952E-01	0.31952E-01
CO2	0.66786E-01	0.96609E-05	0.14707	15222.
N2	0.36397	0.39153E-07	0.80158	0.20469E+08
O2	0.88076E-02	0.28289E-07	0.19397E-01	0.68559E+06

BLOCK: B13 MODEL: HEATX

HOT SIDE:

INLET STREAM: 21
OUTLET STREAM: 22
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

COLD SIDE:

INLET STREAM: 13
OUTLET STREAM: 14
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	0.340482	0.340482	0.000000E+00
MASS(KG/SEC)	8.23726	8.23726	0.000000E+00
ENTHALPY(WATT)	-0.568999E+08	-0.568999E+08	0.111701E-08

*** INPUT DATA ***

FLASH SPECS FOR HOT SIDE:
TWO PHASE FLASH
MAXIMUM NO. ITERATIONS 30
CONVERGENCE TOLERANCE 0.000100000

FLASH SPECS FOR COLD SIDE:
TWO PHASE FLASH
MAXIMUM NO. ITERATIONS 30
CONVERGENCE TOLERANCE 0.000100000

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BLOCK:  B13      MODEL: HEATX (CONTINUED)

   COUNTERCURRENT  HEAT EXCHANGER WITH SPECIFIED HOT OUTLET TEMP APPROACH
   TEMP APPROACH AT HOT STREAM OUTLET (C    )                     10.0000
   HOT STREAM PRESSURE DROP (BAR      )                             0.0
   COLD STREAM PRESSURE DROP (BAR      )                            0.0

   HEAT TRANSFER COEFFICIENTS  (WATT/SQM-K       ):
   HOT STREAM PHASE       COLD STREAM PHASE
   LIQUID                 LIQUID                                  850.000
   BOILING LIQUID         LIQUID                                  850.000
   VAPOR                  LIQUID                                  850.000
   LIQUID                 BOILING LIQUID                          850.000
   BOILING LIQUID         BOILING LIQUID                          850.000
   VAPOR                  BOILING LIQUID                          850.000
   LIQUID                 VAPOR                                   850.000
   BOILING LIQUID         VAPOR                                   850.000
   VAPOR                  VAPOR                                   850.000

                             ***  RESULTS  ***
   HOT STREAM INLET TEMPERATURE (C    )                           593.113
   HOT STREAM OUTLET TEMPERATURE (C    )                          160.399
   COLD STREAM INLET TEMPERATURE (C    )                          150.399
   COLD STREAM OUTLET TEMPERATURE (C    )                         169.706
   EXCHANGER HEAT DUTY (WATT     )                            217,853.
   HEAT TRANSFER AREA (SQM      )                                   2.32223


   AREA CALCULATION RESULTS:

   SECTION  CONDITIONS    AREA                HEAT DUTY
            (HOT-COLD)    (SQM      )          (WATT     )
      1       V-V           2.32223         217,853.

   SECTION   TEMPERATURE LEAVING SECTION
             HOT STREAM             COLD STREAM
             (C        )            (C        )
      1         160.399                169.706



        ------------------------------------------------------------
 21    |      VAP                                                    | 22
------>|                                                             |------>
 593.1 |                                                             | 160.4
       |                                                             |
 14    |      VAP                                                    | 13
<------|                                                             |<------
 169.7 |                                                             | 150.4
       |                                                             |
        ------------------------------------------------------------
```

BLOCK: B15 MODEL: PUMP

INLET STREAM: 23
OUTLET STREAM: 24
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	0.114954	0.114954	0.000000E+00
MASS(KG/SEC)	2.07090	2.07090	0.000000E+00
ENTHALPY(WATT)	-0.332625E+08	-0.332054E+08	-0.171520E-02

*** INPUT DATA ***

OUTLET PRESSURE (BAR)	234.422
PUMP EFFICIENCY	0.85000
DRIVER EFFICIENCY	1.00000
FLASH SPECIFICATIONS:	
LIQUID PHASE CALCULATION	
NO FLASH PERFORMED	
MAXIMUM NUMBER OF ITERATIONS	30
TOLERANCE	0.000100000

*** RESULTS ***

VOLUMETRIC FLOW RATE (CUM/SEC)	0.0020777
PRESSURE CHANGE (BAR)	233.408
FLUID POWER (WATT)	48,494.1
BRAKE POWER (WATT)	57,051.9
ELECTRICITY (WATT)	57,051.9
PUMP EFFICIENCY USED	0.85000
NET WORK (WATT)	-57,051.9

1 2 3 4 5

STREAM ID	1	2	3	4	5
FROM :	----	----	----	B1	B2
TO :	B1	B2	B3	B4	B4
CLASS:	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD
TOTAL STREAM:					
KG/SEC	0.2651	3.7523	4.2197	0.2651	3.7523
WATT	3.3451+04	-5.2970+07	-1.7611+04	4.1859+04	-5.2958+07
SUBSTREAM: MIXED					
PHASE:	LIQUID	MIXED	VAPOR	LIQUID	LIQUID
COMPONENTS: KMOL/SEC					
TOL	2.8771-03	0.0	0.0	2.8771-03	0.0
H2O	0.0	0.1785	0.0	0.0	0.1785
CH4	0.0	1.0194-03	0.0	0.0	1.0194-03
CO2	0.0	4.1226-05	0.0	0.0	4.1226-05
N2	0.0	0.0	0.1155	0.0	0.0
O2	0.0	0.0	3.0729-02	0.0	0.0
TOTAL FLOW:					
KMOL/SEC	2.8771-03	0.1796	0.1462	2.8771-03	0.1796
KG/SEC	0.2651	3.2346	4.2197	0.2651	3.2346
CUM/SEC	3.0618-04	3.8619-03	3.5306	3.0791-04	3.7866-03
STATE VARIABLES:					
TEMP C	21.1111	148.8889	21.1111	26.4340	149.6357
PRES BAR	1.0135	206.8430	1.0135	234.4218	234.4220
VFRAC	0.0	4.0544-03	1.0000	0.0	0.0
LFRAC	1.0000	0.9959	0.0	1.0000	1.0000
SFRAC	0.0	0.0	0.0	0.0	0.0
ENTHALPY:					
J/KMOL	1.1627+07	-2.7496+08	-1.2040+05	1.4549+07	-2.7489+08
J/KG	1.2618+05	-1.5267+07	-4173.3528	1.5790+05	-1.5263+07
WATT	3.3451+04	-4.9384+07	-1.7611+04	4.1859+04	-4.9372+07
ENTROPY:					
J/KMOL-K	-3.4337+05	-1.3654+05	3865.4994	-3.4288+05	-1.3654+05
J/KG-K	-3726.5845	-7581.3082	133.9841	-3721.2527	-7581.4503
DENSITY:					
KMOL/CUM	9.3967	46.5064	4.1428-02	9.3440	47.4318
KG/CUM	865.8220	837.5712	1.1952	860.9739	854.2366
AVG MW	92.1410	18.0097	28.8504	92.1410	18.0097
SUBSTREAM: CISOLID	STRUCTURE: CONVENTIONAL				
COMPONENTS: KMOL/SEC					
NACL	0.0	8.8586-03	0.0	0.0	8.8586-03
TOTAL FLOW:					
KMOL/SEC	0.0	8.8586-03	0.0	0.0	8.8586-03
KG/SEC	0.0	0.5177	0.0	0.0	0.5177
CUM/SEC	0.0	2.3932-04	0.0	0.0	2.3932-04
STATE VARIABLES:					
TEMP C	MISSING	148.8889	MISSING	MISSING	149.6357
PRES BAR	1.0135	206.8430	1.0135	234.4218	234.4220
VFRAC	MISSING	0.0	MISSING	MISSING	0.0
LFRAC	MISSING	0.0	MISSING	MISSING	0.0
SFRAC	MISSING	1.0000	MISSING	MISSING	1.0000

1 2 3 4 5 (CONTINUED)

STREAM ID	1	2	3	4	5
ENTHALPY:					
J/KMOL	MISSING	-4.0486+08	MISSING	MISSING	-4.0483+08
J/KG	MISSING	-6.9275+06	MISSING	MISSING	-6.9268+06
WATT	MISSING	-3.5865+06	MISSING	MISSING	-3.5862+06
ENTROPY:					
J/KMOL-K	MISSING	-7.2803+04	MISSING	MISSING	-7.2709+04
J/KG-K	MISSING	-1245.7035	MISSING	MISSING	-1244.1078
DENSITY:					
KMOL/CUM	MISSING	37.0164	MISSING	MISSING	37.0164
KG/CUM	MISSING	2163.3536	MISSING	MISSING	2163.3536
AVG MW	MISSING	58.4430	MISSING	MISSING	58.4430

FLOWSHEET
STREAM SECTION

6 7 8 9 10

STREAM ID	6	7	8	9	10
FROM :	B3	B4	B5	B6	B7
TO :	B5	B5	B6	B7	B8
CLASS:	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD
TOTAL STREAM:					
KG/SEC	4.2197	4.0174	8.2372	7.7195	7.7195
WATT	8.7769+05	-5.2916+07	-5.2039+07	-4.8675+07	-4.9452+07
SUBSTREAM: MIXED					
PHASE:	VAPOR	MIXED	VAPOR	VAPOR	VAPOR
COMPONENTS: KMOL/SEC					
TOL	0.0	2.8771-03	0.0	0.0	0.0
H2O	0.0	0.1785	0.1920	0.1920	0.1920
CH4	0.0	1.0194-03	0.0	0.0	0.0
CO2	0.0	4.1226-05	2.1200-02	2.1200-02	2.1200-02
N2	0.1155	0.0	0.1155	0.1155	0.1155
O2	3.0729-02	0.0	2.7958-03	2.7958-03	2.7958-03
TOTAL FLOW:					
KMOL/SEC	0.1462	0.1824	0.3316	0.3316	0.3316
KG/SEC	4.2197	3.4997	7.7195	7.7195	7.7195
CUM/SEC	2.9052-02	5.2735-03	0.1038	0.1038	9.6172-02
STATE VARIABLES:					
TEMP C	224.0843	156.6696	593.1128	593.1128	537.7777
PRES BAR	234.4220	234.4218	234.4220	234.4220	234.4220
VFRAC	1.0000	1.3440-02	1.0000	1.0000	1.0000
LFRAC	0.0	0.9865	0.0	0.0	0.0
SFRAC	0.0	0.0	0.0	0.0	0.0
ENTHALPY:					
J/KMOL	6.0007+06	-2.7035+08	-1.4678+08	-1.4678+08	-1.4912+08
J/KG	2.0799+05	-1.4096+07	-6.3055+06	-6.3055+06	-6.4061+06
WATT	8.7769+05	-4.9333+07	-4.8675+07	-4.8675+07	-4.9452+07
ENTROPY:					
J/KMOL-K	-2.6674+04	-1.3981+05	-2.8206+04	-2.8206+04	-3.1000+04
J/KG-K	-924.5734	-7290.0712	-1211.7032	-1211.7032	-1331.7104
DENSITY:					
KMOL/CUM	5.0345	34.6033	3.1938	3.1938	3.4482
KG/CUM	145.2499	663.6425	74.3455	74.3455	80.2679
AVG MW	28.8504	19.1785	23.2779	23.2779	23.2779
SUBSTREAM: CISOLID	STRUCTURE: CONVENTIONAL				
COMPONENTS: KMOL/SEC					
NACL	0.0	8.8586-03	8.8586-03	0.0	0.0
TOTAL FLOW:					
KMOL/SEC	0.0	8.8586-03	8.8586-03	0.0	0.0
KG/SEC	0.0	0.5177	0.5177	0.0	0.0
CUM/SEC	0.0	2.3932-04	2.3932-04	0.0	0.0
STATE VARIABLES:					
TEMP C	MISSING	156.6696	593.1128	MISSING	MISSING
PRES BAR	234.4220	234.4218	234.4220	234.4220	234.4220
VFRAC	MISSING	0.0	0.0	MISSING	MISSING
LFRAC	MISSING	0.0	0.0	MISSING	MISSING
SFRAC	MISSING	1.0000	1.0000	MISSING	MISSING

6 7 8 9 10 (CONTINUED)

STREAM ID	6	7	8	9	10
ENTHALPY:					
J/KMOL	MISSING	-4.0445+08	-3.7966+08	MISSING	MISSING
J/KG	MISSING	-6.9205+06	-6.4963+06	MISSING	MISSING
WATT	MISSING	-3.5829+06	-3.3633+06	MISSING	MISSING
ENTROPY:					
J/KMOL-K	MISSING	-7.1838+04	-3.2350+04	MISSING	MISSING
J/KG-K	MISSING	-1229.1970	-553.5393	MISSING	MISSING
DENSITY:					
KMOL/CUM	MISSING	37.0164	37.0164	MISSING	MISSING
KG/CUM	MISSING	2163.3536	2163.3536	MISSING	MISSING
AVG MW	MISSING	58.4430	58.4430	MISSING	MISSING

FLOWSHEET
STREAM SECTION

11 12 13 14 15

STREAM ID	11	12	13	14	15
FROM :	B8	B7	B9	B13	B10
TO :	B7	B9	B13	B10	B11
CLASS:	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD
TOTAL STREAM:					
KG/SEC	7.7195	7.7195	7.7195	7.7195	7.4639
WATT	-5.2210+07	-5.1433+07	-5.3537+07	-5.3319+07	-5.0978+07
SUBSTREAM: MIXED					
PHASE:	VAPOR	VAPOR	VAPOR	VAPOR	MIXED
COMPONENTS: KMOL/SEC					
H2O	0.1920	0.1920	0.1920	0.1920	0.1779
CO2	2.1200-02	2.1200-02	2.1200-02	2.1200-02	2.1200-02
N2	0.1155	0.1155	0.1155	0.1155	0.1155
O2	2.7958-03	2.7958-03	2.7958-03	2.7958-03	2.7958-03
TOTAL FLOW:					
KMOL/SEC	0.3316	0.3316	0.3316	0.3316	0.3174
KG/SEC	7.7195	7.7195	7.7195	7.7195	7.4639
CUM/SEC	0.3773	0.4259	1.7368	1.8202	9.2075
STATE VARIABLES:					
TEMP C	283.1392	346.4270	150.3994	169.7060	87.1351
PRES BAR	39.3690	39.3690	6.6189	6.6189	1.0135
VFRAC	1.0000	1.0000	1.0000	1.0000	0.9851
LFRAC	0.0	0.0	0.0	0.0	1.4879-02
SFRAC	0.0	0.0	0.0	0.0	0.0
ENTHALPY:					
J/KMOL	-1.5744+08	-1.5509+08	-1.6144+08	-1.6078+08	-1.6059+08
J/KG	-6.7633+06	-6.6627+06	-6.9352+06	-6.9070+06	-6.8300+06
WATT	-5.2210+07	-5.1433+07	-5.3537+07	-5.3319+07	-5.0978+07
ENTROPY:					
J/KMOL-K	-2.8735+04	-2.4748+04	-2.2486+04	-2.0969+04	-1.2805+04
J/KG-K	-1234.4393	-1063.1592	-965.9587	-900.8034	-544.5786
DENSITY:					
KMOL/CUM	0.8788	0.7784	0.1909	0.1821	3.4476-02
KG/CUM	20.4583	18.1212	4.4445	4.2409	0.8106
AVG MW	23.2779	23.2779	23.2779	23.2779	23.5132

FLOWSHEET
STREAM SECTION

16 17 18 19 21

STREAM ID	16	17	18	19	21
FROM :	B11	B12	B12	B10	B6
TO :	B12	----	----	----	B13
CLASS:	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD
TOTAL STREAM:					
KG/SEC	7.4639	4.3418	3.1220	0.2556	0.5177
WATT	-5.9453+07	-9.4414+06	-5.0011+07	-3.9994+06	-3.3633+06
SUBSTREAM: MIXED					
PHASE:	MIXED	VAPOR	LIQUID	LIQUID	MIXED
COMPONENTS: KMOL/SEC					
H2O	0.1779	4.6054-03	0.1733	1.4188-02	0.0
CO2	2.1200-02	2.1199-02	1.6742-06	2.1076-07	0.0
N2	0.1155	0.1155	6.7852-09	8.7151-09	0.0
O2	2.7958-03	2.7958-03	4.9025-09	2.0773-09	0.0
TOTAL FLOW:					
KMOL/SEC	0.3174	0.1441	0.1733	1.4188-02	0.0
KG/SEC	7.4639	4.3418	3.1220	0.2556	0.0
CUM/SEC	3.5856	3.5825	3.1594-03	2.8085-04	0.0
STATE VARIABLES:					
TEMP C	30.0000	30.0013	30.0013	106.9295	MISSING
PRES BAR	1.0135	1.0135	1.0135	6.6189	234.4220
VFRAC	0.4540	1.0000	0.0	0.0	MISSING
LFRAC	0.5459	0.0	1.0000	1.0000	MISSING
SFRAC	0.0	0.0	0.0	0.0	MISSING
ENTHALPY:					
J/KMOL	-1.8729+08	-6.5503+07	-2.8858+08	-2.8188+08	MISSING
J/KG	-7.9654+06	-2.1745+06	-1.6019+07	-1.5647+07	MISSING
WATT	-5.9453+07	-9.4414+06	-5.0011+07	-3.9994+06	MISSING
ENTROPY:					
J/KMOL-K	-9.0248+04	4858.6830	-1.6935+05	-1.4968+05	MISSING
J/KG-K	-3838.1650	161.2916	-9400.2445	-8308.6894	MISSING
DENSITY:					
KMOL/CUM	8.8529-02	4.0233-02	54.8528	50.5177	MISSING
KG/CUM	2.0816	1.2119	988.1876	910.0977	MISSING
AVG MW	23.5132	30.1236	18.0152	18.0153	MISSING
SUBSTREAM: CISOLID	STRUCTURE: CONVENTIONAL				
COMPONENTS: KMOL/SEC					
NACL	0.0	0.0	0.0	0.0	8.8586-03
TOTAL FLOW:					
KMOL/SEC	0.0	0.0	0.0	0.0	8.8586-03
KG/SEC	0.0	0.0	0.0	0.0	0.5177
CUM/SEC	0.0	0.0	0.0	0.0	2.3932-04
STATE VARIABLES:					
TEMP C	MISSING	MISSING	MISSING	MISSING	593.1128
PRES BAR	1.0135	1.0135	1.0135	6.6189	234.4220
VFRAC	MISSING	MISSING	MISSING	MISSING	0.0
LFRAC	MISSING	MISSING	MISSING	MISSING	0.0
SFRAC	MISSING	MISSING	MISSING	MISSING	1.0000
ENTHALPY:					
J/KMOL	MISSING	MISSING	MISSING	MISSING	-3.7966+08
J/KG	MISSING	MISSING	MISSING	MISSING	-6.4963+06
WATT	MISSING	MISSING	MISSING	MISSING	-3.3633+06

16 17 18 19 21 (CONTINUED)

STREAM ID	16	17	18	19	21
ENTROPY:					
J/KMOL-K	MISSING	MISSING	MISSING	MISSING	-3.2350+04
J/KG-K	MISSING	MISSING	MISSING	MISSING	-553.5393
DENSITY:					
KMOL/CUM	MISSING	MISSING	MISSING	MISSING	37.0164
KG/CUM	MISSING	MISSING	MISSING	MISSING	2163.3536
AVG MW	MISSING	MISSING	MISSING	MISSING	58.4430

22 23 24 25

STREAM ID	22	23	24	25
FROM :	B13	----	B15	B14
TO :	B14	B15	B14	----
CLASS:	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD
TOTAL STREAM:				
KG/SEC	0.5177	2.0709	2.0709	2.5886
WATT	-3.5812+06	-3.3262+07	-3.3205+07	-3.6787+07
SUBSTREAM: MIXED				
PHASE:	MIXED	LIQUID	LIQUID	LIQUID
COMPONENTS: KMOL/SEC				
H2O	0.0	0.1149	0.1149	0.1149
TOTAL FLOW:				
KMOL/SEC	0.0	0.1149	0.1149	0.1149
KG/SEC	0.0	2.0709	2.0709	2.0709
CUM/SEC	0.0	2.0777-03	2.0788-03	2.0912-03
STATE VARIABLES:				
TEMP C	MISSING	21.1111	21.7079	27.8369
PRES BAR	234.4220	1.0135	234.4220	234.4220
VFRAC	MISSING	0.0	0.0	0.0
LFRAC	MISSING	1.0000	1.0000	1.0000
SFRAC	MISSING	0.0	0.0	0.0
ENTHALPY:				
J/KMOL	MISSING	-2.8935+08	-2.8886+08	-2.8833+08
J/KG	MISSING	-1.6062+07	-1.6034+07	-1.6005+07
WATT	MISSING	-3.3262+07	-3.3205+07	-3.3145+07
ENTROPY:				
J/KMOL-K	MISSING	-1.7193+05	-1.7213+05	-1.7036+05
J/KG-K	MISSING	-9543.8898	-9554.8915	-9456.3724
DENSITY:				
KMOL/CUM	MISSING	55.3289	55.2971	54.9695
KG/CUM	MISSING	996.7515	996.1788	990.2767
AVG MW	MISSING	18.0150	18.0150	18.0150
SUBSTREAM: CISOLID	STRUCTURE: CONVENTIONAL			
COMPONENTS: KMOL/SEC				
NACL	8.8586-03	0.0	0.0	8.8586-03
TOTAL FLOW:				
KMOL/SEC	8.8586-03	0.0	0.0	8.8586-03
KG/SEC	0.5177	0.0	0.0	0.5177
CUM/SEC	2.3932-04	0.0	0.0	2.3932-04
STATE VARIABLES:				
TEMP C	160.3994	MISSING	MISSING	27.8369
PRES BAR	234.4220	1.0135	234.4220	234.4220
VFRAC	0.0	MISSING	MISSING	0.0
LFRAC	0.0	MISSING	MISSING	0.0
SFRAC	1.0000	MISSING	MISSING	1.0000
ENTHALPY:				
J/KMOL	-4.0426+08	MISSING	MISSING	-4.1112+08
J/KG	-6.9171+06	MISSING	MISSING	-7.0345+06
WATT	-3.5812+06	MISSING	MISSING	-3.6419+06
ENTROPY:				
J/KMOL-K	-7.1381+04	MISSING	MISSING	-9.0241+04
J/KG-K	-1221.3749	MISSING	MISSING	-1544.0833

FLOWSHEET
STREAM SECTION

22 23 24 25 (CONTINUED)

STREAM ID	22	23	24	25
DENSITY:				
KMOL/CUM	37.0164	MISSING	MISSING	37.0164
KG/CUM	2163.3536	MISSING	MISSING	2163.3536
AVG MW	58.4430	MISSING	MISSING	58.4430

Appendix A.2 ASPEN PLUS™ Output File for 100,000 gpd Case with Oxygen as Oxidant

```
                                                                                          TM
AAAAA    SSSSS    PPPPP    EEEEE    NN      N    PPPPP    L        U   U    SSSSS
A   A    S        P   P    E        N N     N    P   P    L        U   U    S
AAAAA    SSSSS    PPPPP    EEEEE    N   N N      PPPPP    L        U   U    SSSSS
A   A        S    P        E        N     NN     P        L        U   U        S
A   A    SSSSS    P        EEEEE    N      N     P        LLLLL    UUUUU    SSSSS
```


251 VASSAR STREET
CAMBRIDGE, MASSACHUSETTS 02139
617/497-9010

HOTLINE:
U.S.A. 617/497-9010
EUROPE (32) 2/732-6300

VERSION: PC-DOS
RELEASE: 8.5-3
INSTALLATION: MITELAB

NOVEMBER 11, 1992
WEDNESDAY
7:27:36 P.M.

TABLE OF CONTENTS

```
RUN CONTROL INFORMATION
-----------------------

THIS VERSION OF ASPEN PLUS LICENSED TO MIT ENERGY LAB
TYPE OF RUN: NEW

INPUT FILE NAME: LIQO.inp

OUTPUT PROBLEM DATA FILE NAME:  LIQO     VERSION NO.   1
LOCATED IN:                     G:\LIQO


PDF SIZE USED FOR INPUT TRANSLATION:
  NUMBER OF FILE RECORDS (PSIZE) = 99999
  NUMBER OF IN-CORE RECORDS      =   400
PSIZE NEEDED FOR SIMULATION     =   300

CALLING PROGRAM NAME:            apmod
LOCATED IN:                     d:\ap85b\xeq\apmod

SIMULATION REQUESTED FOR ENTIRE FLOWSHEET

BLOCK STATUS
------------

****************************************************************************
*                                                                          *
* ALL UNIT OPERATION BLOCKS WERE COMPLETED NORMALLY                        *
*                                                                          *
* ALL CONVERGENCE BLOCKS WERE COMPLETED NORMALLY                           *
*                                                                          *
****************************************************************************
```

INPUT FILE(S)

```
>>ORIGINAL RUN                                NOVEMBER 11, 1992
  7:26:45 P.M.                                WEDNESDAY
  INPUT FILE: LIQO.inp
  OUTPUT PDF: LIQO      VERSION:  1
  LOCATED IN: G:\LIQO
      ;
      ;Input file created by ModelManager Rel. 3.3-3 on Wed Nov 11 19:26:13
      ;Directory G:\  Runid LIQO
      ;



      TITLE "FLOWSHEET"

      IN-UNITS SI PRESSURE=BAR TEMPERATURE=C DELTA-T=C

      DEF-STREAMS MIXCISLD ALL

      DATABANKS ASPENPCD / SOLIDS / BINARY

      PROP-SOURCES ASPENPCD / SOLIDS / BINARY

      COMPONENTS
          TOL C7H8 TOL /
          H2O H2O H2O /
          NACL NACL NACL /
          CH4 CH4 CH4 /
          CO2 CO2 CO2 /
          N2 N2 N2 /
          O2 O2 O2

      HENRY-COMPS GASES CH4 CO2

      FLOWSHEET
          BLOCK B1 IN=1 OUT=4
          BLOCK B2 IN=2 OUT=5
          BLOCK B5 IN=7 61 OUT=8
          BLOCK B4 IN=4 5 OUT=7
          BLOCK B7 IN=9 11 OUT=10 12
          BLOCK B13 IN=21 13 OUT=22 14
          BLOCK B14 IN=22 24 OUT=25
          BLOCK B15 IN=23 OUT=24
          BLOCK B11 IN=15 OUT=16
          BLOCK B6 IN=8 OUT=9 21
          BLOCK B8 IN=10 OUT=11
          BLOCK B9 IN=12 OUT=13
          BLOCK B10 IN=14 OUT=15 19
          BLOCK B3 IN=3 OUT=6
          BLOCK B31 IN=6 OUT=61
          BLOCK B12 IN=16 OUT=17 18

      PROPERTIES SYSOP3 HENRY-COMPS=GASES
          PROPERTIES SYSOP10A / SYSOP15S
```

INPUT FILE(S) (CONTINUED)

```

PROP-REPLACE SYSOP15S SYSOP15S
    PROP VLMX VLMX01

PROP-REPLACE SYSOP3 SYSOP3
    PROP VLMX VLMX01
    PROP VL VL01

STREAM 1
    SUBSTREAM MIXED TEMP=21.11112 PRES=1.013529
    MASS-FLOW TOL .2308281

STREAM 2
    SUBSTREAM MIXED TEMP=148.8889 PRES=206.8427
    MASS-FLOW H2O 3.247469 / CH4 .0165183 / CO2 1.83957E-3
    SUBSTREAM CISOLID TEMP=148.8889 PRES=206.8427
    MASS-FLOW NACL .5227652

STREAM 23
    SUBSTREAM MIXED TEMP=21.11112 PRES=1.013529
    MASS-FLOW H2O 2.091061

STREAM 3
    SUBSTREAM MIXED PRES=10.13250 VFRAC=0
    MASS-FLOW O2 .8661094

BLOCK B14 MIXER
    IN-UNITS SI

BLOCK B4 MIXER

BLOCK B6 SEP
    FRAC STREAM=9 SUBSTREAM=MIXED COMPS=H2O CO2 N2 O2  &
        FRACS=1 1 1 1
    FRAC STREAM=21 SUBSTREAM=CISOLID COMPS=NACL FRACS=1

BLOCK B11 HEATER
    PARAM TEMP=30.00000 PRES=1.013529

BLOCK B31 HEATER
    PARAM TEMP=21.11111 PRES=234.4220

BLOCK B12 FLASH2
    PARAM PRES=1.013529 DUTY=0.0

BLOCK B13 HEATX
    PARAM DELT-HOT=10 <K>
    FEEDS HOT=21 COLD=13
    PRODUCTS HOT=22 COLD=14

BLOCK B7 HEATX
    PARAM T-HOT=1000 <F>
    FEEDS HOT=9 COLD=11
```

INPUT FILE(S) (CONTINUED)

```
        PRODUCTS HOT=10 COLD=12

    BLOCK B5 RSTOIC
        PARAM PRES=234.4220 DUTY=0.0
        STOIC 1 MIXED TOL -1 / O2 -9 / CO2 7 / H2O 4
        STOIC 2 MIXED CH4 -1 / O2 -2 / CO2 1 / H2O 2
        CONV 1 MIXED TOL 1
        CONV 2 MIXED CH4 1

    BLOCK B1 PUMP
        PARAM PRES=234.4220 EFF=0.85

    BLOCK B15 PUMP
        PARAM PRES=234.4220 EFF=0.85

    BLOCK B2 PUMP
        PARAM PRES=234.4220 EFF=0.85
        PROPERTIES SYSOP10A HENRY-COMPS=GASES

    BLOCK B3 PUMP
        PARAM PRES=234.4220 EFF=0.85

    BLOCK B10 MCOMPR
        PARAM NSTAGE=5 TYPE=ISENTROPIC PRES=1.013529 COMPR-NPHASE=2
        FEEDS 14 1
        PRODUCTS 15 5 / 19 GLOBAL L
        COMPR-SPECS 1 SEFF=0.85 MEFF=1 / 2 SEFF=0.85 MEFF=1 / 3  &
            SEFF=0.85 MEFF=1 / 4 SEFF=0.85 MEFF=1 / 5 SEFF=0.85  &
            MEFF=1
        COOLER-SPECS 1 DUTY=0.0 / 2 DUTY=0.0 / 3 DUTY=0.0 / 4  &
            DUTY=0.0 / 5 DUTY=0.0

    BLOCK B8 MCOMPR
        PARAM NSTAGE=5 TYPE=ISENTROPIC PRES=39.36907 COMPR-NPHASE=2
        FEEDS 10 1
        PRODUCTS 11 5
        COMPR-SPECS 1 SEFF=0.85 MEFF=1 / 2 SEFF=0.85 MEFF=1 / 3  &
            SEFF=0.85 MEFF=1 / 4 SEFF=0.85 MEFF=1 / 5 SEFF=0.85  &
            MEFF=1
        COOLER-SPECS 1 DUTY=0.0 / 2 DUTY=0.0 / 3 DUTY=0.0 / 4  &
            DUTY=0.0 / 5 DUTY=0.0

    BLOCK B9 MCOMPR
        PARAM NSTAGE=5 TYPE=ISENTROPIC PRES=6.618967 COMPR-NPHASE=2
        FEEDS 12 1
        PRODUCTS 13 5
        COMPR-SPECS 1 SEFF=0.85 MEFF=1 / 2 SEFF=0.85 MEFF=1 / 3  &
            SEFF=0.85 MEFF=1 / 4 SEFF=0.85 MEFF=1 / 5 SEFF=0.85  &
            MEFF=1
        COOLER-SPECS 1 DUTY=0.0 / 2 DUTY=0.0 / 3 DUTY=0.0 / 4  &
            DUTY=0.0 / 5 DUTY=0.0

    REPORT INPUT NOFLOWSHEET NOPROPERTIES
```

INPUT FILE(S) (CONTINUED)

```

BLOCK-REPORT NEWPAGE NOSORT INCL-BLOCKS=B1 B2 B3 B31 B5 B6  &
        B7 B8 B9 B10 B11 B12 B13 B15

STREAM-REPOR NOSORT INCL-STREAMS=1 2 3 4 5 6 61 7 8 9 10  &
        11 12 13 14 15 16 17 18 19 21 22 23 24 25
;
;
;
;
;
```

SIMULATION STARTED   MODULE USED: apmod   CREATION: 02/14/92 11:21:55
LOCATED IN:d:\ap85b\xeq\apmod
SIMULATION COMPLETED FOR ENTIRE FLOWSHEET

FLOWSHEET
U-O-S BLOCK SECTION

BLOCK: B1 MODEL: PUMP

INLET STREAM: 1
OUTLET STREAM: 4
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	0.250516E-02	0.250516E-02	0.000000E+00
MASS(KG/SEC)	0.230828	0.230828	0.000000E+00
ENTHALPY(WATT)	29126.8	36447.6	-0.200858

*** INPUT DATA ***

OUTLET PRESSURE (BAR)	234.422
PUMP EFFICIENCY	0.85000
DRIVER EFFICIENCY	1.00000

FLASH SPECIFICATIONS:
LIQUID PHASE CALCULATION
NO FLASH PERFORMED

MAXIMUM NUMBER OF ITERATIONS	30
TOLERANCE	0.000100000

*** RESULTS ***

VOLUMETRIC FLOW RATE (CUM/SEC)	0.00026660
PRESSURE CHANGE (BAR)	233.408
FLUID POWER (WATT)	6,222.67
BRAKE POWER (WATT)	7,320.79
ELECTRICITY (WATT)	7,320.79
PUMP EFFICIENCY USED	0.85000
NET WORK (WATT)	-7,320.79

BLOCK: B2 MODEL: PUMP

INLET STREAM: 2
OUTLET STREAM: 5
PROPERTY OPTION SET: SYSOP10A RENON (NRTL) / REDLICH-KWONG
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	0.190281	0.190281	0.000000E+00
MASS(KG/SEC)	3.78859	3.78859	0.000000E+00
ENTHALPY(WATT)	-0.534813E+08	-0.534689E+08	-0.231778E-03

*** INPUT DATA ***

OUTLET PRESSURE (BAR)	234.422
PUMP EFFICIENCY	0.85000
DRIVER EFFICIENCY	1.00000

FLASH SPECIFICATIONS:
LIQUID PHASE CALCULATION
NO FLASH PERFORMED

MAXIMUM NUMBER OF ITERATIONS	30
TOLERANCE	0.000100000

*** RESULTS ***

VOLUMETRIC FLOW RATE (CUM/SEC)	0.0038204
PRESSURE CHANGE (BAR)	27.5793
FLUID POWER (WATT)	10,536.4
BRAKE POWER (WATT)	12,395.8
ELECTRICITY (WATT)	12,395.8
PUMP EFFICIENCY USED	0.85000
NET WORK (WATT)	-12,395.8

BLOCK: B3 MODEL: PUMP

INLET STREAM:	3	
OUTLET STREAM:	6	
PROPERTY OPTION SET:	SYSOP3	REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID:	GASES	

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	0.270668E-01	0.270668E-01	0.000000E+00
MASS(KG/SEC)	0.866109	0.866109	0.000000E+00
ENTHALPY(WATT)	-305551.	-282284.	-0.761494E-01

*** INPUT DATA ***

OUTLET PRESSURE (BAR)	234.422
PUMP EFFICIENCY	0.85000
DRIVER EFFICIENCY	1.00000

FLASH SPECIFICATIONS:
LIQUID PHASE CALCULATION
NO FLASH PERFORMED

MAXIMUM NUMBER OF ITERATIONS	30
TOLERANCE	0.000100000

*** RESULTS ***

VOLUMETRIC FLOW RATE (CUM/SEC)	0.00088178
PRESSURE CHANGE (BAR)	224.289
FLUID POWER (WATT)	19,777.4
BRAKE POWER (WATT)	23,267.6
ELECTRICITY (WATT)	23,267.6
PUMP EFFICIENCY USED	0.85000
NET WORK (WATT)	-23,267.6

BLOCK: B31 MODEL: HEATER

INLET STREAM:	6
OUTLET STREAM:	61
PROPERTY OPTION SET:	SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID:	GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	0.270668E-01	0.270668E-01	0.000000E+00
MASS(KG/SEC)	0.866109	0.866109	0.000000E+00
ENTHALPY(WATT)	-282284.	-45984.8	-0.837097

*** INPUT DATA ***

TWO PHASE TP FLASH

SPECIFIED TEMPERATURE	C	21.1111
SPECIFIED PRESSURE	BAR	234.422
MAXIMUM NO. ITERATIONS		30
CONVERGENCE TOLERANCE		0.000100000

*** RESULTS ***

OUTLET TEMPERATURE	C	21.111
OUTLET PRESSURE	BAR	234.42
HEAT DUTY	WATT	0.23630E+06
VAPOR FRACTION		1.0000

V-L PHASE EQUILIBRIUM :

COMP	F(I)	X(I)	Y(I)	K(I)
O2	1.0000	1.0000	1.0000	1.0952

FLOWSHEET
U-O-S BLOCK SECTION

BLOCK: B5 MODEL: RSTOIC

INLET STREAMS: 7 61
OUTLET STREAM: 8
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	GENERATION	RELATIVE DIFF.
TOTAL BALANCE				
MOLE(KMOL/SEC)	0.219853	0.222358	0.250516E-02	0.000000E+00
MASS(KG/SEC)	4.88553	4.88552		0.123629E-05
ENTHALPY(WATT)	-0.534784E+08	-0.534784E+08		0.267269E-06

*** INPUT DATA ***

SIMULTANEOUS REACTIONS
STOICHIOMETRY MATRIX:

REACTION # 1:
SUBSTREAM MIXED :

TOL	-1.00	H2O	4.00	CO2	7.00	O2	-9.00

SUBSTREAM CISOLID :
NO PARTICIPATING COMPONENTS

REACTION # 2:
SUBSTREAM MIXED :

H2O	2.00	CH4	-1.00	CO2	1.00	O2	-2.00

SUBSTREAM CISOLID :
NO PARTICIPATING COMPONENTS

REACTION CONVERSION SPECS: NUMBER= 2
REACTION # 1:
SUBSTREAM:MIXED KEY COMP:TOL CONV FRAC: 1.000
REACTION # 2:
SUBSTREAM:MIXED KEY COMP:CH4 CONV FRAC: 1.000

TWO PHASE PQ FLASH

SPECIFIED PRESSURE	BAR	234.422
SPECIFIED HEAT DUTY	WATT	0.0
MAXIMUM NO. ITERATIONS		30
CONVERGENCE TOLERANCE		0.000100000

BLOCK: B5 MODEL: RSTOIC (CONTINUED)

*** RESULTS ***

OUTLET TEMPERATURE	C	597.19
OUTLET PRESSURE	BAR	234.42
VAPOR FRACTION		1.0000

V-L PHASE EQUILIBRIUM :

COMP	F(I)	X(I)	Y(I)	K(I)
H2O	0.90128	0.96885	0.90128	2.2544
CO2	0.87190E-01	0.28354E-01	0.87190E-01	3.4795
O2	0.11532E-01	0.27993E-02	0.11532E-01	3.6862

BLOCK: B6 MODEL: SEP

INLET STREAM:	8	
OUTLET STREAMS:	9	21
PROPERTY OPTION SET:	SYSOP3	REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID:	GASES	

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	0.222358	0.222358	0.000000E+00
MASS(KG/SEC)	4.88552	4.88552	0.000000E+00
ENTHALPY(WATT)	-0.534784E+08	-0.534784E+08	0.000000E+00

*** INPUT DATA ***

FLASH SPECS FOR STREAM 9
TWO PHASE TP FLASH

PRESSURE DROP	BAR	0.0
MAXIMUM NO. ITERATIONS		30
CONVERGENCE TOLERANCE		0.000100000

FLASH SPECS FOR STREAM 21
TWO PHASE TP FLASH

PRESSURE DROP	BAR	0.0
MAXIMUM NO. ITERATIONS		30
CONVERGENCE TOLERANCE		0.000100000

FRACTION OF FEED

SUBSTREAM= MIXED			
STREAM= 9	CPT= H2O	FRACTION=	1.00000
	CO2		1.00000
	N2		1.00000
	O2		1.00000
SUBSTREAM= CISOLID			
STREAM= 21	CPT= NACL	FRACTION=	1.00000

*** RESULTS ***

COMPONENT = H2O

STREAM	SUBSTREAM	SPLIT FRACTION
9	MIXED	1.00000

BLOCK: B6 MODEL: SEP (CONTINUED)

COMPONENT = NACL

STREAM	SUBSTREAM	SPLIT FRACTION
21	CISOLID	1.00000

COMPONENT = CO2

STREAM	SUBSTREAM	SPLIT FRACTION
9	MIXED	1.00000

COMPONENT = O2

STREAM	SUBSTREAM	SPLIT FRACTION
9	MIXED	1.00000

BLOCK: B7 MODEL: HEATX

HOT SIDE:

INLET STREAM: 9
OUTLET STREAM: 10
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

COLD SIDE:

INLET STREAM: 11
OUTLET STREAM: 12
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	0.426826	0.426826	0.000000E+00
MASS(KG/SEC)	8.72552	8.72552	0.000000E+00
ENTHALPY(WATT)	-0.102422E+09	-0.102422E+09	-0.806398E-06

*** INPUT DATA ***

FLASH SPECS FOR HOT SIDE:
TWO PHASE FLASH
MAXIMUM NO. ITERATIONS 30
CONVERGENCE TOLERANCE 0.000100000

FLASH SPECS FOR COLD SIDE:
TWO PHASE FLASH
MAXIMUM NO. ITERATIONS 30
CONVERGENCE TOLERANCE 0.000100000

```
BLOCK:  B7       MODEL: HEATX (CONTINUED)


   COUNTERCURRENT  HEAT EXCHANGER WITH SPECIFIED HOT OUTLET TEMPERATURE
   HOT STREAM OUTLET TEMPERATURE (C    )                       537.778
   HOT STREAM PRESSURE DROP (BAR      )                          0.0
   COLD STREAM PRESSURE DROP (BAR      )                         0.0

   HEAT TRANSFER COEFFICIENTS  (WATT/SQM-K        ):
   HOT STREAM PHASE      COLD STREAM PHASE
   LIQUID                LIQUID                                850.000
   BOILING LIQUID        LIQUID                                850.000
   VAPOR                 LIQUID                                850.000
   LIQUID                BOILING LIQUID                        850.000
   BOILING LIQUID        BOILING LIQUID                        850.000
   VAPOR                 BOILING LIQUID                        850.000
   LIQUID                VAPOR                                 850.000
   BOILING LIQUID        VAPOR                                 850.000
   VAPOR                 VAPOR                                 850.000

                           ***  RESULTS  ***
   HOT STREAM INLET TEMPERATURE (C    )                        597.189
   HOT STREAM OUTLET TEMPERATURE (C    )                       537.778
   COLD STREAM INLET TEMPERATURE (C    )                       273.261
   COLD STREAM OUTLET TEMPERATURE (C    )                      348.117
   EXCHANGER HEAT DUTY (WATT     )                         667,536.
   HEAT TRANSFER AREA (SQM      )                                3.05916


   AREA CALCULATION RESULTS:

   SECTION  CONDITIONS    AREA                HEAT DUTY
            (HOT-COLD)    (SQM      )         (WATT     )
      1       V-V           3.05916        667,536.

   SECTION   TEMPERATURE LEAVING SECTION
             HOT STREAM              COLD STREAM
             (C        )             (C        )
      1         537.778                 348.117



            -------------------------------------------------------------
           |                                                           |
 9         |      VAP                                                  |  10
------>    |                                                           | ------>
 597.2     |                                                           |  537.8
           |                                                           |
 12        |      VAP                                                  |  11
<------    |                                                           | <------
 348.1     |                                                           |  273.3
           |                                                           |
            -------------------------------------------------------------
```

BLOCK: B8 MODEL: MCOMPR

INLET STREAMS: 10 TO STAGE 1
OUTLET STREAMS: 11 FROM STAGE 5
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	0.213413	0.213413	0.000000E+00
MASS(KG/SEC)	4.36276	4.36276	0.000000E+00
ENTHALPY(WATT)	-0.507521E+08	-0.523378E+08	0.302966E-01

*** INPUT DATA ***

ISENTROPIC CENTRIFUGAL COMPRESSOR
NUMBER OF STAGES 5
FINAL PRESSURE, BAR 39.3691

COMPRESSOR SPECIFICATIONS PER STAGE

STAGE NUMBER	MECHANICAL EFFICIENCY	ISENTROPIC EFFICIENCY
1	1.000	0.8500
2	1.000	0.8500
3	1.000	0.8500
4	1.000	0.8500
5	1.000	0.8500

*** RESULTS ***

FINAL PRESSURE, BAR 39.3691
TOTAL WORK REQUIRED, WATT -1,585,590.

*** PROFILE ***

COMPRESSOR PROFILE

STAGE NUMBER	OUTLET PRESSURE BAR	PRESSURE RATIO	OUTLET TEMPERATURE C
1	164.1	0.6999	477.3
2	114.8	0.6999	420.2
3	80.37	0.6999	367.0
4	56.25	0.6999	318.3
5	39.37	0.6999	273.3

BLOCK: B8 MODEL: MCOMPR (CONTINUED)

STAGE NUMBER	INDICATED HORSEPOWER WATT	BRAKE HORSEPOWER WATT
1	-.3699E+06	-.3699E+06
2	-.3393E+06	-.3393E+06
3	-.3134E+06	-.3134E+06
4	-.2913E+06	-.2913E+06
5	-.2717E+06	-.2717E+06

BLOCK: B9 MODEL: MCOMPR

INLET STREAMS: 12 TO STAGE 1
OUTLET STREAMS: 13 FROM STAGE 5
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	0.213413	0.213413	0.000000E+00
MASS(KG/SEC)	4.36276	4.36276	0.000000E+00
ENTHALPY(WATT)	-0.516702E+08	-0.529898E+08	0.249028E-01

*** INPUT DATA ***

ISENTROPIC CENTRIFUGAL COMPRESSOR
NUMBER OF STAGES 5
FINAL PRESSURE, BAR 6.61897

COMPRESSOR SPECIFICATIONS PER STAGE

STAGE NUMBER	MECHANICAL EFFICIENCY	ISENTROPIC EFFICIENCY
1	1.000	0.8500
2	1.000	0.8500
3	1.000	0.8500
4	1.000	0.8500
5	1.000	0.8500

*** RESULTS ***

FINAL PRESSURE, BAR 6.61897
TOTAL WORK REQUIRED, WATT -1,319,520.

*** PROFILE ***

COMPRESSOR PROFILE

STAGE NUMBER	OUTLET PRESSURE BAR	PRESSURE RATIO	OUTLET TEMPERATURE C
1	27.56	0.7000	303.8
2	19.29	0.7000	262.6
3	13.51	0.7000	224.3
4	9.455	0.7000	188.6
5	6.619	0.7000	159.2

BLOCK: B9 MODEL: MCOMPR (CONTINUED)

STAGE NUMBER	INDICATED HORSEPOWER WATT	BRAKE HORSEPOWER WATT
1	-.3009E+06	-.3009E+06
2	-.2811E+06	-.2811E+06
3	-.2627E+06	-.2627E+06
4	-.2453E+06	-.2453E+06
5	-.2296E+06	-.2296E+06

BLOCK: B10 MODEL: MCOMPR

INLET STREAMS:	14	TO STAGE	1
OUTLET STREAMS:	15	FROM STAGE	5
	19	GLOBAL OUTLET	

PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	0.213413	0.213413	0.000000E+00
MASS(KG/SEC)	4.36276	4.36276	0.000000E+00
ENTHALPY(WATT)	-0.527717E+08	-0.538658E+08	0.203103E-01

*** INPUT DATA ***

ISENTROPIC CENTRIFUGAL COMPRESSOR

NUMBER OF STAGES	5
FINAL PRESSURE, BAR	1.01353

COMPRESSOR SPECIFICATIONS PER STAGE

STAGE NUMBER	MECHANICAL EFFICIENCY	ISENTROPIC EFFICIENCY
1	1.000	0.8500
2	1.000	0.8500
3	1.000	0.8500
4	1.000	0.8500
5	1.000	0.8500

*** RESULTS ***

FINAL PRESSURE, BAR	1.01353
TOTAL WORK REQUIRED, WATT	-1,093,810.

*** PROFILE ***

COMPRESSOR PROFILE

STAGE NUMBER	OUTLET PRESSURE BAR	PRESSURE RATIO	OUTLET TEMPERATURE C
1	4.548	0.6871	149.3
2	3.125	0.6871	132.8
3	2.147	0.6871	120.9
4	1.475	0.6871	109.8
5	1.014	0.6871	99.48

BLOCK: B10 MODEL: MCOMPR (CONTINUED)

STAGE NUMBER	INDICATED HORSEPOWER WATT	BRAKE HORSEPOWER WATT
1	-.2404E+06	-.2404E+06
2	-.2267E+06	-.2267E+06
3	-.2174E+06	-.2174E+06
4	-.2088E+06	-.2088E+06
5	-.2006E+06	-.2006E+06

FLOWSHEET
U-O-S BLOCK SECTION

BLOCK: B11 MODEL: HEATER

INLET STREAM:	15
OUTLET STREAM:	16
PROPERTY OPTION SET:	SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID:	GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	0.203938	0.203938	0.000000E+00
MASS(KG/SEC)	4.19206	4.19206	0.000000E+00
ENTHALPY(WATT)	-0.512065E+08	-0.600644E+08	0.147473

*** INPUT DATA ***

TWO PHASE TP FLASH		
SPECIFIED TEMPERATURE	C	30.0000
SPECIFIED PRESSURE	BAR	1.01353
MAXIMUM NO. ITERATIONS		30
CONVERGENCE TOLERANCE		0.000100000

*** RESULTS ***

OUTLET TEMPERATURE	C	30.000
OUTLET PRESSURE	BAR	1.0135
HEAT DUTY	WATT	-0.88579E+07
VAPOR FRACTION		0.10668

V-L PHASE EQUILIBRIUM :

COMP	F(I)	X(I)	Y(I)	K(I)
H2O	0.89669	0.99994	0.32094E-01	0.32096E-01
CO2	0.91240E-01	0.56121E-04	0.85479	15231.
O2	0.12068E-01	0.16534E-06	0.11312	0.68413E+06

BLOCK: B12 MODEL: FLASH2

INLET STREAM:	16
OUTLET VAPOR STREAM:	17
OUTLET LIQUID STREAM:	18
PROPERTY OPTION SET:	SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID:	GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	0.203938	0.203938	0.000000E+00
MASS(KG/SEC)	4.19206	4.19206	0.000000E+00
ENTHALPY(WATT)	-0.600644E+08	-0.600644E+08	-0.962243E-08

*** INPUT DATA ***

TWO PHASE PQ FLASH

SPECIFIED PRESSURE	BAR	1.01353
SPECIFIED HEAT DUTY	WATT	0.0
MAXIMUM NO. ITERATIONS		30
CONVERGENCE TOLERANCE		0.000100000

*** RESULTS ***

OUTLET TEMPERATURE	C	30.000
OUTLET PRESSURE	BAR	1.0135
VAPOR FRACTION		0.10668

V-L PHASE EQUILIBRIUM :

COMP	F(I)	X(I)	Y(I)	K(I)
H2O	0.89669	0.99994	0.32094E-01	0.32096E-01
CO2	0.91240E-01	0.56121E-04	0.85479	15231.
O2	0.12068E-01	0.16534E-06	0.11312	0.68412E+06

```
BLOCK:  B13      MODEL: HEATX
-----------------------------
  HOT SIDE:
  ---------
  INLET STREAM:            21
  OUTLET STREAM:           22
  PROPERTY OPTION SET:     SYSOP3    REDLICH-KWONG-SOAVE EQUATION OF STATE
  HENRY-COMPS ID:          GASES

  COLD SIDE:
  ----------
  INLET STREAM:            13
  OUTLET STREAM:           14
  PROPERTY OPTION SET:     SYSOP3    REDLICH-KWONG-SOAVE EQUATION OF STATE
  HENRY-COMPS ID:          GASES

                        ***  MASS AND ENERGY BALANCE  ***
                                       IN              OUT          RELATIVE DIFF.
   TOTAL BALANCE
      MOLE(KMOL/SEC)              0.222358         0.222358        0.000000E+00
      MASS(KG/SEC  )              4.88552          4.88552         0.000000E+00
      ENTHALPY(WATT     )        -0.563836E+08    -0.563836E+08    0.100212E-08

                            ***  INPUT DATA  ***

  FLASH SPECS FOR HOT SIDE:
  TWO    PHASE      FLASH
  MAXIMUM NO. ITERATIONS                                        30
  CONVERGENCE TOLERANCE                                          0.000100000

  FLASH SPECS FOR COLD SIDE:
  TWO    PHASE      FLASH
  MAXIMUM NO. ITERATIONS                                        30
  CONVERGENCE TOLERANCE                                          0.000100000
```

BLOCK: B13 MODEL: HEATX (CONTINUED)

COUNTERCURRENT HEAT EXCHANGER WITH SPECIFIED HOT OUTLET TEMP APPROACH

TEMP APPROACH AT HOT STREAM OUTLET (C)	10.0000
HOT STREAM PRESSURE DROP (BAR)	0.0
COLD STREAM PRESSURE DROP (BAR)	0.0

HEAT TRANSFER COEFFICIENTS (WATT/SQM-K):

HOT STREAM PHASE	COLD STREAM PHASE	
LIQUID	LIQUID	850.000
BOILING LIQUID	LIQUID	850.000
VAPOR	LIQUID	850.000
LIQUID	BOILING LIQUID	850.000
BOILING LIQUID	BOILING LIQUID	850.000
VAPOR	BOILING LIQUID	850.000
LIQUID	VAPOR	850.000
BOILING LIQUID	VAPOR	850.000
VAPOR	VAPOR	850.000

*** RESULTS ***

HOT STREAM INLET TEMPERATURE (C)	597.189
HOT STREAM OUTLET TEMPERATURE (C)	169.160
COLD STREAM INLET TEMPERATURE (C)	159.160
COLD STREAM OUTLET TEMPERATURE (C)	183.276
EXCHANGER HEAT DUTY (WATT)	218,034.
HEAT TRANSFER AREA (SQM)	0.192560-30

BLOCK: B13 MODEL: HEATX (CONTINUED)

AREA CALCULATION RESULTS:

SECTION	CONDITIONS (HOT-COLD)	AREA (SQM)	HEAT DUTY (WATT)
1	V-V	0.165360-30	188,502.
2	V-B	0.272007-31	29,532.8

SECTION	TEMPERATURE LEAVING SECTION HOT STREAM (C)	COLD STREAM (C)
1	MISSING	183.276
2	169.160	159.175

```
           ------------------------------------------------------------
          |                             |                             |
 21       |      VAP                    |      VAP                    |  22
------>   |                             |                             | ------>
 597.2    |                             |                             |  169.2
          |                             |                             |
 14       |      VAP                    |     BOIL                    |  13
<------   |                             |                             | <------
 183.3    |                        159.2|                             |  159.2
          |                             |                             |
           ------------------------------------------------------------
```

BLOCK: B15 MODEL: PUMP

INLET STREAM:	23	
OUTLET STREAM:	24	
PROPERTY OPTION SET:	SYSOP3	REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID:	GASES	

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	0.116073	0.116073	0.000000E+00
MASS(KG/SEC)	2.09106	2.09106	0.000000E+00
ENTHALPY(WATT)	-0.335863E+08	-0.335287E+08	-0.171520E-02

*** INPUT DATA ***

OUTLET PRESSURE (BAR)	234.422
PUMP EFFICIENCY	0.85000
DRIVER EFFICIENCY	1.00000

FLASH SPECIFICATIONS:
LIQUID PHASE CALCULATION
NO FLASH PERFORMED

MAXIMUM NUMBER OF ITERATIONS	30
TOLERANCE	0.000100000

*** RESULTS ***

VOLUMETRIC FLOW RATE (CUM/SEC)	0.0020979
PRESSURE CHANGE (BAR)	233.408
FLUID POWER (WATT)	48,966.2
BRAKE POWER (WATT)	57,607.3
ELECTRICITY (WATT)	57,607.3
PUMP EFFICIENCY USED	0.85000
NET WORK (WATT)	-57,607.3

FLOWSHEET
STREAM SECTION

1 2 3 4 5

STREAM ID	1	2	3	4	5
FROM :	----	----	----	B1	B2
TO :	B1	B2	B3	B4	B4
CLASS:	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD
TOTAL STREAM:					
KG/SEC	0.2308	3.7885	0.8661	0.2308	3.7885
WATT	2.9127+04	-5.3481+07	-3.0555+05	3.6448+04	-5.3469+07
SUBSTREAM: MIXED					
PHASE:	LIQUID	MIXED	LIQUID	LIQUID	LIQUID
COMPONENTS: KMOL/SEC					
TOL	2.5052-03	0.0	0.0	2.5052-03	0.0
H2O	0.0	0.1802	0.0	0.0	0.1802
NACL	0.0	0.0	0.0	0.0	0.0
CH4	0.0	1.0296-03	0.0	0.0	1.0296-03
CO2	0.0	4.1799-05	0.0	0.0	4.1799-05
N2	0.0	0.0	0.0	0.0	0.0
O2	0.0	0.0	2.7067-02	0.0	0.0
TOTAL FLOW:					
KMOL/SEC	2.5052-03	0.1813	2.7067-02	2.5052-03	0.1813
KG/SEC	0.2308	3.2658	0.8661	0.2308	3.2658
CUM/SEC	2.6660-04	3.8992-03	8.8178-04	2.6810-04	3.8231-03
STATE VARIABLES:					
TEMP C	21.1111	148.8889	-153.3901	26.4341	149.6359
PRES BAR	1.0135	206.8427	10.1325	234.4220	234.4220
VFRAC	0.0	4.0570-03	0.0	0.0	0.0
LFRAC	1.0000	0.9959	1.0000	1.0000	1.0000
SFRAC	0.0	0.0	0.0	0.0	0.0
ENTHALPY:					
J/KMOL	1.1627+07	-2.7496+08	-1.1289+07	1.4549+07	-2.7489+08
J/KG	1.2618+05	-1.5267+07	-3.5279+05	1.5790+05	-1.5263+07
WATT	2.9127+04	-4.9860+07	-3.0555+05	3.6448+04	-4.9848+07
ENTROPY:					
J/KMOL-K	-3.4337+05	-1.3654+05	-9.5330+04	-3.4288+05	-1.3654+05
J/KG-K	-3726.5844	-7581.2897	-2979.1601	-3721.2527	-7581.4330
DENSITY:					
KMOL/CUM	9.3967	46.5056	30.6955	9.3440	47.4316
KG/CUM	865.8220	837.5576	982.2271	860.9738	854.2333
AVG MW	92.1410	18.0097	31.9990	92.1410	18.0097

SUBSTREAM: CISOLID STRUCTURE: CONVENTIONAL

COMPONENTS: KMOL/SEC					
TOL	0.0	0.0	0.0	0.0	0.0
H2O	0.0	0.0	0.0	0.0	0.0
NACL	0.0	8.9449-03	0.0	0.0	8.9449-03
CH4	0.0	0.0	0.0	0.0	0.0
CO2	0.0	0.0	0.0	0.0	0.0
N2	0.0	0.0	0.0	0.0	0.0
O2	0.0	0.0	0.0	0.0	0.0
TOTAL FLOW:					
KMOL/SEC	0.0	8.9449-03	0.0	0.0	8.9449-03
KG/SEC	0.0	0.5227	0.0	0.0	0.5227
CUM/SEC	0.0	2.4165-04	0.0	0.0	2.4165-04

1 2 3 4 5 (CONTINUED)

STREAM ID	1	2	3	4	5
STATE VARIABLES:					
TEMP C	MISSING	148.8889	MISSING	MISSING	149.6359
PRES BAR	1.0135	206.8427	10.1325	234.4220	234.4220
VFRAC	MISSING	0.0	MISSING	MISSING	0.0
LFRAC	MISSING	0.0	MISSING	MISSING	0.0
SFRAC	MISSING	1.0000	MISSING	MISSING	1.0000
ENTHALPY:					
J/KMOL	MISSING	-4.0486+08	MISSING	MISSING	-4.0483+08
J/KG	MISSING	-6.9275+06	MISSING	MISSING	-6.9268+06
WATT	MISSING	-3.6215+06	MISSING	MISSING	-3.6211+06
ENTROPY:					
J/KMOL-K	MISSING	-7.2803+04	MISSING	MISSING	-7.2709+04
J/KG-K	MISSING	-1245.7035	MISSING	MISSING	-1244.1074
DENSITY:					
KMOL/CUM	MISSING	37.0164	MISSING	MISSING	37.0164
KG/CUM	MISSING	2163.3536	MISSING	MISSING	2163.3536
AVG MW	MISSING	58.4430	MISSING	MISSING	58.4430

6 61 7 8 9

STREAM ID	6	61	7	8	9
FROM :	B3	B31	B4	B5	B6
TO :	B31	B5	B5	B6	B7
CLASS:	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD
TOTAL STREAM:					
KG/SEC	0.8661	0.8661	4.0194	4.8855	4.3627
WATT	-2.8228+05	-4.5985+04	-5.3432+07	-5.3478+07	-5.0085+07
SUBSTREAM: MIXED					
PHASE:	LIQUID	VAPOR	MIXED	VAPOR	VAPOR
COMPONENTS: KMOL/SEC					
TOL	0.0	0.0	2.5052-03	0.0	0.0
H2O	0.0	0.0	0.1802	0.1923	0.1923
NACL	0.0	0.0	0.0	0.0	0.0
CH4	0.0	0.0	1.0296-03	0.0	0.0
CO2	0.0	0.0	4.1799-05	1.8608-02	1.8608-02
N2	0.0	0.0	0.0	0.0	0.0
O2	2.7067-02	2.7067-02	0.0	2.4611-03	2.4611-03
TOTAL FLOW:					
KMOL/SEC	2.7067-02	2.7067-02	0.1838	0.2134	0.2134
KG/SEC	0.8661	0.8661	3.4966	4.3627	4.3627
CUM/SEC	9.7178-04	2.8182-03	5.0602-03	6.1383-02	6.1383-02
STATE VARIABLES:					
TEMP C	-140.8585	21.1111	158.0549	597.1894	597.1894
PRES BAR	234.4220	234.4220	234.4220	234.4220	234.4220
VFRAC	0.0	1.0000	1.1812-02	1.0000	1.0000
LFRAC	1.0000	0.0	0.9881	0.0	0.0
SFRAC	0.0	0.0	0.0	0.0	0.0
ENTHALPY:					
J/KMOL	-1.0429+07	-1.6989+06	-2.7097+08	-2.3468+08	-2.3468+08
J/KG	-3.2592+05	-5.3094+04	-1.4247+07	-1.1480+07	-1.1480+07
WATT	-2.8228+05	-4.5985+04	-4.9815+07	-5.0085+07	-5.0085+07
ENTROPY:					
J/KMOL-K	-9.4357+04	-5.0535+04	-1.3939+05	-4.6284+04	-4.6284+04
J/KG-K	-2948.7496	-1579.2576	-7328.8446	-2264.0778	-2264.0778
DENSITY:					
KMOL/CUM	27.8527	9.6043	36.3305	3.4767	3.4767
KG/CUM	891.2585	307.3280	691.0065	71.0748	71.0748
AVG MW	31.9990	31.9990	19.0199	20.4427	20.4427

SUBSTREAM: CISOLID STRUCTURE: CONVENTIONAL

COMPONENTS: KMOL/SEC					
TOL	0.0	0.0	0.0	0.0	0.0
H2O	0.0	0.0	0.0	0.0	0.0
NACL	0.0	0.0	8.9449-03	8.9449-03	0.0
CH4	0.0	0.0	0.0	0.0	0.0
CO2	0.0	0.0	0.0	0.0	0.0
N2	0.0	0.0	0.0	0.0	0.0
O2	0.0	0.0	0.0	0.0	0.0
TOTAL FLOW:					
KMOL/SEC	0.0	0.0	8.9449-03	8.9449-03	0.0
KG/SEC	0.0	0.0	0.5227	0.5227	0.0
CUM/SEC	0.0	0.0	2.4165-04	2.4165-04	0.0

6 61 7 8 9 (CONTINUED)

STREAM ID	6	61	7	8	9
STATE VARIABLES:					
TEMP C	MISSING	MISSING	158.0549	597.1894	MISSING
PRES BAR	234.4220	234.4220	234.4220	234.4220	234.4220
VFRAC	MISSING	MISSING	0.0	0.0	MISSING
LFRAC	MISSING	MISSING	0.0	0.0	MISSING
SFRAC	MISSING	MISSING	1.0000	1.0000	MISSING
ENTHALPY:					
J/KMOL	MISSING	MISSING	-4.0438+08	-3.7942+08	MISSING
J/KG	MISSING	MISSING	-6.9192+06	-6.4921+06	MISSING
WATT	MISSING	MISSING	-3.6171+06	-3.3938+06	MISSING
ENTROPY:					
J/KMOL-K	MISSING	MISSING	-7.1668+04	-3.2065+04	MISSING
J/KG-K	MISSING	MISSING	-1226.2852	-548.6584	MISSING
DENSITY:					
KMOL/CUM	MISSING	MISSING	37.0164	37.0164	MISSING
KG/CUM	MISSING	MISSING	2163.3536	2163.3536	MISSING
AVG MW	MISSING	MISSING	58.4430	58.4430	MISSING

FLOWSHEET
STREAM SECTION

10 11 12 13 14

STREAM ID	10	11	12	13	14
FROM :	B7	B8	B7	B9	B13
TO :	B8	B7	B9	B13	B10
CLASS:	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD
TOTAL STREAM:					
KG/SEC	4.3627	4.3627	4.3627	4.3627	4.3627
WATT	-5.0752+07	-5.2338+07	-5.1670+07	-5.2990+07	-5.2772+07
SUBSTREAM: MIXED					
PHASE:	VAPOR	VAPOR	VAPOR	MIXED	VAPOR
COMPONENTS: KMOL/SEC					
TOL	0.0	0.0	0.0	0.0	0.0
H2O	0.1923	0.1923	0.1923	0.1923	0.1923
NACL	0.0	0.0	0.0	0.0	0.0
CH4	0.0	0.0	0.0	0.0	0.0
CO2	1.8608-02	1.8608-02	1.8608-02	1.8608-02	1.8608-02
N2	0.0	0.0	0.0	0.0	0.0
O2	2.4611-03	2.4611-03	2.4611-03	2.4611-03	2.4611-03
TOTAL FLOW:					
KMOL/SEC	0.2134	0.2134	0.2134	0.2134	0.2134
KG/SEC	4.3627	4.3627	4.3627	4.3627	4.3627
CUM/SEC	5.4801-02	0.2213	0.2624	1.1161	1.1888
STATE VARIABLES:					
TEMP C	537.7777	273.2615	348.1173	159.1597	183.2759
PRES BAR	234.4220	39.3690	39.3690	6.6189	6.6189
VFRAC	1.0000	1.0000	1.0000	0.9965	1.0000
LFRAC	0.0	0.0	0.0	3.4990-03	0.0
SFRAC	0.0	0.0	0.0	0.0	0.0
ENTHALPY:					
J/KMOL	-2.3781+08	-2.4524+08	-2.4211+08	-2.4830+08	-2.4727+08
J/KG	-1.1633+07	-1.1996+07	-1.1843+07	-1.2146+07	-1.2096+07
WATT	-5.0752+07	-5.2338+07	-5.1670+07	-5.2990+07	-5.2772+07
ENTROPY:					
J/KMOL-K	-5.0007+04	-4.7963+04	-4.2596+04	-4.0408+04	-3.8099+04
J/KG-K	-2446.2189	-2346.2296	-2083.6938	-1976.6185	-1863.7069
DENSITY:					
KMOL/CUM	3.8943	0.9641	0.8130	0.1912	0.1795
KG/CUM	79.6114	19.7103	16.6217	3.9087	3.6697
AVG MW	20.4427	20.4427	20.4427	20.4427	20.4427

15 16 17 18 19

STREAM ID	15	16	17	18	19
FROM :	B10	B11	B12	B12	B10
TO :	B11	B12	----	----	----
CLASS:	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD
TOTAL STREAM:					
KG/SEC	4.1920	4.1920	0.9097	3.2822	0.1706
WATT	-5.1207+07	-6.0064+07	-7.4888+06	-5.2576+07	-2.6593+06
SUBSTREAM: MIXED					
PHASE:	MIXED	MIXED	VAPOR	LIQUID	LIQUID
COMPONENTS: KMOL/SEC					
TOL	0.0	0.0	0.0	0.0	0.0
H2O	0.1828	0.1828	6.9826-04	0.1821	9.4746-03
NACL	0.0	0.0	0.0	0.0	0.0
CH4	0.0	0.0	0.0	0.0	0.0
CO2	1.8607-02	1.8607-02	1.8597-02	1.0224-05	2.1042-07
N2	0.0	0.0	0.0	0.0	0.0
O2	2.4611-03	2.4611-03	2.4610-03	3.0123-08	2.4574-09
TOTAL FLOW:					
KMOL/SEC	0.2039	0.2039	2.1756-02	0.1821	9.4748-03
KG/SEC	4.1920	4.1920	0.9097	3.2822	0.1706
CUM/SEC	6.0928	0.5420	0.5387	3.3214-03	1.9067-04
STATE VARIABLES:					
TEMP C	99.4778	30.0000	30.0000	30.0000	120.7014
PRES BAR	1.0135	1.0135	1.0135	1.0135	6.6189
VFRAC	0.9848	0.1066	1.0000	0.0	0.0
LFRAC	1.5128-02	0.8933	0.0	1.0000	1.0000
SFRAC	0.0	0.0	0.0	0.0	0.0
ENTHALPY:					
J/KMOL	-2.5109+08	-2.9452+08	-3.4421+08	-2.8859+08	-2.8067+08
J/KG	-1.2215+07	-1.4328+07	-8.2313+06	-1.6018+07	-1.5579+07
WATT	-5.1207+07	-6.0064+07	-7.4888+06	-5.2576+07	-2.6593+06
ENTROPY:					
J/KMOL-K	-3.0671+04	-1.5067+05	5696.5389	-1.6934+05	-1.4654+05
J/KG-K	-1492.0816	-7329.7049	136.2252	-9399.1284	-8134.1368
DENSITY:					
KMOL/CUM	3.3472-02	0.3762	4.0386-02	54.8504	49.6918
KG/CUM	0.6880	7.7339	1.6888	988.2113	895.2268
AVG MW	20.5555	20.5555	41.8170	18.0164	18.0155

FLOWSHEET
STREAM SECTION

21 22 23 24 25

STREAM ID	21	22	23	24	25
FROM :	B6	B13	----	B15	B14
TO :	B13	B14	B15	B14	----
CLASS:	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD
TOTAL STREAM:					
KG/SEC	0.5227	0.5227	2.0910	2.0910	2.6138
WATT	-3.3938+06	-3.6119+06	-3.3586+07	-3.3529+07	-3.7141+07
SUBSTREAM: MIXED					
PHASE:	MIXED	MIXED	LIQUID	LIQUID	LIQUID
COMPONENTS: KMOL/SEC					
TOL	0.0	0.0	0.0	0.0	0.0
H2O	0.0	0.0	0.1160	0.1160	0.1160
NACL	0.0	0.0	0.0	0.0	0.0
CH4	0.0	0.0	0.0	0.0	0.0
CO2	0.0	0.0	0.0	0.0	0.0
N2	0.0	0.0	0.0	0.0	0.0
O2	0.0	0.0	0.0	0.0	0.0
TOTAL FLOW:					
KMOL/SEC	0.0	0.0	0.1160	0.1160	0.1160
KG/SEC	0.0	0.0	2.0910	2.0910	2.0910
CUM/SEC	0.0	0.0	2.0979-03	2.0991-03	2.1124-03
STATE VARIABLES:					
TEMP C	MISSING	MISSING	21.1111	21.7079	28.2341
PRES BAR	234.4220	234.4220	1.0135	234.4220	234.4220
VFRAC	MISSING	MISSING	0.0	0.0	0.0
LFRAC	MISSING	MISSING	1.0000	1.0000	1.0000
SFRAC	MISSING	MISSING	0.0	0.0	0.0
ENTHALPY:					
J/KMOL	MISSING	MISSING	-2.8935+08	-2.8886+08	-2.8829+08
J/KG	MISSING	MISSING	-1.6062+07	-1.6034+07	-1.6003+07
WATT	MISSING	MISSING	-3.3586+07	-3.3529+07	-3.3463+07
ENTROPY:					
J/KMOL-K	MISSING	MISSING	-1.7193+05	-1.7213+05	-1.7024+05
J/KG-K	MISSING	MISSING	-9543.8897	-9554.8913	-9450.0606
DENSITY:					
KMOL/CUM	MISSING	MISSING	55.3289	55.2971	54.9482
KG/CUM	MISSING	MISSING	996.7514	996.1788	989.8928
AVG MW	MISSING	MISSING	18.0150	18.0150	18.0150
SUBSTREAM: CISOLID	STRUCTURE: CONVENTIONAL				
COMPONENTS: KMOL/SEC					
TOL	0.0	0.0	0.0	0.0	0.0
H2O	0.0	0.0	0.0	0.0	0.0
NACL	8.9449-03	8.9449-03	0.0	0.0	8.9449-03
CH4	0.0	0.0	0.0	0.0	0.0
CO2	0.0	0.0	0.0	0.0	0.0
N2	0.0	0.0	0.0	0.0	0.0
O2	0.0	0.0	0.0	0.0	0.0
TOTAL FLOW:					
KMOL/SEC	8.9449-03	8.9449-03	0.0	0.0	8.9449-03
KG/SEC	0.5227	0.5227	0.0	0.0	0.5227
CUM/SEC	2.4165-04	2.4165-04	0.0	0.0	2.4165-04

21 22 23 24 25 (CONTINUED)

STREAM ID	21	22	23	24	25
STATE VARIABLES:					
TEMP C	597.1894	169.1597	MISSING	MISSING	28.2341
PRES BAR	234.4220	234.4220	1.0135	234.4220	234.4220
VFRAC	0.0	0.0	MISSING	MISSING	0.0
LFRAC	0.0	0.0	MISSING	MISSING	0.0
SFRAC	1.0000	1.0000	MISSING	MISSING	1.0000
ENTHALPY:					
J/KMOL	-3.7942+08	-4.0379+08	MISSING	MISSING	-4.1110+08
J/KG	-6.4921+06	-6.9092+06	MISSING	MISSING	-7.0341+06
WATT	-3.3938+06	-3.6119+06	MISSING	MISSING	-3.6772+06
ENTROPY:					
J/KMOL-K	-3.2065+04	-7.0320+04	MISSING	MISSING	-9.0174+04
J/KG-K	-548.6584	-1203.2260	MISSING	MISSING	-1542.9422
DENSITY:					
KMOL/CUM	37.0164	37.0164	MISSING	MISSING	37.0164
KG/CUM	2163.3536	2163.3536	MISSING	MISSING	2163.3536
AVG MW	58.4430	58.4430	MISSING	MISSING	58.4430

Appendix A.3 ASPEN PLUS™ Output File for 100,000 bpd Case with Air as Oxidant

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                                                                      TM
AAAAA   SSSSS   PPPPP   EEEEE   NN    N   PPPPP   L       U   U   SSSSS
A   A   S       P   P   E       N N   N   P   P   L       U   U   S
AAAAA   SSSSS   PPPPP   EEEEE   N  N  N   PPPPP   L       U   U   SSSSS
A   A       S   P       E       N   N N   P       L       U   U       S
A   A   SSSSS   P       EEEEE   N    NN   P       LLLLL   UUUUU   SSSSS
```

ASPEN PLUS IS A TRADEMARK OF
ASPEN TECHNOLOGY, INC.
251 VASSAR STREET
CAMBRIDGE, MASSACHUSETTS 02139
617/497-9010

HOTLINE:
U.S.A. 617/497-9010
EUROPE (32) 2/732-6300

VERSION: PC-DOS
RELEASE: 8.5-3
INSTALLATION: MITELAB

NOVEMBER 11, 1992
WEDNESDAY
7:41:47 P.M.

TABLE OF CONTENTS

FLOWSHEET
RUN CONTROL SECTION

```
RUN CONTROL INFORMATION
-----------------------

THIS VERSION OF ASPEN PLUS LICENSED TO MIT ENERGY LAB
TYPE OF RUN: NEW

INPUT FILE NAME: TOL2.inp

OUTPUT PROBLEM DATA FILE NAME:  TOL2     VERSION NO.   1
LOCATED IN:                    G:\TOL2


PDF SIZE USED FOR INPUT TRANSLATION:
  NUMBER OF FILE RECORDS (PSIZE) = 99999
  NUMBER OF IN-CORE RECORDS      =   400
PSIZE NEEDED FOR SIMULATION    =   300

CALLING PROGRAM NAME:           apmod
LOCATED IN:                    d:\ap85b\xeq\apmod

SIMULATION REQUESTED FOR ENTIRE FLOWSHEET

BLOCK STATUS
------------

****************************************************************************
*                                                                          *
* ALL UNIT OPERATION BLOCKS WERE COMPLETED NORMALLY                        *
*                                                                          *
* ALL CONVERGENCE BLOCKS WERE COMPLETED NORMALLY                           *
*                                                                          *
****************************************************************************
```

INPUT FILE(S)

```
>>ORIGINAL RUN                                 NOVEMBER 11, 1992
  7:40:55 P.M.                                 WEDNESDAY
  INPUT FILE: TOL2.inp
  OUTPUT PDF: TOL2      VERSION:  1
  LOCATED IN: G:\TOL2
;
;Input file created by ModelManager Rel. 3.3-3 on Wed Nov 11 19:40:23
;Directory G:\  Runid TOL2
;



TITLE "FLOWSHEET"

IN-UNITS SI PRESSURE=BAR TEMPERATURE=C DELTA-T=C

DEF-STREAMS MIXCISLD ALL

DATABANKS ASPENPCD / SOLIDS / BINARY

PROP-SOURCES ASPENPCD / SOLIDS / BINARY

COMPONENTS
    TOL C7H8 TOL /
    H2O H2O H2O /
    NACL NACL NACL /
    CH4 CH4 CH4 /
    CO2 CO2 CO2 /
    N2 N2 N2 /
    O2 O2 O2

HENRY-COMPS GASES CH4 CO2

FLOWSHEET
    BLOCK B1 IN=1 OUT=4
    BLOCK B2 IN=2 OUT=5
    BLOCK B3 IN=3 OUT=6
    BLOCK B5 IN=6 7 OUT=8
    BLOCK B4 IN=4 5 OUT=7
    BLOCK B13 IN=21 13 OUT=22 14
    BLOCK B14 IN=24 22 OUT=25
    BLOCK B15 IN=23 OUT=24
    BLOCK B11 IN=15 OUT=16
    BLOCK B6 IN=8 OUT=9 21
    BLOCK B8 IN=10 OUT=11
    BLOCK B9 IN=12 OUT=13
    BLOCK B10 IN=14 OUT=15 19
    BLOCK B12 IN=16 OUT=17 18
    BLOCK B7 IN=9 11 OUT=10 12

PROPERTIES SYSOP3 HENRY-COMPS=GASES
    PROPERTIES SYSOP10A / SYSOP15S

```

INPUT FILE(S) (CONTINUED)

```
PROP-REPLACE SYSOP15S SYSOP15S
    PROP VLMX VLMX01

PROP-REPLACE SYSOP3 SYSOP3
    PROP VLMX VLMX01
    PROP VL VL01

STREAM 1
    SUBSTREAM MIXED TEMP=21.11111 PRES=1.013530
    MASS-FLOW TOL 11.1342

STREAM 2
    SUBSTREAM MIXED TEMP=148.8889 PRES=206.8430
    MASS-FLOW H2O 135.091908 / CH4 0.686889 / CO2 0.07620354
    SUBSTREAM CISOLID TEMP=148.8889 PRES=206.8430
    MASS-FLOW NACL 21.7444626

STREAM 23
    SUBSTREAM MIXED TEMP=21.11111 PRES=1.013530
    MASS-FLOW H2O 86.977842

STREAM 3
    SUBSTREAM MIXED TEMP=21.11111 PRES=1.013530
    MASS-FLOW N2 135.933294 / O2 41.2980708

BLOCK B14 MIXER
    IN-UNITS SI

BLOCK B4 MIXER

BLOCK B6 SEP
    FRAC STREAM=9 SUBSTREAM=MIXED COMPS=H2O CO2 N2 O2  &
        FRACS=1 1 1 1
    FRAC STREAM=21 SUBSTREAM=CISOLID COMPS=NACL FRACS=1

BLOCK B11 HEATER
    PARAM TEMP=30.00000 PRES=1.013529

BLOCK B12 FLASH2
    PARAM PRES=1.013529 DUTY=0

BLOCK B13 HEATX
    PARAM DELT-HOT=10 <K>
    FEEDS HOT=21 COLD=13
    PRODUCTS HOT=22 COLD=14

BLOCK B7 HEATX
    PARAM T-HOT=1000 <F>
    FEEDS HOT=9 COLD=11
    PRODUCTS HOT=10 COLD=12

BLOCK B5 RSTOIC
    PARAM PRES=234.4220 DUTY=0.0
```

INPUT FILE(S) (CONTINUED)

```
        STOIC 1 MIXED TOL -1 / O2 -9 / CO2 7 / H2O 4
        STOIC 2 MIXED CH4 -1 / O2 -2 / CO2 1 / H2O 2
        CONV 1 MIXED TOL 1
        CONV 2 MIXED CH4 1

    BLOCK B1 PUMP
        PARAM PRES=234.4218 EFF=0.85

    BLOCK B15 PUMP
        PARAM PRES=234.4220 EFF=0.85

    BLOCK B2 PUMP
        PARAM PRES=234.4220 EFF=0.85
        PROPERTIES SYSOP10A HENRY-COMPS=GASES

    BLOCK B10 MCOMPR
        PARAM NSTAGE=5 TYPE=ISENTROPIC PRES=1.013529 COMPR-NPHASE=2
        FEEDS 14 1
        PRODUCTS 15 5 / 19 GLOBAL L
        COMPR-SPECS 1 SEFF=0.85 MEFF=1 / 2 SEFF=0.85 MEFF=1 / 3  &
            SEFF=0.85 MEFF=1 / 4 SEFF=0.85 MEFF=1 / 5 SEFF=0.85  &
            MEFF=1
        COOLER-SPECS 1 DUTY=0.0 / 2 DUTY=0.0 / 3 DUTY=0.0 / 4  &
            DUTY=0.0 / 5 DUTY=0.0

    BLOCK B3 MCOMPR
        PARAM NSTAGE=4 TYPE=ISENTROPIC PRES=234.4220 COMPR-NPHASE=2
        FEEDS 3 1
        PRODUCTS 6 4
        COMPR-SPECS 1 SEFF=0.85 MEFF=0.98 / 2 SEFF=0.85 MEFF=0.98  &
            / 3 SEFF=0.85 MEFF=0.98 / 4 SEFF=0.85 MEFF=0.98
        COOLER-SPECS 1 TEMP=48.88891 / 2 TEMP=48.88891 / 3  &
            TEMP=48.88891 / 4 DUTY=0.0

    BLOCK B8 MCOMPR
        PARAM NSTAGE=5 TYPE=ISENTROPIC PRES=39.36907 COMPR-NPHASE=2
        FEEDS 10 1
        PRODUCTS 11 5
        COMPR-SPECS 1 SEFF=0.85 MEFF=1 / 2 SEFF=0.85 MEFF=1 / 3  &
            SEFF=0.85 MEFF=1 / 4 SEFF=0.85 MEFF=1 / 5 SEFF=0.85  &
            MEFF=1
        COOLER-SPECS 1 DUTY=0.0 / 2 DUTY=0.0 / 3 DUTY=0.0 / 4  &
            DUTY=0.0 / 5 DUTY=0.0

    BLOCK B9 MCOMPR
        PARAM NSTAGE=5 TYPE=ISENTROPIC PRES=6.618967 COMPR-NPHASE=2
        FEEDS 12 1
        PRODUCTS 13 5
        COMPR-SPECS 1 SEFF=0.85 MEFF=1 / 2 SEFF=0.85 MEFF=1 / 3  &
            SEFF=0.85 MEFF=1 / 4 SEFF=0.85 MEFF=1 / 5 SEFF=0.85  &
            MEFF=1
        COOLER-SPECS 1 DUTY=0.0 / 2 DUTY=0.0 / 3 DUTY=0.0 / 4  &
            DUTY=0.0 / 5 DUTY=0.0
```

INPUT FILE(S) (CONTINUED)

```

CONVERGENCE $OLVER01 WEGSTEIN
    TEAR 11

REPORT INPUT NOFLOWSHEET NOPROPERTIES

BLOCK-REPORT NEWPAGE NOSORT INCL-BLOCKS=B1 B2 B3 B5 B6 B7 B8  &
        B9 B10 B11 B12 B13 B15

STREAM-REPOR NOSORT INCL-STREAMS=1 2 3 4 5 6 7 8 9 10 11  &
        12 13 14 15 16 17 18 19 21 22 23 24 25
;
;
;
;
;
```

SIMULATION STARTED MODULE USED: apmod CREATION: 02/14/92 11:21:55
LOCATED IN:d:\ap85b\xeq\apmod
SIMULATION COMPLETED FOR ENTIRE FLOWSHEET

BLOCK: B1 MODEL: PUMP

INLET STREAM:	1
OUTLET STREAM:	4
PROPERTY OPTION SET:	SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID:	GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	0.120839	0.120839	0.000000E+00
MASS(KG/SEC)	11.1342	11.1342	0.000000E+00
ENTHALPY(WATT)	0.140496E+07	0.175808E+07	-0.200858

*** INPUT DATA ***

OUTLET PRESSURE (BAR)	234.422
PUMP EFFICIENCY	0.85000
DRIVER EFFICIENCY	1.00000

FLASH SPECIFICATIONS:
LIQUID PHASE CALCULATION
NO FLASH PERFORMED

MAXIMUM NUMBER OF ITERATIONS	30
TOLERANCE	0.000100000

*** RESULTS ***

VOLUMETRIC FLOW RATE (CUM/SEC)	0.012860
PRESSURE CHANGE (BAR)	233.408
FLUID POWER (WATT)	300,156.
BRAKE POWER (WATT)	353,124.
ELECTRICITY (WATT)	353,124.
PUMP EFFICIENCY USED	0.85000
NET WORK (WATT)	-353,124.

```
BLOCK:  B2       MODEL: PUMP
----------------------------
  INLET STREAM:            2
  OUTLET STREAM:           5
  PROPERTY OPTION SET:     SYSOP10A  RENON (NRTL) / REDLICH-KWONG
  HENRY-COMPS ID:          GASES

                     ***  MASS AND ENERGY BALANCE  ***
                                   IN              OUT          RELATIVE DIFF.
   TOTAL BALANCE
      MOLE(KMOL/SEC)            7.91547         7.91547         0.000000E+00
      MASS(KG/SEC  )            157.599         157.599         0.000000E+00
      ENTHALPY(WATT    )      -0.222476E+10   -0.222424E+10   -0.231775E-03

                         ***  INPUT DATA  ***
   OUTLET PRESSURE (BAR      )                              234.422
   PUMP EFFICIENCY                                            0.85000
   DRIVER EFFICIENCY                                          1.00000

   FLASH SPECIFICATIONS:
   LIQUID PHASE CALCULATION
   NO FLASH PERFORMED
   MAXIMUM NUMBER OF ITERATIONS                               30
   TOLERANCE                                                  0.000100000

                          ***  RESULTS  ***
   VOLUMETRIC FLOW RATE (CUM/SEC )                            0.15892
   PRESSURE CHANGE (BAR      )                               27.5790
   FLUID POWER (WATT     )                              438,297.
   BRAKE POWER (WATT     )                              515,643.
   ELECTRICITY (WATT     )                              515,643.
   PUMP EFFICIENCY USED                                       0.85000
   NET WORK (WATT    )                                 -515,643.
```

BLOCK: B3 MODEL: MCOMPR

INLET STREAMS: 3 TO STAGE 1
OUTLET STREAMS: 6 FROM STAGE 4
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	6.14311	6.14311	0.000000E+00
MASS(KG/SEC)	177.231	177.231	0.000000E+00
ENTHALPY(WATT)	-739649.	0.368631E+08	-1.02006

*** INPUT DATA ***

ISENTROPIC CENTRIFUGAL COMPRESSOR

NUMBER OF STAGES	4
FINAL PRESSURE, BAR	234.422

COMPRESSOR SPECIFICATIONS PER STAGE

STAGE NUMBER	MECHANICAL EFFICIENCY	ISENTROPIC EFFICIENCY
1	0.9800	0.8500
2	0.9800	0.8500
3	0.9800	0.8500
4	0.9800	0.8500

COOLER SPECIFICATIONS PER STAGE

STAGE NUMBER	PRESSURE DROP BAR	TEMPERATURE C
1	0.0000E+00	48.89
2	0.0000E+00	48.89
3	0.0000E+00	48.89

*** RESULTS ***

FINAL PRESSURE, BAR	234.422
TOTAL WORK REQUIRED, WATT	0.131218+09

BLOCK: B3 MODEL: MCOMPR (CONTINUED)

*** PROFILE ***

COMPRESSOR PROFILE

STAGE NUMBER	OUTLET PRESSURE BAR	PRESSURE RATIO	OUTLET TEMPERATURE C
1	3.953	3.900	183.7
2	15.41	3.900	225.9
3	60.11	3.900	225.7
4	234.4	3.900	224.1

STAGE NUMBER	INDICATED HORSEPOWER WATT	BRAKE HORSEPOWER WATT
1	0.2940E+08	0.3000E+08
2	0.3226E+08	0.3291E+08
3	0.3264E+08	0.3331E+08
4	0.3429E+08	0.3499E+08

COOLER PROFILE

STAGE NUMBER	OUTLET TEMPERATURE C	OUTLET PRESSURE BAR	COOLING LOAD WATT	VAPOR FRACTION
1	48.89	3.953	-.2450E+08	1.000
2	48.89	15.41	-.3261E+08	1.000
3	48.89	60.11	-.3389E+08	1.000

FLOWSHEET
U-O-S BLOCK SECTION

BLOCK: B5 MODEL: RSTOIC

```
-----------------------------
  INLET STREAMS:          6           7
  OUTLET STREAM:          8
  PROPERTY OPTION SET:    SYSOP3    REDLICH-KWONG-SOAVE EQUATION OF STATE
  HENRY-COMPS ID:         GASES

                        ***  MASS AND ENERGY BALANCE  ***
                              IN            OUT        GENERATION   RELATIVE DIFF.
  TOTAL BALANCE
  MOLE(KMOL/SEC)          14.1794        14.3003       0.120839     -0.139746E-15
  MASS(KG/SEC  )          345.965        345.965                     0.822317E-06
  ENTHALPY(WATT     )   -0.218562E+10 -0.218562E+10                  0.112521E-05

                            ***  INPUT DATA  ***

  SIMULTANEOUS REACTIONS
  STOICHIOMETRY MATRIX:

   REACTION #    1:
    SUBSTREAM MIXED    :
    TOL        -1.00   H2O        4.00   CO2          7.00   O2          -9.00
    SUBSTREAM CISOLID :
    NO PARTICIPATING COMPONENTS

   REACTION #    2:
    SUBSTREAM MIXED    :
    H2O         2.00   CH4       -1.00   CO2          1.00   O2          -2.00
    SUBSTREAM CISOLID :
    NO PARTICIPATING COMPONENTS


  REACTION CONVERSION SPECS: NUMBER=     2
    REACTION #    1:
    SUBSTREAM:MIXED    KEY COMP:TOL      CONV FRAC:  1.000
    REACTION #    2:
    SUBSTREAM:MIXED    KEY COMP:CH4      CONV FRAC:  1.000


  TWO    PHASE  PQ  FLASH
  SPECIFIED PRESSURE    BAR                              234.422
  SPECIFIED HEAT DUTY   WATT                               0.0
  MAXIMUM NO. ITERATIONS                                  30
  CONVERGENCE TOLERANCE                                    0.000100000
```

BLOCK: B5 MODEL: RSTOIC (CONTINUED)

*** RESULTS ***

OUTLET TEMPERATURE	C	593.11
OUTLET PRESSURE	BAR	234.42
VAPOR FRACTION		1.0000

V-L PHASE EQUILIBRIUM :

COMP	F(I)	X(I)	Y(I)	K(I)
H2O	0.57925	0.98882	0.57925	2.5533
CO2	0.63929E-01	0.49054E-02	0.63929E-01	3.6210
N2	0.34839	0.59754E-02	0.34839	4.0210
O2	0.84308E-02	0.29555E-03	0.84308E-02	3.7604

BLOCK: B6 MODEL: SEP

INLET STREAM: 8
OUTLET STREAMS: 9 21
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

TOTAL BALANCE	IN	OUT	RELATIVE DIFF.
MOLE(KMOL/SEC)	14.3003	14.3003	0.000000E+00
MASS(KG/SEC)	345.965	345.965	0.000000E+00
ENTHALPY(WATT)	-0.218562E+10	-0.218562E+10	0.000000E+00

*** INPUT DATA ***

FLASH SPECS FOR STREAM 9
TWO PHASE TP FLASH

PRESSURE DROP	BAR	0.0
MAXIMUM NO. ITERATIONS		30
CONVERGENCE TOLERANCE		0.000100000

FLASH SPECS FOR STREAM 21
TWO PHASE TP FLASH

PRESSURE DROP	BAR	0.0
MAXIMUM NO. ITERATIONS		30
CONVERGENCE TOLERANCE		0.000100000

FRACTION OF FEED

SUBSTREAM= MIXED			
STREAM= 9	CPT= H2O	FRACTION=	1.00000
	CO2		1.00000
	N2		1.00000
	O2		1.00000
SUBSTREAM= CISOLID			
STREAM= 21	CPT= NACL	FRACTION=	1.00000

*** RESULTS ***

COMPONENT = H2O

STREAM	SUBSTREAM	SPLIT FRACTION
9	MIXED	1.00000

BLOCK: B6 MODEL: SEP (CONTINUED)

COMPONENT = NACL

STREAM	SUBSTREAM	SPLIT FRACTION
21	CISOLID	1.00000

COMPONENT = CO2

STREAM	SUBSTREAM	SPLIT FRACTION
9	MIXED	1.00000

COMPONENT = N2

STREAM	SUBSTREAM	SPLIT FRACTION
9	MIXED	1.00000

COMPONENT = O2

STREAM	SUBSTREAM	SPLIT FRACTION
9	MIXED	1.00000

FLOWSHEET
U-O-S BLOCK SECTION

BLOCK: B7 MODEL: HEATX

HOT SIDE:

INLET STREAM: 9
OUTLET STREAM: 10
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

COLD SIDE:

INLET STREAM: 11
OUTLET STREAM: 12
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	27.8564	27.8564	0.000000E+00
MASS(KG/SEC)	648.441	648.441	0.000000E+00
ENTHALPY(WATT)	-0.423717E+10	-0.423716E+10	-0.439029E-06

*** INPUT DATA ***

FLASH SPECS FOR HOT SIDE:
TWO PHASE FLASH
MAXIMUM NO. ITERATIONS 30
CONVERGENCE TOLERANCE 0.000100000

FLASH SPECS FOR COLD SIDE:
TWO PHASE FLASH
MAXIMUM NO. ITERATIONS 30
CONVERGENCE TOLERANCE 0.000100000

BLOCK: B7   MODEL: HEATX (CONTINUED)

COUNTERCURRENT HEAT EXCHANGER WITH SPECIFIED HOT OUTLET TEMPERATURE	
HOT STREAM OUTLET TEMPERATURE (C)	537.778
HOT STREAM PRESSURE DROP (BAR)	0.0
COLD STREAM PRESSURE DROP (BAR)	0.0

HEAT TRANSFER COEFFICIENTS (WATT/SQM-K):

HOT STREAM PHASE	COLD STREAM PHASE	
LIQUID	LIQUID	850.000
BOILING LIQUID	LIQUID	850.000
VAPOR	LIQUID	850.000
LIQUID	BOILING LIQUID	850.000
BOILING LIQUID	BOILING LIQUID	850.000
VAPOR	BOILING LIQUID	850.000
LIQUID	VAPOR	850.000
BOILING LIQUID	VAPOR	850.000
VAPOR	VAPOR	850.000

*** RESULTS ***

HOT STREAM INLET TEMPERATURE (C)	593.113
HOT STREAM OUTLET TEMPERATURE (C)	537.778
COLD STREAM INLET TEMPERATURE (C)	283.139
COLD STREAM OUTLET TEMPERATURE (C)	346.427
EXCHANGER HEAT DUTY (WATT)	0.326156+08
HEAT TRANSFER AREA (SQM)	153.092

AREA CALCULATION RESULTS:

SECTION	CONDITIONS (HOT-COLD)	AREA (SQM)	HEAT DUTY (WATT)
1	V-V	153.092	0.326156+08

SECTION	TEMPERATURE LEAVING SECTION HOT STREAM (C)	COLD STREAM (C)
1	537.778	346.427

```
          ------------------------------------------------------------
         |                                                            |
 9       |      VAP                                                   |  10
------>  |                                                            |  ------>
 593.1   |                                                            |  537.8
         |                                                            |
 12      |      VAP                                                   |  11
<------  |                                                            |  <------
 346.4   |                                                            |  283.1
         |                                                            |
          ------------------------------------------------------------
```

BLOCK: B8 MODEL: MCOMPR

INLET STREAMS: 10 TO STAGE 1
OUTLET STREAMS: 11 FROM STAGE 5
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	13.9282	13.9282	0.000000E+00
MASS(KG/SEC)	324.220	324.220	0.000000E+00
ENTHALPY(WATT)	-0.207698E+10	-0.219280E+10	0.528206E-01

*** INPUT DATA ***

ISENTROPIC CENTRIFUGAL COMPRESSOR
NUMBER OF STAGES 5
FINAL PRESSURE, BAR 39.3691

COMPRESSOR SPECIFICATIONS PER STAGE

STAGE NUMBER	MECHANICAL EFFICIENCY	ISENTROPIC EFFICIENCY
1	1.000	0.8500
2	1.000	0.8500
3	1.000	0.8500
4	1.000	0.8500
5	1.000	0.8500

*** RESULTS ***

FINAL PRESSURE, BAR 39.3691
TOTAL WORK REQUIRED, WATT -0.115837+09

*** PROFILE ***

COMPRESSOR PROFILE

STAGE NUMBER	OUTLET PRESSURE BAR	PRESSURE RATIO	OUTLET TEMPERATURE C
1	164.1	0.6999	480.4
2	114.8	0.6999	426.2
3	80.37	0.6999	375.1
4	56.25	0.6999	327.6
5	39.37	0.6999	283.1

BLOCK: B8 MODEL: MCOMPR (CONTINUED)

STAGE NUMBER	INDICATED HORSEPOWER WATT	BRAKE HORSEPOWER WATT
1	-.2726E+08	-.2726E+08
2	-.2495E+08	-.2495E+08
3	-.2293E+08	-.2293E+08
4	-.2115E+08	-.2115E+08
5	-.1955E+08	-.1955E+08

BLOCK: B9 MODEL: MCOMPR

INLET STREAMS: 12 TO STAGE 1
OUTLET STREAMS: 13 FROM STAGE 5
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	13.9282	13.9282	0.000000E+00
MASS(KG/SEC)	324.220	324.220	0.000000E+00
ENTHALPY(WATT)	-0.216019E+10	-0.224854E+10	0.392920E-01

*** INPUT DATA ***

ISENTROPIC CENTRIFUGAL COMPRESSOR	
NUMBER OF STAGES	5
FINAL PRESSURE, BAR	6.61897

COMPRESSOR SPECIFICATIONS PER STAGE

STAGE NUMBER	MECHANICAL EFFICIENCY	ISENTROPIC EFFICIENCY
1	1.000	0.8500
2	1.000	0.8500
3	1.000	0.8500
4	1.000	0.8500
5	1.000	0.8500

*** RESULTS ***

FINAL PRESSURE, BAR	6.61897
TOTAL WORK REQUIRED, WATT	-0.883177+08

*** PROFILE ***

COMPRESSOR PROFILE

STAGE NUMBER	OUTLET PRESSURE BAR	PRESSURE RATIO	OUTLET TEMPERATURE C
1	27.56	0.7000	301.7
2	19.29	0.7000	259.9
3	13.51	0.7000	220.8
4	9.455	0.7000	184.4
5	6.619	0.7000	150.4

BLOCK: B9 MODEL: MCOMPR (CONTINUED)

STAGE NUMBER	INDICATED HORSEPOWER WATT	BRAKE HORSEPOWER WATT
1	-.2043E+08	-.2043E+08
2	-.1894E+08	-.1894E+08
3	-.1756E+08	-.1756E+08
4	-.1629E+08	-.1629E+08
5	-.1510E+08	-.1510E+08

BLOCK: B10 MODEL: MCOMPR

INLET STREAMS: 14 TO STAGE 1
OUTLET STREAMS: 15 FROM STAGE 5
19 GLOBAL OUTLET
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	13.9282	13.9282	0.000000E+00
MASS(KG/SEC)	324.220	324.220	-0.350647E-15
ENTHALPY(WATT)	-0.223939E+10	-0.230907E+10	0.301781E-01

*** INPUT DATA ***

ISENTROPIC CENTRIFUGAL COMPRESSOR

NUMBER OF STAGES	5
FINAL PRESSURE, BAR	1.01353

COMPRESSOR SPECIFICATIONS PER STAGE

STAGE NUMBER	MECHANICAL EFFICIENCY	ISENTROPIC EFFICIENCY
1	1.000	0.8500
2	1.000	0.8500
3	1.000	0.8500
4	1.000	0.8500
5	1.000	0.8500

*** RESULTS ***

FINAL PRESSURE, BAR	1.01353
TOTAL WORK REQUIRED, WATT	-0.696684+08

*** PROFILE ***

COMPRESSOR PROFILE

STAGE NUMBER	OUTLET PRESSURE BAR	PRESSURE RATIO	OUTLET TEMPERATURE C
1	4.548	0.6871	135.3
2	3.125	0.6871	118.5
3	2.147	0.6871	107.4
4	1.475	0.6871	96.93
5	1.014	0.6871	87.14

BLOCK: B10 MODEL: MCOMPR (CONTINUED)

STAGE NUMBER	INDICATED HORSEPOWER WATT	BRAKE HORSEPOWER WATT
1	-.1540E+08	-.1540E+08
2	-.1444E+08	-.1444E+08
3	-.1383E+08	-.1383E+08
4	-.1326E+08	-.1326E+08
5	-.1273E+08	-.1273E+08

BLOCK: B11 MODEL: HEATER

INLET STREAM: 15
OUTLET STREAM: 16
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	13.3323	13.3323	0.000000E+00
MASS(KG/SEC)	313.485	313.485	0.000000E+00
ENTHALPY(WATT)	-0.214110E+10	-0.249702E+10	0.142540

*** INPUT DATA ***

TWO PHASE TP FLASH		
SPECIFIED TEMPERATURE	C	30.0000
SPECIFIED PRESSURE	BAR	1.01353
MAXIMUM NO. ITERATIONS		30
CONVERGENCE TOLERANCE		0.000100000

*** RESULTS ***

OUTLET TEMPERATURE	C	30.000
OUTLET PRESSURE	BAR	1.0135
HEAT DUTY	WATT	-0.35593E+09
VAPOR FRACTION		0.45406

V-L PHASE EQUILIBRIUM :

COMP	F(I)	X(I)	Y(I)	K(I)
H2O	0.56044	0.99999	0.31949E-01	0.31950E-01
CO2	0.66786E-01	0.96621E-05	0.14707	15222.
N2	0.36397	0.39158E-07	0.80158	0.20471E+08
O2	0.88076E-02	0.28292E-07	0.19397E-01	0.68561E+06

BLOCK: B12 MODEL: FLASH2

INLET STREAM: 16
OUTLET VAPOR STREAM: 17
OUTLET LIQUID STREAM: 18
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	13.3323	13.3323	0.133237E-15
MASS(KG/SEC)	313.485	313.485	0.000000E+00
ENTHALPY(WATT)	-0.249702E+10	-0.249702E+10	-0.756587E-06

*** INPUT DATA ***

TWO PHASE PQ FLASH		
SPECIFIED PRESSURE	BAR	1.01353
SPECIFIED HEAT DUTY	WATT	0.0
MAXIMUM NO. ITERATIONS		30
CONVERGENCE TOLERANCE		0.000100000

*** RESULTS ***

OUTLET TEMPERATURE	C	30.001
OUTLET PRESSURE	BAR	1.0135
VAPOR FRACTION		0.45406

V-L PHASE EQUILIBRIUM :

COMP	F(I)	X(I)	Y(I)	K(I)
H2O	0.56044	0.99999	0.31952E-01	0.31952E-01
CO2	0.66786E-01	0.96609E-05	0.14707	15222.
N2	0.36397	0.39153E-07	0.80158	0.20469E+08
O2	0.88076E-02	0.28289E-07	0.19397E-01	0.68559E+06

BLOCK: B13 MODEL: HEATX

HOT SIDE:

INLET STREAM:	21	
OUTLET STREAM:	22	
PROPERTY OPTION SET:	SYSOP3	REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID:	GASES	

COLD SIDE:

INLET STREAM:	13	
OUTLET STREAM:	14	
PROPERTY OPTION SET:	SYSOP3	REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID:	GASES	

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	14.3003	14.3003	0.000000E+00
MASS(KG/SEC)	345.965	345.965	0.000000E+00
ENTHALPY(WATT)	-0.238979E+10	-0.238979E+10	0.111701E-08

*** INPUT DATA ***

FLASH SPECS FOR HOT SIDE:

TWO PHASE FLASH	
MAXIMUM NO. ITERATIONS	30
CONVERGENCE TOLERANCE	0.000100000

FLASH SPECS FOR COLD SIDE:

TWO PHASE FLASH	
MAXIMUM NO. ITERATIONS	30
CONVERGENCE TOLERANCE	0.000100000

BLOCK: B13 MODEL: HEATX (CONTINUED)

```
   COUNTERCURRENT  HEAT EXCHANGER WITH SPECIFIED HOT OUTLET TEMP APPROACH
   TEMP APPROACH AT HOT STREAM OUTLET (C    )                      10.0000
   HOT STREAM PRESSURE DROP (BAR      )                              0.0
   COLD STREAM PRESSURE DROP (BAR      )                             0.0

   HEAT TRANSFER COEFFICIENTS  (WATT/SQM-K       ):
   HOT STREAM PHASE      COLD STREAM PHASE
   LIQUID                LIQUID                                   850.000
   BOILING LIQUID        LIQUID                                   850.000
   VAPOR                 LIQUID                                   850.000
   LIQUID                BOILING LIQUID                           850.000
   BOILING LIQUID        BOILING LIQUID                           850.000
   VAPOR                 BOILING LIQUID                           850.000
   LIQUID                VAPOR                                    850.000
   BOILING LIQUID        VAPOR                                    850.000
   VAPOR                 VAPOR                                    850.000

                           ***  RESULTS  ***
   HOT STREAM INLET TEMPERATURE (C    )                           593.113
   HOT STREAM OUTLET TEMPERATURE (C    )                          160.399
   COLD STREAM INLET TEMPERATURE (C    )                          150.399
   COLD STREAM OUTLET TEMPERATURE (C    )                         169.706
   EXCHANGER HEAT DUTY (WATT     )                          9,149,820.
   HEAT TRANSFER AREA (SQM      )                                  97.5337


   AREA CALCULATION RESULTS:

   SECTION  CONDITIONS    AREA                HEAT DUTY
            (HOT-COLD)    (SQM      )          (WATT     )
      1        V-V         97.5337         9,149,820.

   SECTION   TEMPERATURE LEAVING SECTION
             HOT STREAM                CLEAR
             (C        )               (C        )
      1         160.399                   169.706
```

```
            ------------------------------------------------------------
           |                                                            |
 21        |      VAP                                                   |  22
 ------>   |                                                            |  ------>
  593.1    |                                                            |  160.4
           |                                                            |
 14        |      VAP                                                   |  13
 <------   |                                                            |  <------
  169.7    |                                                            |  150.4
           |                                                            |
            ------------------------------------------------------------
```

BLOCK: B15 MODEL: PUMP

INLET STREAM:	23
OUTLET STREAM:	24
PROPERTY OPTION SET:	SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID:	GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	4.82808	4.82808	0.000000E+00
MASS(KG/SEC)	86.9778	86.9778	0.000000E+00
ENTHALPY(WATT)	-0.139702E+10	-0.139463E+10	-0.171520E-02

*** INPUT DATA ***

OUTLET PRESSURE (BAR)	234.422
PUMP EFFICIENCY	0.85000
DRIVER EFFICIENCY	1.00000
FLASH SPECIFICATIONS:	
LIQUID PHASE CALCULATION	
NO FLASH PERFORMED	
MAXIMUM NUMBER OF ITERATIONS	30
TOLERANCE	0.000100000

*** RESULTS ***

VOLUMETRIC FLOW RATE (CUM/SEC)	0.087261
PRESSURE CHANGE (BAR)	233.408
FLUID POWER (WATT)	2,036,750.
BRAKE POWER (WATT)	2,396,180.
ELECTRICITY (WATT)	2,396,180.
PUMP EFFICIENCY USED	0.85000
NET WORK (WATT)	-2,396,180.

FLOWSHEET
STREAM SECTION

1 2 3 4 5

STREAM ID	1	2	3	4	5
FROM :	----	----	----	B1	B2
TO :	B1	B2	B3	B4	B4
CLASS:	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD
TOTAL STREAM:					
KG/SEC	11.1342	157.5994	177.2313	11.1342	157.5994
WATT	1.4050+06	-2.2248+09	-7.3965+05	1.7581+06	-2.2242+09
SUBSTREAM: MIXED					
PHASE:	LIQUID	MIXED	VAPOR	LIQUID	LIQUID
COMPONENTS: KMOL/SEC					
TOL	0.1208	0.0	0.0	0.1208	0.0
H2O	0.0	7.4988	0.0	0.0	7.4988
NACL	0.0	0.0	0.0	0.0	0.0
CH4	0.0	4.2815-02	0.0	0.0	4.2815-02
CO2	0.0	1.7315-03	0.0	0.0	1.7315-03
N2	0.0	0.0	4.8525	0.0	0.0
O2	0.0	0.0	1.2906	0.0	0.0
TOTAL FLOW:					
KMOL/SEC	0.1208	7.5434	6.1431	0.1208	7.5434
KG/SEC	11.1342	135.8550	177.2313	11.1342	135.8550
CUM/SEC	1.2860-02	0.1622	148.2858	1.2932-02	0.1590
STATE VARIABLES:					
TEMP C	21.1111	148.8889	21.1111	26.4340	149.6357
PRES BAR	1.0135	206.8430	1.0135	234.4218	234.4220
VFRAC	0.0	4.0544-03	1.0000	0.0	0.0
LFRAC	1.0000	0.9959	0.0	1.0000	1.0000
SFRAC	0.0	0.0	0.0	0.0	0.0
ENTHALPY:					
J/KMOL	1.1627+07	-2.7496+08	-1.2040+05	1.4549+07	-2.7489+08
J/KG	1.2618+05	-1.5267+07	-4173.3528	1.5790+05	-1.5263+07
WATT	1.4050+06	-2.0741+09	-7.3965+05	1.7581+06	-2.0736+09
ENTROPY:					
J/KMOL-K	-3.4337+05	-1.3654+05	3865.4994	-3.4288+05	-1.3654+05
J/KG-K	-3726.5845	-7581.3082	133.9841	-3721.2527	-7581.4503
DENSITY:					
KMOL/CUM	9.3967	46.5064	4.1428-02	9.3440	47.4318
KG/CUM	865.8220	837.5712	1.1952	860.9739	854.2366
AVG MW	92.1410	18.0097	28.8504	92.1410	18.0097
SUBSTREAM: CISOLID	STRUCTURE: CONVENTIONAL				
COMPONENTS: KMOL/SEC					
TOL	0.0	0.0	0.0	0.0	0.0
H2O	0.0	0.0	0.0	0.0	0.0
NACL	0.0	0.3720	0.0	0.0	0.3720
CH4	0.0	0.0	0.0	0.0	0.0
CO2	0.0	0.0	0.0	0.0	0.0
N2	0.0	0.0	0.0	0.0	0.0
O2	0.0	0.0	0.0	0.0	0.0
TOTAL FLOW:					
KMOL/SEC	0.0	0.3720	0.0	0.0	0.3720
KG/SEC	0.0	21.7444	0.0	0.0	21.7444
CUM/SEC	0.0	1.0051-02	0.0	0.0	1.0051-02

FLOWSHEET
STREAM SECTION

1 2 3 4 5 (CONTINUED)

STREAM ID	1	2	3	4	5
STATE VARIABLES:					
TEMP C	MISSING	148.8889	MISSING	MISSING	149.6357
PRES BAR	1.0135	206.8430	1.0135	234.4218	234.4220
VFRAC	MISSING	0.0	MISSING	MISSING	0.0
LFRAC	MISSING	0.0	MISSING	MISSING	0.0
SFRAC	MISSING	1.0000	MISSING	MISSING	1.0000
ENTHALPY:					
J/KMOL	MISSING	-4.0486+08	MISSING	MISSING	-4.0483+08
J/KG	MISSING	-6.9275+06	MISSING	MISSING	-6.9268+06
WATT	MISSING	-1.5063+08	MISSING	MISSING	-1.5062+08
ENTROPY:					
J/KMOL-K	MISSING	-7.2803+04	MISSING	MISSING	-7.2709+04
J/KG-K	MISSING	-1245.7035	MISSING	MISSING	-1244.1078
DENSITY:					
KMOL/CUM	MISSING	37.0164	MISSING	MISSING	37.0164
KG/CUM	MISSING	2163.3536	MISSING	MISSING	2163.3536
AVG MW	MISSING	58.4430	MISSING	MISSING	58.4430

FLOWSHEET
STREAM SECTION

6 7 8 9 10

STREAM ID	6	7	8	9	10
FROM :	B3	B4	B5	B6	B7
TO :	B5	B5	B6	B7	B8
CLASS:	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD
TOTAL STREAM:					
KG/SEC	177.2313	168.7336	345.9647	324.2202	324.2202
WATT	3.6863+07	-2.2225+09	-2.1856+09	-2.0444+09	-2.0770+09
SUBSTREAM: MIXED					
PHASE:	VAPOR	MIXED	VAPOR	VAPOR	VAPOR
COMPONENTS: KMOL/SEC					
TOL	0.0	0.1208	0.0	0.0	0.0
H2O	0.0	7.4988	8.0678	8.0678	8.0678
NACL	0.0	0.0	0.0	0.0	0.0
CH4	0.0	4.2815-02	0.0	0.0	0.0
CO2	0.0	1.7315-03	0.8904	0.8904	0.8904
N2	4.8525	0.0	4.8525	4.8525	4.8525
O2	1.2906	0.0	0.1174	0.1174	0.1174
TOTAL FLOW:					
KMOL/SEC	6.1431	7.6642	13.9281	13.9281	13.9281
KG/SEC	177.2313	146.9892	324.2202	324.2202	324.2202
CUM/SEC	1.2201	0.2214	4.3609	4.3609	4.0392
STATE VARIABLES:					
TEMP C	224.0843	156.6696	593.1128	593.1128	537.7777
PRES BAR	234.4220	234.4218	234.4220	234.4220	234.4220
VFRAC	1.0000	1.3440-02	1.0000	1.0000	1.0000
LFRAC	0.0	0.9865	0.0	0.0	0.0
SFRAC	0.0	0.0	0.0	0.0	0.0
ENTHALPY:					
J/KMOL	6.0007+06	-2.7035+08	-1.4678+08	-1.4678+08	-1.4912+08
J/KG	2.0799+05	-1.4096+07	-6.3055+06	-6.3055+06	-6.4061+06
WATT	3.6863+07	-2.0720+09	-2.0444+09	-2.0444+09	-2.0770+09
ENTROPY:					
J/KMOL-K	-2.6674+04	-1.3981+05	-2.8206+04	-2.8206+04	-3.1000+04
J/KG-K	-924.5734	-7290.0712	-1211.7032	-1211.7032	-1331.7104
DENSITY:					
KMOL/CUM	5.0345	34.6033	3.1938	3.1938	3.4482
KG/CUM	145.2499	663.6425	74.3455	74.3455	80.2679
AVG MW	28.8504	19.1785	23.2779	23.2779	23.2779
SUBSTREAM: CISOLID	STRUCTURE: CONVENTIONAL				
COMPONENTS: KMOL/SEC					
TOL	0.0	0.0	0.0	0.0	0.0
H2O	0.0	0.0	0.0	0.0	0.0
NACL	0.0	0.3720	0.3720	0.0	0.0
CH4	0.0	0.0	0.0	0.0	0.0
CO2	0.0	0.0	0.0	0.0	0.0
N2	0.0	0.0	0.0	0.0	0.0
O2	0.0	0.0	0.0	0.0	0.0
TOTAL FLOW:					
KMOL/SEC	0.0	0.3720	0.3720	0.0	0.0
KG/SEC	0.0	21.7444	21.7444	0.0	0.0
CUM/SEC	0.0	1.0051-02	1.0051-02	0.0	0.0

6 7 8 9 10 (CONTINUED)

STREAM ID	6	7	8	9	10
STATE VARIABLES:					
TEMP C	MISSING	156.6696	593.1128	MISSING	MISSING
PRES BAR	234.4220	234.4218	234.4220	234.4220	234.4220
VFRAC	MISSING	0.0	0.0	MISSING	MISSING
LFRAC	MISSING	0.0	0.0	MISSING	MISSING
SFRAC	MISSING	1.0000	1.0000	MISSING	MISSING
ENTHALPY:					
J/KMOL	MISSING	-4.0445+08	-3.7966+08	MISSING	MISSING
J/KG	MISSING	-6.9205+06	-6.4963+06	MISSING	MISSING
WATT	MISSING	-1.5048+08	-1.4126+08	MISSING	MISSING
ENTROPY:					
J/KMOL-K	MISSING	-7.1838+04	-3.2350+04	MISSING	MISSING
J/KG-K	MISSING	-1229.1970	-553.5393	MISSING	MISSING
DENSITY:					
KMOL/CUM	MISSING	37.0164	37.0164	MISSING	MISSING
KG/CUM	MISSING	2163.3536	2163.3536	MISSING	MISSING
AVG MW	MISSING	58.4430	58.4430	MISSING	MISSING

FLOWSHEET
STREAM SECTION

11 12 13 14 15

STREAM ID	11	12	13	14	15
FROM :	B8	B7	B9	B13	B10
TO :	B7	B9	B13	B10	B11
CLASS:	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD
TOTAL STREAM:					
KG/SEC	324.2202	324.2202	324.2202	324.2202	313.4848
WATT	-2.1928+09	-2.1602+09	-2.2485+09	-2.2394+09	-2.1411+09
SUBSTREAM: MIXED					
PHASE:	VAPOR	VAPOR	VAPOR	VAPOR	MIXED
COMPONENTS: KMOL/SEC					
TOL	0.0	0.0	0.0	0.0	0.0
H2O	8.0678	8.0678	8.0678	8.0678	7.4719
NACL	0.0	0.0	0.0	0.0	0.0
CH4	0.0	0.0	0.0	0.0	0.0
CO2	0.8904	0.8904	0.8904	0.8904	0.8904
N2	4.8525	4.8525	4.8525	4.8525	4.8525
O2	0.1174	0.1174	0.1174	0.1174	0.1174
TOTAL FLOW:					
KMOL/SEC	13.9281	13.9281	13.9281	13.9281	13.3322
KG/SEC	324.2202	324.2202	324.2202	324.2202	313.4848
CUM/SEC	15.8478	17.8916	72.9483	76.4502	386.7169
STATE VARIABLES:					
TEMP C	283.1392	346.4270	150.3994	169.7060	87.1351
PRES BAR	39.3690	39.3690	6.6189	6.6189	1.0135
VFRAC	1.0000	1.0000	1.0000	1.0000	0.9851
LFRAC	0.0	0.0	0.0	0.0	1.4879-02
SFRAC	0.0	0.0	0.0	0.0	0.0
ENTHALPY:					
J/KMOL	-1.5744+08	-1.5509+08	-1.6144+08	-1.6078+08	-1.6059+08
J/KG	-6.7633+06	-6.6627+06	-6.9352+06	-6.9070+06	-6.8300+06
WATT	-2.1928+09	-2.1602+09	-2.2485+09	-2.2394+09	-2.1411+09
ENTROPY:					
J/KMOL-K	-2.8735+04	-2.4748+04	-2.2486+04	-2.0969+04	-1.2805+04
J/KG-K	-1234.4393	-1063.1592	-965.9587	-900.8035	-544.5786
DENSITY:					
KMOL/CUM	0.8788	0.7784	0.1909	0.1821	3.4476-02
KG/CUM	20.4583	18.1212	4.4445	4.2409	0.8106
AVG MW	23.2779	23.2779	23.2779	23.2779	23.5132

FLOWSHEET
STREAM SECTION

16 17 18 19 21

STREAM ID	16	17	18	19	21
FROM :	B11	B12	B12	B10	B6
TO :	B12	----	----	----	B13
CLASS:	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD
TOTAL STREAM:					
KG/SEC	313.4848	182.3591	131.1256	10.7354	21.7444
WATT	-2.4970+09	-3.9654+08	-2.1005+09	-1.6797+08	-1.4126+08
SUBSTREAM: MIXED					
PHASE:	MIXED	VAPOR	LIQUID	LIQUID	MIXED
COMPONENTS: KMOL/SEC					
TOL	0.0	0.0	0.0	0.0	0.0
H2O	7.4719	0.1934	7.2785	0.5958	0.0
NACL	0.0	0.0	0.0	0.0	0.0
CH4	0.0	0.0	0.0	0.0	0.0
CO2	0.8904	0.8903	7.0318-05	8.8519-06	0.0
N2	4.8525	4.8525	2.8498-07	3.6603-07	0.0
O2	0.1174	0.1174	2.0590-07	8.7245-08	0.0
TOTAL FLOW:					
KMOL/SEC	13.3322	6.0537	7.2785	0.5959	0.0
KG/SEC	313.4848	182.3591	131.1256	10.7354	0.0
CUM/SEC	150.5977	150.4661	0.1326	1.1796-02	0.0
STATE VARIABLES:					
TEMP C	30.0000	30.0013	30.0013	106.9295	MISSING
PRES BAR	1.0135	1.0135	1.0135	6.6189	234.4220
VFRAC	0.4540	1.0000	0.0	0.0	MISSING
LFRAC	0.5459	0.0	1.0000	1.0000	MISSING
SFRAC	0.0	0.0	0.0	0.0	MISSING
ENTHALPY:					
J/KMOL	-1.8729+08	-6.5503+07	-2.8858+08	-2.8188+08	MISSING
J/KG	-7.9654+06	-2.1745+06	-1.6019+07	-1.5647+07	MISSING
WATT	-2.4970+09	-3.9654+08	-2.1005+09	-1.6797+08	MISSING
ENTROPY:					
J/KMOL-K	-9.0248+04	4858.6830	-1.6935+05	-1.4968+05	MISSING
J/KG-K	-3838.1650	161.2916	-9400.2445	-8308.6894	MISSING
DENSITY:					
KMOL/CUM	8.8529-02	4.0233-02	54.8528	50.5177	MISSING
KG/CUM	2.0816	1.2119	988.1876	910.0977	MISSING
AVG MW	23.5132	30.1236	18.0152	18.0153	MISSING
SUBSTREAM: CISOLID	STRUCTURE: CONVENTIONAL				
COMPONENTS: KMOL/SEC					
TOL	0.0	0.0	0.0	0.0	0.0
H2O	0.0	0.0	0.0	0.0	0.0
NACL	0.0	0.0	0.0	0.0	0.3720
CH4	0.0	0.0	0.0	0.0	0.0
CO2	0.0	0.0	0.0	0.0	0.0
N2	0.0	0.0	0.0	0.0	0.0
O2	0.0	0.0	0.0	0.0	0.0
TOTAL FLOW:					
KMOL/SEC	0.0	0.0	0.0	0.0	0.3720
KG/SEC	0.0	0.0	0.0	0.0	21.7444
CUM/SEC	0.0	0.0	0.0	0.0	1.0051-02

16 17 18 19 21 (CONTINUED)

STREAM ID	16	17	18	19	21
STATE VARIABLES:					
TEMP C	MISSING	MISSING	MISSING	MISSING	593.1128
PRES BAR	1.0135	1.0135	1.0135	6.6189	234.4220
VFRAC	MISSING	MISSING	MISSING	MISSING	0.0
LFRAC	MISSING	MISSING	MISSING	MISSING	0.0
SFRAC	MISSING	MISSING	MISSING	MISSING	1.0000
ENTHALPY:					
J/KMOL	MISSING	MISSING	MISSING	MISSING	-3.7966+08
J/KG	MISSING	MISSING	MISSING	MISSING	-6.4963+06
WATT	MISSING	MISSING	MISSING	MISSING	-1.4126+08
ENTROPY:					
J/KMOL-K	MISSING	MISSING	MISSING	MISSING	-3.2350+04
J/KG-K	MISSING	MISSING	MISSING	MISSING	-553.5393
DENSITY:					
KMOL/CUM	MISSING	MISSING	MISSING	MISSING	37.0164
KG/CUM	MISSING	MISSING	MISSING	MISSING	2163.3536
AVG MW	MISSING	MISSING	MISSING	MISSING	58.4430

FLOWSHEET
STREAM SECTION

22 23 24 25

STREAM ID	22	23	24	25
FROM :	B13	----	B15	B14
TO :	B14	B15	B14	----
CLASS:	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD
TOTAL STREAM:				
KG/SEC	21.7444	86.9778	86.9778	108.7223
WATT	-1.5041+08	-1.3970+09	-1.3946+09	-1.5450+09
SUBSTREAM: MIXED				
PHASE:	MIXED	LIQUID	LIQUID	LIQUID
COMPONENTS: KMOL/SEC				
TOL	0.0	0.0	0.0	0.0
H2O	0.0	4.8280	4.8280	4.8280
NACL	0.0	0.0	0.0	0.0
CH4	0.0	0.0	0.0	0.0
CO2	0.0	0.0	0.0	0.0
N2	0.0	0.0	0.0	0.0
O2	0.0	0.0	0.0	0.0
TOTAL FLOW:				
KMOL/SEC	0.0	4.8280	4.8280	4.8280
KG/SEC	0.0	86.9778	86.9778	86.9778
CUM/SEC	0.0	8.7261-02	8.7311-02	8.7832-02
STATE VARIABLES:				
TEMP C	MISSING	21.1111	21.7079	27.8369
PRES BAR	234.4220	1.0135	234.4220	234.4220
VFRAC	MISSING	0.0	0.0	0.0
LFRAC	MISSING	1.0000	1.0000	1.0000
SFRAC	MISSING	0.0	0.0	0.0
ENTHALPY:				
J/KMOL	MISSING	-2.8935+08	-2.8886+08	-2.8833+08
J/KG	MISSING	-1.6062+07	-1.6034+07	-1.6005+07
WATT	MISSING	-1.3970+09	-1.3946+09	-1.3921+09
ENTROPY:				
J/KMOL-K	MISSING	-1.7193+05	-1.7213+05	-1.7036+05
J/KG-K	MISSING	-9543.8898	-9554.8915	-9456.3724
DENSITY:				
KMOL/CUM	MISSING	55.3289	55.2971	54.9695
KG/CUM	MISSING	996.7515	996.1788	990.2767
AVG MW	MISSING	18.0150	18.0150	18.0150
SUBSTREAM: CISOLID	STRUCTURE: CONVENTIONAL			
COMPONENTS: KMOL/SEC				
TOL	0.0	0.0	0.0	0.0
H2O	0.0	0.0	0.0	0.0
NACL	0.3720	0.0	0.0	0.3720
CH4	0.0	0.0	0.0	0.0
CO2	0.0	0.0	0.0	0.0
N2	0.0	0.0	0.0	0.0
O2	0.0	0.0	0.0	0.0
TOTAL FLOW:				
KMOL/SEC	0.3720	0.0	0.0	0.3720
KG/SEC	21.7444	0.0	0.0	21.7444
CUM/SEC	1.0051-02	0.0	0.0	1.0051-02

22 23 24 25 (CONTINUED)

STREAM ID	22	23	24	25
STATE VARIABLES:				
TEMP C	160.3994	MISSING	MISSING	27.8369
PRES BAR	234.4220	1.0135	234.4220	234.4220
VFRAC	0.0	MISSING	MISSING	0.0
LFRAC	0.0	MISSING	MISSING	0.0
SFRAC	1.0000	MISSING	MISSING	1.0000
ENTHALPY:				
J/KMOL	-4.0426+08	MISSING	MISSING	-4.1112+08
J/KG	-6.9171+06	MISSING	MISSING	-7.0345+06
WATT	-1.5041+08	MISSING	MISSING	-1.5296+08
ENTROPY:				
J/KMOL-K	-7.1381+04	MISSING	MISSING	-9.0241+04
J/KG-K	-1221.3749	MISSING	MISSING	-1544.0833
DENSITY:				
KMOL/CUM	37.0164	MISSING	MISSING	37.0164
KG/CUM	2163.3536	MISSING	MISSING	2163.3536
AVG MW	58.4430	MISSING	MISSING	58.4430

Appendix A.4 ASPEN PLUS^{TM} Output File for 100,000 bpd Case with Oxygen as Oxidant

```
                                                                                 TM
AAAAA   SSSSS   PPPPP   EEEEE   NN    N   PPPPP   L       U   U   SSSSS
A   A   S       P   P   E       N N   N   P   P   L       U   U   S
AAAAA   SSSSS   PPPPP   EEEEE   N  N  N   PPPPP   L       U   U   SSSSS
A   A       S   P       E       N   NN    P       L       U   U       S
A   A   SSSSS   P       EEEEE   N    N    P       LLLLL   UUUUU   SSSSS
```

ASPEN PLUS IS A TRADEMARK OF
ASPEN TECHNOLOGY, INC.
251 VASSAR STREET
CAMBRIDGE, MASSACHUSETTS 02139
617/497-9010

HOTLINE:
U.S.A. 617/497-9010
EUROPE (32) 2/732-6300

VERSION: PC-DOS
RELEASE: 8.5-3
INSTALLATION: MITELAB

NOVEMBER 11, 1992
WEDNESDAY
7:51:37 P.M.

TABLE OF CONTENTS

```
RUN CONTROL INFORMATION
-----------------------

THIS VERSION OF ASPEN PLUS LICENSED TO MIT ENERGY LAB
TYPE OF RUN: NEW

INPUT FILE NAME: LIQO1.inp

OUTPUT PROBLEM DATA FILE NAME:  LIQO1    VERSION NO.   1
LOCATED IN:                    G:\LIQO1


PDF SIZE USED FOR INPUT TRANSLATION:
  NUMBER OF FILE RECORDS (PSIZE) = 99999
  NUMBER OF IN-CORE RECORDS      =   400
PSIZE NEEDED FOR SIMULATION    =   300

CALLING PROGRAM NAME:           apmod
LOCATED IN:                    d:\ap85b\xeq\apmod

SIMULATION REQUESTED FOR ENTIRE FLOWSHEET

BLOCK STATUS
------------

****************************************************************************
*                                                                          *
* ALL UNIT OPERATION BLOCKS WERE COMPLETED NORMALLY                        *
*                                                                          *
* ALL CONVERGENCE BLOCKS WERE COMPLETED NORMALLY                           *
*                                                                          *
****************************************************************************
```

INPUT FILE(S)

```
>>ORIGINAL RUN                              NOVEMBER 11, 1992
  7:50:45 P.M.                              WEDNESDAY
  INPUT FILE: LIQO1.inp
  OUTPUT PDF: LIQO1    VERSION:  1
  LOCATED IN: G:\LIQO1

;
;Input file created by ModelManager Rel. 3.3-3 on Wed Nov 11 19:50:10
;Directory G:\  Runid LIQO1
;



TITLE "FLOWSHEET"

IN-UNITS SI PRESSURE=BAR TEMPERATURE=C DELTA-T=C

DEF-STREAMS MIXCISLD ALL

DATABANKS ASPENPCD / SOLIDS / BINARY

PROP-SOURCES ASPENPCD / SOLIDS / BINARY

COMPONENTS
    TOL C7H8 TOL /
    H2O H2O H2O /
    NACL NACL NACL /
    CH4 CH4 CH4 /
    CO2 CO2 CO2 /
    N2 N2 N2 /
    O2 O2 O2

HENRY-COMPS GASES CH4 CO2

FLOWSHEET
    BLOCK B1 IN=1 OUT=4
    BLOCK B2 IN=2 OUT=5
    BLOCK B5 IN=7 61 OUT=8
    BLOCK B4 IN=4 5 OUT=7
    BLOCK B7 IN=9 11 OUT=10 12
    BLOCK B13 IN=21 13 OUT=22 14
    BLOCK B14 IN=22 24 OUT=25
    BLOCK B15 IN=23 OUT=24
    BLOCK B11 IN=15 OUT=16
    BLOCK B6 IN=8 OUT=9 21
    BLOCK B8 IN=10 OUT=11
    BLOCK B9 IN=12 OUT=13
    BLOCK B10 IN=14 OUT=15 19
    BLOCK B3 IN=3 OUT=6
    BLOCK B31 IN=6 OUT=61
    BLOCK B12 IN=16 OUT=17 18

PROPERTIES SYSOP3 HENRY-COMPS=GASES
    PROPERTIES SYSOP10A / SYSOP15S
```

INPUT FILE(S) (CONTINUED)

```

PROP-REPLACE SYSOP15S SYSOP15S
    PROP VLMX VLMX01

PROP-REPLACE SYSOP3 SYSOP3
    PROP VLMX VLMX01
    PROP VL VL01

STREAM 1
    SUBSTREAM MIXED TEMP=21.11112 PRES=1.013529
    MASS-FLOW TOL 9.6947802

STREAM 2
    SUBSTREAM MIXED TEMP=148.8889 PRES=206.8427
    MASS-FLOW H2O 136.393698 / CH4 .6937686 / CO2 .07726194
    SUBSTREAM CISOLID TEMP=148.8889 PRES=206.8427
    MASS-FLOW NACL 21.9561384

STREAM 23
    SUBSTREAM MIXED TEMP=21.11112 PRES=1.013529
    MASS-FLOW H2O 87.824562

STREAM 3
    SUBSTREAM MIXED PRES=10.13250 VFRAC=0
    MASS-FLOW O2 36.3765948

BLOCK B14 MIXER
    IN-UNITS SI

BLOCK B4 MIXER

BLOCK B6 SEP
    FRAC STREAM=9 SUBSTREAM=MIXED COMPS=H2O CO2 N2 O2  &
        FRACS=1 1 1 1
    FRAC STREAM=21 SUBSTREAM=CISOLID COMPS=NACL FRACS=1

BLOCK B11 HEATER
    PARAM TEMP=30.00000 PRES=1.013529

BLOCK B31 HEATER
    PARAM TEMP=21.11111 PRES=234.4220

BLOCK B12 FLASH2
    PARAM PRES=1.013529 DUTY=0.0

BLOCK B13 HEATX
    PARAM DELT-HOT=10 <K>
    FEEDS HOT=21 COLD=13
    PRODUCTS HOT=22 COLD=14

BLOCK B7 HEATX
    PARAM T-HOT=1000 <F>
    FEEDS HOT=9 COLD=11
```

INPUT FILE(S) (CONTINUED)

```
        PRODUCTS HOT=10 COLD=12

    BLOCK B5 RSTOIC
        PARAM PRES=234.4220 DUTY=0.0
        STOIC 1 MIXED TOL -1 / O2 -9 / CO2 7 / H2O 4
        STOIC 2 MIXED CH4 -1 / O2 -2 / CO2 1 / H2O 2
        CONV 1 MIXED TOL 1
        CONV 2 MIXED CH4 1

    BLOCK B1 PUMP
        PARAM PRES=234.4220 EFF=0.85

    BLOCK B15 PUMP
        PARAM PRES=234.4220 EFF=0.85

    BLOCK B2 PUMP
        PARAM PRES=234.4220 EFF=0.85
        PROPERTIES SYSOP10A HENRY-COMPS=GASES

    BLOCK B3 PUMP
        PARAM PRES=234.4220 EFF=0.85

    BLOCK B10 MCOMPR
        PARAM NSTAGE=5 TYPE=ISENTROPIC PRES=1.013529 COMPR-NPHASE=2
        FEEDS 14 1
        PRODUCTS 15 5 / 19 GLOBAL L
        COMPR-SPECS 1 SEFF=0.85 MEFF=1 / 2 SEFF=0.85 MEFF=1 / 3  &
            SEFF=0.85 MEFF=1 / 4 SEFF=0.85 MEFF=1 / 5 SEFF=0.85  &
            MEFF=1
        COOLER-SPECS 1 DUTY=0.0 / 2 DUTY=0.0 / 3 DUTY=0.0 / 4  &
            DUTY=0.0 / 5 DUTY=0.0

    BLOCK B8 MCOMPR
        PARAM NSTAGE=5 TYPE=ISENTROPIC PRES=39.36907 COMPR-NPHASE=2
        FEEDS 10 1
        PRODUCTS 11 5
        COMPR-SPECS 1 SEFF=0.85 MEFF=1 / 2 SEFF=0.85 MEFF=1 / 3  &
            SEFF=0.85 MEFF=1 / 4 SEFF=0.85 MEFF=1 / 5 SEFF=0.85  &
            MEFF=1
        COOLER-SPECS 1 DUTY=0.0 / 2 DUTY=0.0 / 3 DUTY=0.0 / 4  &
            DUTY=0.0 / 5 DUTY=0.0

    BLOCK B9 MCOMPR
        PARAM NSTAGE=5 TYPE=ISENTROPIC PRES=6.618967 COMPR-NPHASE=2
        FEEDS 12 1
        PRODUCTS 13 5
        COMPR-SPECS 1 SEFF=0.85 MEFF=1 / 2 SEFF=0.85 MEFF=1 / 3  &
            SEFF=0.85 MEFF=1 / 4 SEFF=0.85 MEFF=1 / 5 SEFF=0.85  &
            MEFF=1
        COOLER-SPECS 1 DUTY=0.0 / 2 DUTY=0.0 / 3 DUTY=0.0 / 4  &
            DUTY=0.0 / 5 DUTY=0.0

    REPORT INPUT NOFLOWSHEET NOPROPERTIES
```

INPUT FILE(S) (CONTINUED)

```

BLOCK-REPORT NEWPAGE NOSORT INCL-BLOCKS=B1 B2 B3 B31 B5 B6  &
        B7 B8 B9 B10 B11 B12 B13 B15

STREAM-REPOR NOSORT INCL-STREAMS=1 2 3 4 5 6 61 7 8 9 10  &
        11 12 13 14 15 16 17 18 19 21 22 23 24 25
;
;
;
;
;
```

SIMULATION STARTED MODULE USED: apmod CREATION: 02/14/92 11:21:55
LOCATED IN:d:\ap85b\xeq\apmod
SIMULATION COMPLETED FOR ENTIRE FLOWSHEET

FLOWSHEET
U-O-S BLOCK SECTION

BLOCK: B1 MODEL: PUMP

INLET STREAM:	1
OUTLET STREAM:	4
PROPERTY OPTION SET:	SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID:	GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	0.105217	0.105217	0.000000E+00
MASS(KG/SEC)	9.69478	9.69478	0.000000E+00
ENTHALPY(WATT)	0.122333E+07	0.153080E+07	-0.200858

*** INPUT DATA ***

OUTLET PRESSURE (BAR)	234.422
PUMP EFFICIENCY	0.85000
DRIVER EFFICIENCY	1.00000
FLASH SPECIFICATIONS:	
LIQUID PHASE CALCULATION	
NO FLASH PERFORMED	
MAXIMUM NUMBER OF ITERATIONS	30
TOLERANCE	0.000100000

*** RESULTS ***

VOLUMETRIC FLOW RATE (CUM/SEC)	0.011197
PRESSURE CHANGE (BAR)	233.408
FLUID POWER (WATT)	261,352.
BRAKE POWER (WATT)	307,473.
ELECTRICITY (WATT)	307,473.
PUMP EFFICIENCY USED	0.85000
NET WORK (WATT)	-307,473.

BLOCK: B2 MODEL: PUMP

INLET STREAM: 2
OUTLET STREAM: 5
PROPERTY OPTION SET: SYSOP10A RENON (NRTL) / REDLICH-KWONG
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	7.99180	7.99180	0.000000E+00
MASS(KG/SEC)	159.121	159.121	0.000000E+00
ENTHALPY(WATT)	-0.224621E+10	-0.224569E+10	-0.231778E-03

*** INPUT DATA ***

OUTLET PRESSURE (BAR)	234.422
PUMP EFFICIENCY	0.85000
DRIVER EFFICIENCY	1.00000

FLASH SPECIFICATIONS:
LIQUID PHASE CALCULATION
NO FLASH PERFORMED

MAXIMUM NUMBER OF ITERATIONS	30
TOLERANCE	0.000100000

*** RESULTS ***

VOLUMETRIC FLOW RATE (CUM/SEC)	0.16046
PRESSURE CHANGE (BAR)	27.5793
FLUID POWER (WATT)	442,529.
BRAKE POWER (WATT)	520,622.
ELECTRICITY (WATT)	520,622.
PUMP EFFICIENCY USED	0.85000
NET WORK (WATT)	-520,622.

FLOWSHEET
U-O-S BLOCK SECTION

BLOCK: B3 MODEL: PUMP

INLET STREAM: 3
OUTLET STREAM: 6
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	1.13680	1.13680	0.000000E+00
MASS(KG/SEC)	36.3766	36.3766	0.000000E+00
ENTHALPY(WATT)	-0.128332E+08	-0.118559E+08	-0.761494E-01

*** INPUT DATA ***

OUTLET PRESSURE (BAR)	234.422
PUMP EFFICIENCY	0.85000
DRIVER EFFICIENCY	1.00000

FLASH SPECIFICATIONS:
LIQUID PHASE CALCULATION
NO FLASH PERFORMED

MAXIMUM NUMBER OF ITERATIONS	30
TOLERANCE	0.000100000

*** RESULTS ***

VOLUMETRIC FLOW RATE (CUM/SEC)	0.037035
PRESSURE CHANGE (BAR)	224.289
FLUID POWER (WATT)	830,652.
BRAKE POWER (WATT)	977,238.
ELECTRICITY (WATT)	977,238.
PUMP EFFICIENCY USED	0.85000
NET WORK (WATT)	-977,238.

BLOCK: B31 MODEL: HEATER

INLET STREAM:	6
OUTLET STREAM:	61
PROPERTY OPTION SET:	SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID:	GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	1.13680	1.13680	0.000000E+00
MASS(KG/SEC)	36.3766	36.3766	0.000000E+00
ENTHALPY(WATT)	-0.118559E+08	-0.193136E+07	-0.837097

*** INPUT DATA ***

TWO PHASE TP FLASH		
SPECIFIED TEMPERATURE	C	21.1111
SPECIFIED PRESSURE	BAR	234.422
MAXIMUM NO. ITERATIONS		30
CONVERGENCE TOLERANCE		0.000100000

*** RESULTS ***

OUTLET TEMPERATURE	C	21.111
OUTLET PRESSURE	BAR	234.42
HEAT DUTY	WATT	0.99246E+07
VAPOR FRACTION		1.0000

V-L PHASE EQUILIBRIUM :

COMP	F(I)	X(I)	Y(I)	K(I)
O2	1.0000	1.0000	1.0000	1.0952

BLOCK: B5 MODEL: RSTOIC

INLET STREAMS:	7	61
OUTLET STREAM:	8	
PROPERTY OPTION SET:	SYSOP3	REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID:	GASES	

*** MASS AND ENERGY BALANCE ***

	IN	OUT	GENERATION	RELATIVE DIFF.
TOTAL BALANCE				
MOLE(KMOL/SEC)	9.23382	9.33904	0.105217	0.475519E-16
MASS(KG/SEC)	205.192	205.192		0.123629E-05
ENTHALPY(WATT)	-0.224609E+10	-0.224609E+10		0.267269E-06

*** INPUT DATA ***

SIMULTANEOUS REACTIONS
STOICHIOMETRY MATRIX:

REACTION # 1:
SUBSTREAM MIXED :

TOL	-1.00	H2O	4.00	CO2	7.00	O2	-9.00

SUBSTREAM CISOLID :
NO PARTICIPATING COMPONENTS

REACTION # 2:
SUBSTREAM MIXED :

H2O	2.00	CH4	-1.00	CO2	1.00	O2	-2.00

SUBSTREAM CISOLID :
NO PARTICIPATING COMPONENTS

REACTION CONVERSION SPECS: NUMBER= 2
REACTION # 1:
SUBSTREAM:MIXED KEY COMP:TOL CONV FRAC: 1.000
REACTION # 2:
SUBSTREAM:MIXED KEY COMP:CH4 CONV FRAC: 1.000

TWO PHASE PQ FLASH		
SPECIFIED PRESSURE	BAR	234.422
SPECIFIED HEAT DUTY	WATT	0.0
MAXIMUM NO. ITERATIONS		30
CONVERGENCE TOLERANCE		0.000100000

BLOCK: B5 MODEL: RSTOIC (CONTINUED)

*** RESULTS ***

OUTLET TEMPERATURE	C	597.19
OUTLET PRESSURE	BAR	234.42
VAPOR FRACTION		1.0000

V-L PHASE EQUILIBRIUM :

COMP	F(I)	X(I)	Y(I)	K(I)
H2O	0.90128	0.96885	0.90128	2.2544
CO2	0.87190E-01	0.28354E-01	0.87190E-01	3.4795
O2	0.11532E-01	0.27993E-02	0.11532E-01	3.6862

FLOWSHEET
U-O-S BLOCK SECTION

BLOCK: B6 MODEL: SEP

INLET STREAM: 8
OUTLET STREAMS: 9 21
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	9.33904	9.33904	0.000000E+00
MASS(KG/SEC)	205.192	205.192	0.000000E+00
ENTHALPY(WATT)	-0.224609E+10	-0.224609E+10	0.000000E+00

*** INPUT DATA ***

FLASH SPECS FOR STREAM 9
TWO PHASE TP FLASH

PRESSURE DROP	BAR	0.0
MAXIMUM NO. ITERATIONS		30
CONVERGENCE TOLERANCE		0.000100000

FLASH SPECS FOR STREAM 21
TWO PHASE TP FLASH

PRESSURE DROP	BAR	0.0
MAXIMUM NO. ITERATIONS		30
CONVERGENCE TOLERANCE		0.000100000

FRACTION OF FEED

SUBSTREAM= MIXED			
STREAM= 9	CPT= H2O	FRACTION=	1.00000
	CO2		1.00000
	N2		1.00000
	O2		1.00000
SUBSTREAM= CISOLID			
STREAM= 21	CPT= NACL	FRACTION=	1.00000

*** RESULTS ***

COMPONENT = H2O

STREAM	SUBSTREAM	SPLIT FRACTION
9	MIXED	1.00000

BLOCK: B6 MODEL: SEP (CONTINUED)

COMPONENT = NACL

STREAM	SUBSTREAM	SPLIT FRACTION
21	CISOLID	1.00000

COMPONENT = CO2

STREAM	SUBSTREAM	SPLIT FRACTION
9	MIXED	1.00000

COMPONENT = O2

STREAM	SUBSTREAM	SPLIT FRACTION
9	MIXED	1.00000

BLOCK: B7 MODEL: HEATX

HOT SIDE:

INLET STREAM: 9
OUTLET STREAM: 10
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

COLD SIDE:

INLET STREAM: 11
OUTLET STREAM: 12
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	17.9267	17.9267	0.000000E+00
MASS(KG/SEC)	366.472	366.472	0.000000E+00
ENTHALPY(WATT)	-0.430174E+10	-0.430174E+10	-0.806398E-06

*** INPUT DATA ***

FLASH SPECS FOR HOT SIDE:
TWO PHASE FLASH
MAXIMUM NO. ITERATIONS 30
CONVERGENCE TOLERANCE 0.000100000

FLASH SPECS FOR COLD SIDE:
TWO PHASE FLASH
MAXIMUM NO. ITERATIONS 30
CONVERGENCE TOLERANCE 0.000100000

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ASPEN PLUS   VER: PC-DOS     REL: 8.5-3     INST: MITELAB    11/11/92  PAGE 15
                                        FLOWSHEET
                                    U-O-S BLOCK SECTION

BLOCK:  B7       MODEL: HEATX (CONTINUED)


   COUNTERCURRENT  HEAT EXCHANGER WITH SPECIFIED HOT OUTLET TEMPERATURE
   HOT STREAM OUTLET TEMPERATURE (C   )                              537.778
   HOT STREAM PRESSURE DROP (BAR     )                                 0.0
   COLD STREAM PRESSURE DROP (BAR     )                                0.0

   HEAT TRANSFER COEFFICIENTS  (WATT/SQM-K      ):
   HOT STREAM PHASE      COLD STREAM PHASE
   LIQUID                LIQUID                                      850.000
   BOILING LIQUID        LIQUID                                      850.000
   VAPOR                 LIQUID                                      850.000
   LIQUID                BOILING LIQUID                              850.000
   BOILING LIQUID        BOILING LIQUID                              850.000
   VAPOR                 BOILING LIQUID                              850.000
   LIQUID                VAPOR                                       850.000
   BOILING LIQUID        VAPOR                                       850.000
   VAPOR                 VAPOR                                       850.000

                               ***  RESULTS  ***
   HOT STREAM INLET TEMPERATURE (C   )                               597.189
   HOT STREAM OUTLET TEMPERATURE (C   )                              537.778
   COLD STREAM INLET TEMPERATURE (C   )                              273.261
   COLD STREAM OUTLET TEMPERATURE (C   )                             348.117
   EXCHANGER HEAT DUTY (WATT    )                                     0.280365+08
   HEAT TRANSFER AREA (SQM     )                                     128.485


   AREA CALCULATION RESULTS:

   SECTION  CONDITIONS    AREA                    HEAT DUTY
            (HOT-COLD)    (SQM     )              (WATT    )
      1       V-V         128.485                     0.280365+08

   SECTION   TEMPERATURE LEAVING SECTION
             HOT STREAM                 COLD STREAM
             (C        )                (C        )
      1         537.778                    348.117


        -------------------------------------------------------------
       |                                                           |
 9     |      VAP                                                  |   10
------>|                                                           |  ------>
 597.2 |                                                           |   537.8
       |                                                           |
 12    |      VAP                                                  |   11
<------|                                                           |  <------
 348.1 |                                                           |   273.3
       |                                                           |
        -------------------------------------------------------------
```

BLOCK: B8 MODEL: MCOMPR

INLET STREAMS: 10 TO STAGE 1
OUTLET STREAMS: 11 FROM STAGE 5
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	8.96336	8.96336	0.000000E+00
MASS(KG/SEC)	183.236	183.236	0.000000E+00
ENTHALPY(WATT)	-0.213159E+10	-0.219819E+10	0.302966E-01

*** INPUT DATA ***

ISENTROPIC CENTRIFUGAL COMPRESSOR	
NUMBER OF STAGES	5
FINAL PRESSURE, BAR	39.3691

COMPRESSOR SPECIFICATIONS PER STAGE

STAGE NUMBER	MECHANICAL EFFICIENCY	ISENTROPIC EFFICIENCY
1	1.000	0.8500
2	1.000	0.8500
3	1.000	0.8500
4	1.000	0.8500
5	1.000	0.8500

*** RESULTS ***

FINAL PRESSURE, BAR	39.3691
TOTAL WORK REQUIRED, WATT	-0.665947+08

*** PROFILE ***

COMPRESSOR PROFILE

STAGE NUMBER	OUTLET PRESSURE BAR	PRESSURE RATIO	OUTLET TEMPERATURE C
1	164.1	0.6999	477.3
2	114.8	0.6999	420.2
3	80.37	0.6999	367.0
4	56.25	0.6999	318.3
5	39.37	0.6999	273.3

BLOCK: B8 MODEL: MCOMPR (CONTINUED)

STAGE NUMBER	INDICATED HORSEPOWER WATT	BRAKE HORSEPOWER WATT
1	-.1553E+08	-.1553E+08
2	-.1425E+08	-.1425E+08
3	-.1316E+08	-.1316E+08
4	-.1224E+08	-.1224E+08
5	-.1141E+08	-.1141E+08

FLOWSHEET
U-O-S BLOCK SECTION

BLOCK: B9 MODEL: MCOMPR

INLET STREAMS: 12 TO STAGE 1
OUTLET STREAMS: 13 FROM STAGE 5
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	8.96336	8.96336	0.000000E+00
MASS(KG/SEC)	183.236	183.236	0.000000E+00
ENTHALPY(WATT)	-0.217015E+10	-0.222557E+10	0.249028E-01

*** INPUT DATA ***

ISENTROPIC CENTRIFUGAL COMPRESSOR
NUMBER OF STAGES 5
FINAL PRESSURE, BAR 6.61897

COMPRESSOR SPECIFICATIONS PER STAGE

STAGE NUMBER	MECHANICAL EFFICIENCY	ISENTROPIC EFFICIENCY
1	1.000	0.8500
2	1.000	0.8500
3	1.000	0.8500
4	1.000	0.8500
5	1.000	0.8500

*** RESULTS ***

FINAL PRESSURE, BAR 6.61897
TOTAL WORK REQUIRED, WATT -0.554197+08

*** PROFILE ***

COMPRESSOR PROFILE

STAGE NUMBER	OUTLET PRESSURE BAR	PRESSURE RATIO	OUTLET TEMPERATURE C
1	27.56	0.7000	303.8
2	19.29	0.7000	262.6
3	13.51	0.7000	224.3
4	9.455	0.7000	188.6
5	6.619	0.7000	159.2

BLOCK: B9 MODEL: MCOMPR (CONTINUED)

STAGE NUMBER	INDICATED HORSEPOWER WATT	BRAKE HORSEPOWER WATT
1	-.1264E+08	-.1264E+08
2	-.1181E+08	-.1181E+08
3	-.1103E+08	-.1103E+08
4	-.1030E+08	-.1030E+08
5	-.9642E+07	-.9642E+07

BLOCK: B10 MODEL: MCOMPR

INLET STREAMS: 14 TO STAGE 1
OUTLET STREAMS: 15 FROM STAGE 5
19 GLOBAL OUTLET
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	8.96336	8.96336	0.000000E+00
MASS(KG/SEC)	183.236	183.236	-0.155110E-15
ENTHALPY(WATT)	-0.221641E+10	-0.226236E+10	0.203103E-01

*** INPUT DATA ***

ISENTROPIC CENTRIFUGAL COMPRESSOR
NUMBER OF STAGES 5
FINAL PRESSURE, BAR 1.01353

COMPRESSOR SPECIFICATIONS PER STAGE

STAGE NUMBER	MECHANICAL EFFICIENCY	ISENTROPIC EFFICIENCY
1	1.000	0.8500
2	1.000	0.8500
3	1.000	0.8500
4	1.000	0.8500
5	1.000	0.8500

*** RESULTS ***

FINAL PRESSURE, BAR 1.01353
TOTAL WORK REQUIRED, WATT -0.459402+08

*** PROFILE ***

COMPRESSOR PROFILE

STAGE NUMBER	OUTLET PRESSURE BAR	PRESSURE RATIO	OUTLET TEMPERATURE C
1	4.548	0.6871	149.3
2	3.125	0.6871	132.8
3	2.147	0.6871	120.9
4	1.475	0.6871	109.8
5	1.014	0.6871	99.48

BLOCK: B10 MODEL: MCOMPR (CONTINUED)

STAGE NUMBER	INDICATED HORSEPOWER WATT	BRAKE HORSEPOWER WATT
1	-.1010E+08	-.1010E+08
2	-.9520E+07	-.9520E+07
3	-.9132E+07	-.9132E+07
4	-.8768E+07	-.8768E+07
5	-.8423E+07	-.8423E+07

BLOCK: B11 MODEL: HEATER

INLET STREAM: 15
OUTLET STREAM: 16
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	8.56541	8.56541	0.000000E+00
MASS(KG/SEC)	176.067	176.067	0.000000E+00
ENTHALPY(WATT)	-0.215067E+10	-0.252270E+10	0.147473

*** INPUT DATA ***

TWO PHASE TP FLASH		
SPECIFIED TEMPERATURE	C	30.0000
SPECIFIED PRESSURE	BAR	1.01353
MAXIMUM NO. ITERATIONS		30
CONVERGENCE TOLERANCE		0.000100000

*** RESULTS ***

OUTLET TEMPERATURE	C	30.000
OUTLET PRESSURE	BAR	1.0135
HEAT DUTY	WATT	-0.37203E+09
VAPOR FRACTION		0.10668

V-L PHASE EQUILIBRIUM :

COMP	F(I)	X(I)	Y(I)	K(I)
H2O	0.89669	0.99994	0.32094E-01	0.32096E-01
CO2	0.91240E-01	0.56121E-04	0.85479	15231.
O2	0.12068E-01	0.16534E-06	0.11312	0.68413E+06

BLOCK: B12 MODEL: FLASH2

INLET STREAM: 16
OUTLET VAPOR STREAM: 17
OUTLET LIQUID STREAM: 18
PROPERTY OPTION SET: SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID: GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	8.56541	8.56541	0.000000E+00
MASS(KG/SEC)	176.067	176.067	0.645703E-15
ENTHALPY(WATT)	-0.252270E+10	-0.252270E+10	-0.962243E-08

*** INPUT DATA ***

TWO PHASE PQ FLASH		
SPECIFIED PRESSURE	BAR	1.01353
SPECIFIED HEAT DUTY	WATT	0.0
MAXIMUM NO. ITERATIONS		30
CONVERGENCE TOLERANCE		0.000100000

*** RESULTS ***

OUTLET TEMPERATURE	C	30.000
OUTLET PRESSURE	BAR	1.0135
VAPOR FRACTION		0.10668

V-L PHASE EQUILIBRIUM :

COMP	F(I)	X(I)	Y(I)	K(I)
H2O	0.89669	0.99994	0.32094E-01	0.32096E-01
CO2	0.91240E-01	0.56121E-04	0.85479	15231.
O2	0.12068E-01	0.16534E-06	0.11312	0.68412E+06

BLOCK: B13 MODEL: HEATX

HOT SIDE:

INLET STREAM:	21	
OUTLET STREAM:	22	
PROPERTY OPTION SET:	SYSOP3	REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID:	GASES	

COLD SIDE:

INLET STREAM:	13	
OUTLET STREAM:	14	
PROPERTY OPTION SET:	SYSOP3	REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID:	GASES	

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	9.33904	9.33904	0.000000E+00
MASS(KG/SEC)	205.192	205.192	0.000000E+00
ENTHALPY(WATT)	-0.236811E+10	-0.236811E+10	0.100212E-08

*** INPUT DATA ***

FLASH SPECS FOR HOT SIDE:

TWO PHASE FLASH	
MAXIMUM NO. ITERATIONS	30
CONVERGENCE TOLERANCE	0.000100000

FLASH SPECS FOR COLD SIDE:

TWO PHASE FLASH	
MAXIMUM NO. ITERATIONS	30
CONVERGENCE TOLERANCE	0.000100000

BLOCK: B13 MODEL: HEATX (CONTINUED)

COUNTERCURRENT HEAT EXCHANGER WITH SPECIFIED HOT OUTLET TEMP APPROACH

TEMP APPROACH AT HOT STREAM OUTLET (C)	10.0000
HOT STREAM PRESSURE DROP (BAR)	0.0
COLD STREAM PRESSURE DROP (BAR)	0.0

HEAT TRANSFER COEFFICIENTS (WATT/SQM-K):

HOT STREAM PHASE	COLD STREAM PHASE	
LIQUID	LIQUID	850.000
BOILING LIQUID	LIQUID	850.000
VAPOR	LIQUID	850.000
LIQUID	BOILING LIQUID	850.000
BOILING LIQUID	BOILING LIQUID	850.000
VAPOR	BOILING LIQUID	850.000
LIQUID	VAPOR	850.000
BOILING LIQUID	VAPOR	850.000
VAPOR	VAPOR	850.000

*** RESULTS ***

HOT STREAM INLET TEMPERATURE (C)	597.189
HOT STREAM OUTLET TEMPERATURE (C)	169.160
COLD STREAM INLET TEMPERATURE (C)	159.160
COLD STREAM OUTLET TEMPERATURE (C)	183.276
EXCHANGER HEAT DUTY (WATT)	9,157,440.
HEAT TRANSFER AREA (SQM)	0.808754-29

BLOCK: B13 MODEL: HEATX (CONTINUED)

AREA CALCULATION RESULTS:

SECTION	CONDITIONS (HOT-COLD)	AREA (SQM)	HEAT DUTY (WATT)
1	V-V	0.694511-29	7,917,060.
2	V-B	0.114243-29	1,240,380.

SECTION	TEMPERATURE LEAVING SECTION HOT STREAM (C)	COLD STREAM (C)
1	MISSING	183.276
2	169.160	159.175

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         -------------------------------------------------------------
        |                              |                              |
21      |     VAP                      |      VAP                     |  22
------> |                              |                              | ------>
 597.2  |                              |                              |  169.2
        |                              |                              |
14      |     VAP                      |     BOIL                     |  13
<------ |                              |                              | <------
 183.3  |                        159.2 |                              |  159.2
        |                              |                              |
         -------------------------------------------------------------
```

BLOCK: B15 MODEL: PUMP

INLET STREAM:	23
OUTLET STREAM:	24
PROPERTY OPTION SET:	SYSOP3 REDLICH-KWONG-SOAVE EQUATION OF STATE
HENRY-COMPS ID:	GASES

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/SEC)	4.87508	4.87508	0.000000E+00
MASS(KG/SEC)	87.8246	87.8246	0.000000E+00
ENTHALPY(WATT)	-0.141062E+10	-0.140821E+10	-0.171520E-02

*** INPUT DATA ***

OUTLET PRESSURE (BAR)	234.422
PUMP EFFICIENCY	0.85000
DRIVER EFFICIENCY	1.00000
FLASH SPECIFICATIONS:	
LIQUID PHASE CALCULATION	
NO FLASH PERFORMED	
MAXIMUM NUMBER OF ITERATIONS	30
TOLERANCE	0.000100000

*** RESULTS ***

VOLUMETRIC FLOW RATE (CUM/SEC)	0.088111
PRESSURE CHANGE (BAR)	233.408
FLUID POWER (WATT)	2,056,580.
BRAKE POWER (WATT)	2,419,510.
ELECTRICITY (WATT)	2,419,510.
PUMP EFFICIENCY USED	0.85000
NET WORK (WATT)	-2,419,510.

FLOWSHEET
STREAM SECTION

1 2 3 4 5

STREAM ID	1	2	3	4	5
FROM :	----	----	----	B1	B2
TO :	B1	B2	B3	B4	B4
CLASS:	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD
TOTAL STREAM:					
KG/SEC	9.6947	159.1208	36.3765	9.6947	159.1208
WATT	1.2233+06	-2.2462+09	-1.2833+07	1.5308+06	-2.2457+09
SUBSTREAM: MIXED					
PHASE:	LIQUID	MIXED	LIQUID	LIQUID	LIQUID
COMPONENTS: KMOL/SEC					
TOL	0.1052	0.0	0.0	0.1052	0.0
H2O	0.0	7.5711	0.0	0.0	7.5711
NACL	0.0	0.0	0.0	0.0	0.0
CH4	0.0	4.3244-02	0.0	0.0	4.3244-02
CO2	0.0	1.7556-03	0.0	0.0	1.7556-03
N2	0.0	0.0	0.0	0.0	0.0
O2	0.0	0.0	1.1368	0.0	0.0
TOTAL FLOW:					
KMOL/SEC	0.1052	7.6161	1.1368	0.1052	7.6161
KG/SEC	9.6947	137.1647	36.3765	9.6947	137.1647
CUM/SEC	1.1197-02	0.1637	3.7035-02	1.1260-02	0.1605
STATE VARIABLES:					
TEMP C	21.1111	148.8889	-153.3901	26.4341	149.6359
PRES BAR	1.0135	206.8427	10.1325	234.4220	234.4220
VFRAC	0.0	4.0570-03	0.0	0.0	0.0
LFRAC	1.0000	0.9959	1.0000	1.0000	1.0000
SFRAC	0.0	0.0	0.0	0.0	0.0
ENTHALPY:					
J/KMOL	1.1627+07	-2.7496+08	-1.1289+07	1.4549+07	-2.7489+08
J/KG	1.2618+05	-1.5267+07	-3.5279+05	1.5790+05	-1.5263+07
WATT	1.2233+06	-2.0941+09	-1.2833+07	1.5308+06	-2.0936+09
ENTROPY:					
J/KMOL-K	-3.4337+05	-1.3654+05	-9.5330+04	-3.4288+05	-1.3654+05
J/KG-K	-3726.5844	-7581.2897	-2979.1601	-3721.2527	-7581.4330
DENSITY:					
KMOL/CUM	9.3967	46.5056	30.6955	9.3440	47.4316
KG/CUM	865.8220	837.5576	982.2271	860.9738	854.2333
AVG MW	92.1410	18.0097	31.9990	92.1410	18.0097
SUBSTREAM: CISOLID	STRUCTURE: CONVENTIONAL				
COMPONENTS: KMOL/SEC					
TOL	0.0	0.0	0.0	0.0	0.0
H2O	0.0	0.0	0.0	0.0	0.0
NACL	0.0	0.3756	0.0	0.0	0.3756
CH4	0.0	0.0	0.0	0.0	0.0
CO2	0.0	0.0	0.0	0.0	0.0
N2	0.0	0.0	0.0	0.0	0.0
O2	0.0	0.0	0.0	0.0	0.0
TOTAL FLOW:					
KMOL/SEC	0.0	0.3756	0.0	0.0	0.3756
KG/SEC	0.0	21.9561	0.0	0.0	21.9561
CUM/SEC	0.0	1.0149-02	0.0	0.0	1.0149-02

1 2 3 4 5 (CONTINUED)

STREAM ID	1	2	3	4	5
STATE VARIABLES:					
TEMP C	MISSING	148.8889	MISSING	MISSING	149.6359
PRES BAR	1.0135	206.8427	10.1325	234.4220	234.4220
VFRAC	MISSING	0.0	MISSING	MISSING	0.0
LFRAC	MISSING	0.0	MISSING	MISSING	0.0
SFRAC	MISSING	1.0000	MISSING	MISSING	1.0000
ENTHALPY:					
J/KMOL	MISSING	-4.0486+08	MISSING	MISSING	-4.0483+08
J/KG	MISSING	-6.9275+06	MISSING	MISSING	-6.9268+06
WATT	MISSING	-1.5210+08	MISSING	MISSING	-1.5209+08
ENTROPY:					
J/KMOL-K	MISSING	-7.2803+04	MISSING	MISSING	-7.2709+04
J/KG-K	MISSING	-1245.7035	MISSING	MISSING	-1244.1074
DENSITY:					
KMOL/CUM	MISSING	37.0164	MISSING	MISSING	37.0164
KG/CUM	MISSING	2163.3536	MISSING	MISSING	2163.3536
AVG MW	MISSING	58.4430	MISSING	MISSING	58.4430

FLOWSHEET
STREAM SECTION

6 61 7 8 9

STREAM ID	6	61	7	8	9
FROM :	B3	B31	B4	B5	B6
TO :	B31	B5	B5	B6	B7
CLASS:	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD
TOTAL STREAM:					
KG/SEC	36.3765	36.3765	168.8156	205.1919	183.2358
WATT	-1.1856+07	-1.9314+06	-2.2442+09	-2.2461+09	-2.1036+09
SUBSTREAM: MIXED					
PHASE:	LIQUID	VAPOR	MIXED	VAPOR	VAPOR
COMPONENTS: KMOL/SEC					
TOL	0.0	0.0	0.1052	0.0	0.0
H2O	0.0	0.0	7.5711	8.0784	8.0784
NACL	0.0	0.0	0.0	0.0	0.0
CH4	0.0	0.0	4.3244-02	0.0	0.0
CO2	0.0	0.0	1.7556-03	0.7815	0.7815
N2	0.0	0.0	0.0	0.0	0.0
O2	1.1368	1.1368	0.0	0.1033	0.1033
TOTAL FLOW:					
KMOL/SEC	1.1368	1.1368	7.7213	8.9633	8.9633
KG/SEC	36.3765	36.3765	146.8595	183.2358	183.2358
CUM/SEC	4.0815-02	0.1183	0.2125	2.5780	2.5780
STATE VARIABLES:					
TEMP C	-140.8585	21.1111	158.0549	597.1894	597.1894
PRES BAR	234.4220	234.4220	234.4220	234.4220	234.4220
VFRAC	0.0	1.0000	1.1812-02	1.0000	1.0000
LFRAC	1.0000	0.0	0.9881	0.0	0.0
SFRAC	0.0	0.0	0.0	0.0	0.0
ENTHALPY:					
J/KMOL	-1.0429+07	-1.6989+06	-2.7097+08	-2.3468+08	-2.3468+08
J/KG	-3.2592+05	-5.3094+04	-1.4247+07	-1.1480+07	-1.1480+07
WATT	-1.1856+07	-1.9314+06	-2.0922+09	-2.1036+09	-2.1036+09
ENTROPY:					
J/KMOL-K	-9.4357+04	-5.0535+04	-1.3939+05	-4.6284+04	-4.6284+04
J/KG-K	-2948.7496	-1579.2576	-7328.8446	-2264.0778	-2264.0778
DENSITY:					
KMOL/CUM	27.8527	9.6043	36.3305	3.4767	3.4767
KG/CUM	891.2585	307.3280	691.0065	71.0748	71.0748
AVG MW	31.9990	31.9990	19.0199	20.4427	20.4427
SUBSTREAM: CISOLID	STRUCTURE: CONVENTIONAL				
COMPONENTS: KMOL/SEC					
TOL	0.0	0.0	0.0	0.0	0.0
H2O	0.0	0.0	0.0	0.0	0.0
NACL	0.0	0.0	0.3756	0.3756	0.0
CH4	0.0	0.0	0.0	0.0	0.0
CO2	0.0	0.0	0.0	0.0	0.0
N2	0.0	0.0	0.0	0.0	0.0
O2	0.0	0.0	0.0	0.0	0.0
TOTAL FLOW:					
KMOL/SEC	0.0	0.0	0.3756	0.3756	0.0
KG/SEC	0.0	0.0	21.9561	21.9561	0.0
CUM/SEC	0.0	0.0	1.0149-02	1.0149-02	0.0

FLOWSHEET
STREAM SECTION

6 61 7 8 9 (CONTINUED)

STREAM ID	6	61	7	8	9
STATE VARIABLES:					
TEMP C	MISSING	MISSING	158.0549	597.1894	MISSING
PRES BAR	234.4220	234.4220	234.4220	234.4220	234.4220
VFRAC	MISSING	MISSING	0.0	0.0	MISSING
LFRAC	MISSING	MISSING	0.0	0.0	MISSING
SFRAC	MISSING	MISSING	1.0000	1.0000	MISSING
ENTHALPY:					
J/KMOL	MISSING	MISSING	-4.0438+08	-3.7942+08	MISSING
J/KG	MISSING	MISSING	-6.9192+06	-6.4921+06	MISSING
WATT	MISSING	MISSING	-1.5192+08	-1.4254+08	MISSING
ENTROPY:					
J/KMOL-K	MISSING	MISSING	-7.1668+04	-3.2065+04	MISSING
J/KG-K	MISSING	MISSING	-1226.2852	-548.6584	MISSING
DENSITY:					
KMOL/CUM	MISSING	MISSING	37.0164	37.0164	MISSING
KG/CUM	MISSING	MISSING	2163.3536	2163.3536	MISSING
AVG MW	MISSING	MISSING	58.4430	58.4430	MISSING

FLOWSHEET
STREAM SECTION

10 11 12 13 14

STREAM ID	10	11	12	13	14
FROM :	B7	B8	B7	B9	B13
TO :	B8	B7	B9	B13	B10
CLASS:	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD
TOTAL STREAM:					
KG/SEC	183.2358	183.2358	183.2358	183.2358	183.2358
WATT	-2.1316+09	-2.1982+09	-2.1701+09	-2.2256+09	-2.2164+09
SUBSTREAM: MIXED					
PHASE:	VAPOR	VAPOR	VAPOR	MIXED	VAPOR
COMPONENTS: KMOL/SEC					
TOL	0.0	0.0	0.0	0.0	0.0
H2O	8.0784	8.0784	8.0784	8.0784	8.0784
NACL	0.0	0.0	0.0	0.0	0.0
CH4	0.0	0.0	0.0	0.0	0.0
CO2	0.7815	0.7815	0.7815	0.7815	0.7815
N2	0.0	0.0	0.0	0.0	0.0
O2	0.1033	0.1033	0.1033	0.1033	0.1033
TOTAL FLOW:					
KMOL/SEC	8.9633	8.9633	8.9633	8.9633	8.9633
KG/SEC	183.2358	183.2358	183.2358	183.2358	183.2358
CUM/SEC	2.3016	9.2964	11.0238	46.8790	49.9310
STATE VARIABLES:					
TEMP C	537.7777	273.2615	348.1173	159.1597	183.2759
PRES BAR	234.4220	39.3690	39.3690	6.6189	6.6189
VFRAC	1.0000	1.0000	1.0000	0.9965	1.0000
LFRAC	0.0	0.0	0.0	3.4990-03	0.0
SFRAC	0.0	0.0	0.0	0.0	0.0
ENTHALPY:					
J/KMOL	-2.3781+08	-2.4524+08	-2.4211+08	-2.4830+08	-2.4727+08
J/KG	-1.1633+07	-1.1996+07	-1.1843+07	-1.2146+07	-1.2096+07
WATT	-2.1316+09	-2.1982+09	-2.1701+09	-2.2256+09	-2.2164+09
ENTROPY:					
J/KMOL-K	-5.0007+04	-4.7963+04	-4.2596+04	-4.0408+04	-3.8099+04
J/KG-K	-2446.2189	-2346.2296	-2083.6938	-1976.6185	-1863.7069
DENSITY:					
KMOL/CUM	3.8943	0.9641	0.8130	0.1912	0.1795
KG/CUM	79.6114	19.7103	16.6217	3.9087	3.6697
AVG MW	20.4427	20.4427	20.4427	20.4427	20.4427

FLOWSHEET
STREAM SECTION

15 16 17 18 19

STREAM ID	15	16	17	18	19
FROM :	B10	B11	B12	B12	B10
TO :	B11	B12	----	----	----
CLASS:	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD
TOTAL STREAM:					
KG/SEC	176.0666	176.0666	38.2111	137.8555	7.1691
WATT	-2.1507+09	-2.5227+09	-3.1453+08	-2.2082+09	-1.1169+08
SUBSTREAM: MIXED					
PHASE:	MIXED	MIXED	VAPOR	LIQUID	LIQUID
COMPONENTS: KMOL/SEC					
TOL	0.0	0.0	0.0	0.0	0.0
H2O	7.6805	7.6805	2.9327-02	7.6512	0.3979
NACL	0.0	0.0	0.0	0.0	0.0
CH4	0.0	0.0	0.0	0.0	0.0
CO2	0.7815	0.7815	0.7810	4.2942-04	8.8377-06
N2	0.0	0.0	0.0	0.0	0.0
O2	0.1033	0.1033	0.1033	1.2652-06	1.0321-07
TOTAL FLOW:					
KMOL/SEC	8.5654	8.5654	0.9137	7.6516	0.3979
KG/SEC	176.0666	176.0666	38.2111	137.8555	7.1691
CUM/SEC	255.8989	22.7653	22.6258	0.1395	8.0082-03
STATE VARIABLES:					
TEMP C	99.4778	30.0000	30.0000	30.0000	120.7014
PRES BAR	1.0135	1.0135	1.0135	1.0135	6.6189
VFRAC	0.9848	0.1066	1.0000	0.0	0.0
LFRAC	1.5128-02	0.8933	0.0	1.0000	1.0000
SFRAC	0.0	0.0	0.0	0.0	0.0
ENTHALPY:					
J/KMOL	-2.5109+08	-2.9452+08	-3.4421+08	-2.8859+08	-2.8067+08
J/KG	-1.2215+07	-1.4328+07	-8.2313+06	-1.6018+07	-1.5579+07
WATT	-2.1507+09	-2.5227+09	-3.1453+08	-2.2082+09	-1.1169+08
ENTROPY:					
J/KMOL-K	-3.0671+04	-1.5067+05	5696.5389	-1.6934+05	-1.4654+05
J/KG-K	-1492.0816	-7329.7049	136.2252	-9399.1284	-8134.1368
DENSITY:					
KMOL/CUM	3.3472-02	0.3762	4.0386-02	54.8504	49.6918
KG/CUM	0.6880	7.7339	1.6888	988.2113	895.2268
AVG MW	20.5555	20.5555	41.8170	18.0164	18.0155

FLOWSHEET
STREAM SECTION

21 22 23 24 25

STREAM ID	21	22	23	24	25
FROM :	B6	B13	----	B15	B14
TO :	B13	B14	B15	B14	----
CLASS:	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD	MIXCISLD
TOTAL STREAM:					
KG/SEC	21.9561	21.9561	87.8245	87.8245	109.7807
WATT	-1.4254+08	-1.5170+08	-1.4106+09	-1.4082+09	-1.5599+09
SUBSTREAM: MIXED					
PHASE:	MIXED	MIXED	LIQUID	LIQUID	LIQUID
COMPONENTS: KMOL/SEC					
TOL	0.0	0.0	0.0	0.0	0.0
H2O	0.0	0.0	4.8750	4.8750	4.8750
NACL	0.0	0.0	0.0	0.0	0.0
CH4	0.0	0.0	0.0	0.0	0.0
CO2	0.0	0.0	0.0	0.0	0.0
N2	0.0	0.0	0.0	0.0	0.0
O2	0.0	0.0	0.0	0.0	0.0
TOTAL FLOW:					
KMOL/SEC	0.0	0.0	4.8750	4.8750	4.8750
KG/SEC	0.0	0.0	87.8245	87.8245	87.8245
CUM/SEC	0.0	0.0	8.8111-02	8.8161-02	8.8721-02
STATE VARIABLES:					
TEMP C	MISSING	MISSING	21.1111	21.7079	28.2341
PRES BAR	234.4220	234.4220	1.0135	234.4220	234.4220
VFRAC	MISSING	MISSING	0.0	0.0	0.0
LFRAC	MISSING	MISSING	1.0000	1.0000	1.0000
SFRAC	MISSING	MISSING	0.0	0.0	0.0
ENTHALPY:					
J/KMOL	MISSING	MISSING	-2.8935+08	-2.8886+08	-2.8829+08
J/KG	MISSING	MISSING	-1.6062+07	-1.6034+07	-1.6003+07
WATT	MISSING	MISSING	-1.4106+09	-1.4082+09	-1.4055+09
ENTROPY:					
J/KMOL-K	MISSING	MISSING	-1.7193+05	-1.7213+05	-1.7024+05
J/KG-K	MISSING	MISSING	-9543.8897	-9554.8913	-9450.0606
DENSITY:					
KMOL/CUM	MISSING	MISSING	55.3289	55.2971	54.9482
KG/CUM	MISSING	MISSING	996.7514	996.1788	989.8928
AVG MW	MISSING	MISSING	18.0150	18.0150	18.0150
SUBSTREAM: CISOLID	STRUCTURE: CONVENTIONAL				
COMPONENTS: KMOL/SEC					
TOL	0.0	0.0	0.0	0.0	0.0
H2O	0.0	0.0	0.0	0.0	0.0
NACL	0.3756	0.3756	0.0	0.0	0.3756
CH4	0.0	0.0	0.0	0.0	0.0
CO2	0.0	0.0	0.0	0.0	0.0
N2	0.0	0.0	0.0	0.0	0.0
O2	0.0	0.0	0.0	0.0	0.0
TOTAL FLOW:					
KMOL/SEC	0.3756	0.3756	0.0	0.0	0.3756
KG/SEC	21.9561	21.9561	0.0	0.0	21.9561
CUM/SEC	1.0149-02	1.0149-02	0.0	0.0	1.0149-02

FLOWSHEET
STREAM SECTION

21 22 23 24 25 (CONTINUED)

STREAM ID	21	22	23	24	25
STATE VARIABLES:					
TEMP C	597.1894	169.1597	MISSING	MISSING	28.2341
PRES BAR	234.4220	234.4220	1.0135	234.4220	234.4220
VFRAC	0.0	0.0	MISSING	MISSING	0.0
LFRAC	0.0	0.0	MISSING	MISSING	0.0
SFRAC	1.0000	1.0000	MISSING	MISSING	1.0000
ENTHALPY:					
J/KMOL	-3.7942+08	-4.0379+08	MISSING	MISSING	-4.1110+08
J/KG	-6.4921+06	-6.9092+06	MISSING	MISSING	-7.0341+06
WATT	-1.4254+08	-1.5170+08	MISSING	MISSING	-1.5444+08
ENTROPY:					
J/KMOL-K	-3.2065+04	-7.0320+04	MISSING	MISSING	-9.0174+04
J/KG-K	-548.6584	-1203.2260	MISSING	MISSING	-1542.9422
DENSITY:					
KMOL/CUM	37.0164	37.0164	MISSING	MISSING	37.0164
KG/CUM	2163.3536	2163.3536	MISSING	MISSING	2163.3536
AVG MW	58.4430	58.4430	MISSING	MISSING	58.4430