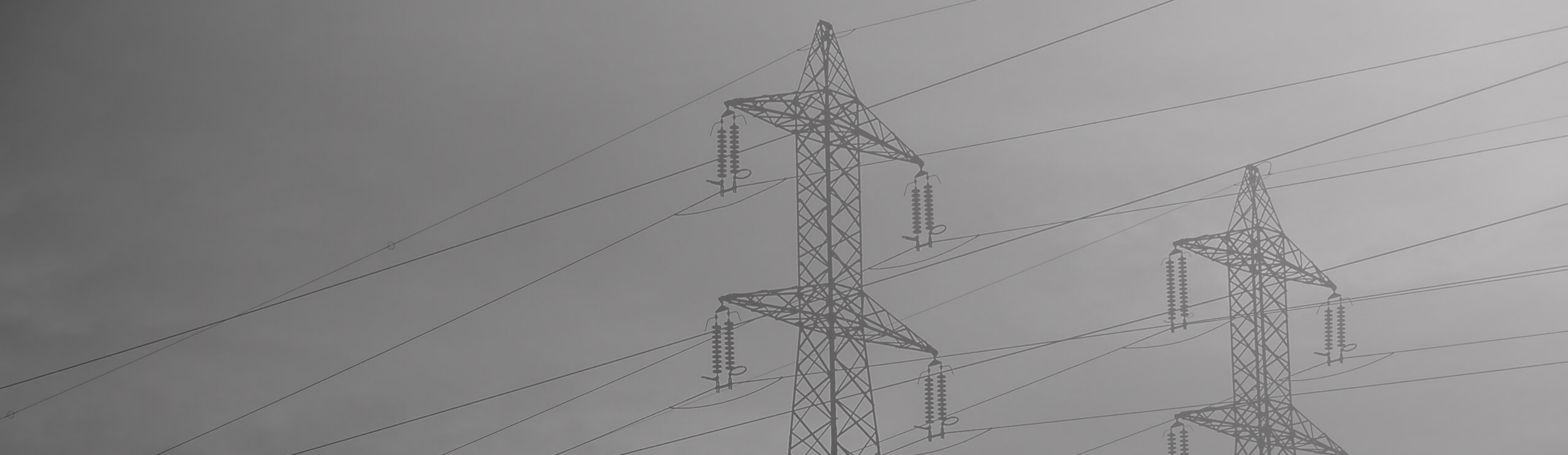

Final Report:
Evaluation of Alternative Technologies for Ethylene, Caustic-Chlorine, Ethylene Oxide, Ammonia, and Terephthalic Acid

December, 2007

Prepared for the Department of Energy
Industrial Technologies Program
by JVP International, Inc.
Staten Island, New York 10314
and Psage Research
Macungie, Pennsylvania 18062

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Preface

The Industrial Technologies Program (ITP) in the US Department of Energy Office of Energy Efficiency and Renewable Energy (DOE/EERE) works with US industry to reduce energy use and carbon emissions associated with industrial processes. Its mission is to improve national energy security, protect the environment, and ensure US economic competitiveness by enhancing the energy efficiency and productivity of US manufacturing. Its work includes sponsoring high-risk, high-return research and development (R & D) in energy-saving technologies, as well as engaging in industry outreach to promote best practice energy management in US facilities.

In order to evaluate research opportunities in energy efficiency, ITP sponsors various analytic studies assessing energy consumption trends and prospects for energy reduction in different industries. This study evaluates alternative technologies for chemicals manufacturing which may present energy efficiency improvements compared to existing technologies. It is an extension of a previous "Chemical Bandwidth Study," which evaluated energy and exergy losses in the US chemicals industry. Both the bandwidth study and current study were initiated by Dr. Dickson Ozokwelu, Technology Manager of the Chemicals Subprogram in ITP, and overseen by Dr. Ozokwelu and Jo Rogers of the American Institute of Chemical Engineers (AIChE). The analysis was carried out by JVP International, Inc, and Psage Research, LLC.

Questions regarding this study or the Chemical Bandwidth Study that led to this report can be directed to the following authors:

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Executive Summary

The DOE ITP "Chemical Bandwidth Study[1]" identified five technologies - Ethylene, Caustic-Chlorine, Ethylene Oxide, Ammonia and Terephthalic Acid - having the highest total exergy losses on an annualized basis (annual volume of chemical production multiplied by Total Exergy Loss per pound). [1] These five technologies were singled out for further study to identify and evaluate possible process improvements. This report summarizes the findings of this work. It suggests alternative process concepts, evaluates improvements in energy/exergy utilization, and assesses each alternative technology's commercialization potential.

For each of the selected technologies, concepts for process changes that would likely yield substantial reductions in total exergy losses were developed and evaluated. After conceptual designs for alternative processes were developed, Aspen simulations and Exergy Analyses of the designs were conducted and the results utilized to estimate capital cost and energy consumptions for each concept. Those ideas which yielded favorable results were then evaluated using DOE/ITP's CPAT software[2], which uses capital and operating cost estimates to asses the potential market penetration of new technologies. CPAT simulations were used to gauge whether the conceptual designs were economical, and, if so, the degree to which, and rate at which, the novel concepts could be deployed throughout the US chemical industry. The CPAT results allowed projections to be made of total potential U.S. energy savings that could be realized by each of the alternative technologies and these are summarized in the following Table.

Process	Annual Energy Savings by 2020 (TBtu/yr.)	Annual Energy Savings by 2030 (TBtu/yr.)
Ethylene	3.94	7.88
Caustic-Chlorine	2.44	4.87
Ethylene Oxide	0.64	5.13
Ammonia	0.21	0.21
Terephthalic Acid	6.96	19.5
TOTAL	14.19	37.59

Note: Based on energy and feedstock costs in mid 2006 (See Appendix 6).

The potential energy savings summarized above illustrate the point that even though a technology may be old and well-developed, there can still be room for substantial improvements that can be justified economically. The Chemicals ITP program provides a unique avenue for encouraging creative ways to improve the energy efficiency of the U.S. chemical industry and it is hoped that the

[1] US DOE 2006, *Chemical Bandwidth Study. Exergy Analysis: A Powerful Tool for Identifying Process Inefficiencies in the US Chemical Industry.* http://www1.eere.energy.gov/industry/chemicals/bandwidth.html,
[2] https://cpat.chemicals.govtools.us/

Bandwidth Studies and this report on Alternative Process Technologies will provide a valuable spring-board for this effort.

Ethylene: The technology evaluated involved altering the cracking equilibrium by removing hydrogen as it was formed so that higher per pass conversion could be attained. Commercial implementation would be possible if a viable separation technology, such as a ceramic or other high-temperature material membrane, could be deployed for less than about $60 million in a grass-roots ethane to ethylene plant of about 1.7 billion lbs/year capacity. A retrofit would save energy but probably would not be economical at an installed capital cost of $60 million.

Other Comments: Avenues of potential research are: (a) replacement of the pyrolysis reaction by a lower-temperature reaction not requiring quenching for ethane dehydrogenation; (b) oxydehydrogenation of ethane to ethylene and propane to propylene; (c) applying some of the novel separation technologies to the distillation section of olefin crackers. Research work in these areas has been funded in recent years by DOE. Use of other feedstocks (e.g. methanol or ethanol) to produce ethylene is actively being commercialized at this time (although ethanol to ethylene has been practiced in Brazil and India for many years).

Chlorine – Caustic: Developing alternative routes to produce chlorine is a difficult challenge. The conversion of the diaphragm cell process to higher efficiency membrane cells was evaluated as the alternative technology because there are still a number of U.S. plants using either mercury cell or diaphragm cell technology. Energy savings can clearly be achieved by a conversion to membrane technology, and the cost of conversion is paid off reasonably rapidly, particularly in an escalating energy cost environment. It is not certain that a “break-through” cell concept with substantial energy savings in comparison to membrane cells is possible – no evidence of research work in this direction has been detected.

Other Comments: The only commercialized alternative technology to produce chlorine that has been found in the patent and technical literature is the conversion of HCl to chlorine, but since HCl is itself a product of the use of chlorine, this is not a “breakthrough”. In fact, it is possible to use HCl and oxygen as a substitute for chlorine in certain reactions, such as oxychlorination. A great deal of chlorine is utilized in chemical reactions but often little or none is found in the final product. This leads to a large consumption of chlorine in the US, essentially downgrading it to HCl or a salt by-product (or waste product).

The objectives of future research in this area ought to be based not only on seeking a more energy-efficient way to produce chlorine from brine, preferably without a co-product, but also to seek process innovations that either use chlorine the moment it is formed, to eliminate the hazardous storage and shipment of chlorine, or even better, to find alternative ways to produce those products not containing chlorine, and alternative products to replace chlorine-containing products (most notably PVC).

Ethylene Oxide: Increasing the ethylene oxide (EO) concentration in the reactor effluent gases of this low conversion/pass process would have a large beneficial effect on process economics and energy intensity. The use of a micro-channel reactor design would allow operation with the reactor feed gases within the flammable envelope leading to increased reaction rate and higher outlet concentrations of EO at lower ethylene conversions, resulting in higher selectivity and EO yield and lowered costs of EO recovery and purification. There has been some work on using fluidized bed reactors in the past, but there are issues of catalyst attrition (silver losses) and adverse effects of back mixing. Both these problems can be averted by use of micro-channel reactor designs (the alternative technology evaluated in this report), and some efforts are underway in this direction. There are issues that need to be solved in terms of reaction system design and scale up, and in safely feeding oxygen uniformly into the individual micro-channels but this approach has great merit.

Other Comments: Promising avenues of research that could lead to a new, more energy-efficient production of EO include (a) use of novel separation schemes that could reduce the energy consumption associated with processing a lean reaction effluent gas, (b) performing the oxidation (epoxidation) in the liquid phase using a hydroperoxide (or hydrogen peroxide, if its cost of production could be sufficiently reduced), and (c) seeking a biocatalytic route although current bio routes produce even more dilute product streams than does the conventional process.

Ammonia: In the conventional process to produce ammonia the product concentration is limited by equilibrium, and thus reducing the amount of ammonia in the recycle stream is important in order to maximize per pass conversion and reduce recycle flow. This has traditionally been accomplished in two stages of product recovery via condensation/refrigeration which is costly and still results incomplete removal of ammonia. The approach evaluated focused on fully removing product ammonia from the recycle gases, but the barrier to success was found to be the capital and utility costs of achieving this. Water absorption was studied and rejected as being uneconomical. The use of a PSA-type adsorption-desorption system appeared to be theoretically feasible, although inadequate thermodynamic data, as well as adsorption isotherms for ammonia in candidate adsorbents, made it impossible to quantify the costs of this alternative process. Nonetheless, it was illustrated that below a certain cost, such a system would be economically viable. It is known that PSA routes are being studied but there is a serious issue regarding the physical and chemical properties of potential adsorbents particularly if they are required to operate under very wide swings in pressure and if high temperatures are required for adequate desorption. Despite these factors this route bears watching.

Other Comments: Much work had been expended through the years in improving the equipment and the catalysts associated with ammonia synthesis but the relatively poor growth prospects in the U.S. have not justified research on alternative technology concepts. Today, given the increase in biotechnology being applied to chemical production, it is intriguing to remember that nitrogen-fixing is accomplished in nature, and one wonders whether there could be a biocatalytic route to ammonia from nitrogen in the air that is awaiting invention.

Terephthalic Acid: The conventional technology to produce terephthalic acid from p-xylene oxidation is a half a century old, but economical improvements have been made through the years. The alternative process studied in this report recognizes that (a) the production of p-xylene should rightly be integrated with the production of PTA, as the only real use of the former is to produce the latter; (b) the separation of p-xylene from mixed xylene streams from refineries and crackers is a very energy-intensive step, and (c) the production of isophthalic acid from m-xylene utilizes essentially the same processing steps, with the major differences being in the solubility of the product in water and in acetic acid as a function of temperature.

The present study was based on a mixed xylenes feedstock, followed by a first cut to remove o-xylene, then feeding the mixed m- and p-xylene stream to oxidation, and separating the mixed isophthalic acid and PTA product by fractional crystallization. Quantitative solubility information of the two products was not available, but the patent literature suggests that the two products differ in their solubilities versus temperature, so the backend of the process was modeled using three stages of crystallization with appropriate recycling (two stages are used in the classical PTA process). It is believed that work is going forward on such a scheme by one organization at least, but no published work has been found.

The third xylene isomer, o-xylene, is used exclusively to produce phthalic anhydride, but by a vapor-phase catalytic oxidation. There is no evidence that the other phthalic acids could be produced by vapor phase oxidation. It is more, but not very likely, that a liquid phase oxidation of o-Xylene would be possible.

Other Comments: Fruitful areas for research would include novel separations to replace the energy-intensive crystallization steps for PTA recovery and a search for an alternative oxidation chemistry that would not require halides and acetic acid solvent. Obviously, a better way to isolation p-xylene from the mixed xylene stream would also be beneficial.

Introduction

In 2004 the Department of Energy Industrial Technologies Program (DOE ITP) initiated a "Chemical Bandwidth Study" to evaluate energy and exergy usages and losses in the U.S. chemical industry. Over 50 processes in commercial practice in the U.S. were studied and the results published in a final report[3] to DOE. The bandwidth study identified five technologies having the highest total exergy losses on an annualized basis (annual volume of chemical production multiplied by Total Exergy Loss per pound). These five technologies (Ethylene, Caustic-Chlorine, Ethylene Oxide, Ammonia and Terephthalic Acid) were singled out for further study to identify possible process improvements. This report summarizes the findings of this work. It suggests alternative process concepts, evaluates improvements in energy/exergy utilization, and assesses each alternative technology's commercialization potential.

For each of the selected technologies, concepts for process changes that would likely yield substantial reductions in total exergy losses were developed and evaluated by JVP International, Inc. After conceptual designs for alternative processes were developed, Aspen simulations and Exergy Analyses of the designs were run by Psage Research. The results were utilized by JVP International, Inc., to estimate capital cost and energy consumptions for each concept. Those ideas which yielded favorable results were then evaluated using DOE/ITP's CPAT software, [4] which uses capital and operating cost estimates to asses the potential market penetration of new technologies. CPAT simulations were used to gauge whether the concepts were economical, and if so, the degree to which, and rate at which, the novel concepts could be deployed throughout the US chemical industry. The CPAT results facilitated projections of total potential U.S. energy savings enabled by each technology.

This report includes the material balances, stream compositions and conditions, and flow sheets for both the base case and the alternative case for each of the five technologies studied. The base case flow sheets correspond to those used in the Chemical Bandwidth Study, with one exception. During the course of this study it was discovered that the base case originally used for Ethylene Oxide was a very poor representation of this technology, and an improved base case was therefore developed. For each alternative process described in this report, the results from both energy/exergy balances and CPAT simulations are discussed. CPAT simulations are based on typical fuel and feedstock costs in 2006 (Appendix 6). Results are evaluated and recommendations are provided for topics warranting further research.

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[3] US DOE 2006, *Chemical Bandwidth Study. Exergy Analysis: A Powerful Tool for Identifying Process Inefficiencies in the US Chemical Industry.* *http://www1.eere.energy.gov/industry/chemicals/bandwidth.html*,
[4] https://cpat.chemicals.govtools.us/

Details

1. Ethylene

A. Introduction

In the Bandwidth Studies, three processes to produce ethylene were studied, all based on pyrolysis of hydrocarbon feeds. The three processes differed primarily in the choice of feedstock – ethane, propane and naphtha – and while the processes increased in complexity in that order, areas of high energy intensity were similar. The ethane to ethylene process was chosen to illustrate the improvements that might be made to all three.

In the Exergy Analysis performed on the Ethane to Ethylene Process, the three sub-sections of the process that contributed the greatest energy losses and total exergy losses are Cracking, Compression and Refrigeration. The sections of the process dealing with product separation and purification did not contribute much directly, but the high refrigeration load reflects the net reboiler load of the distillation columns, which all operate at low temperature and utilize cascades of refrigerants (ethylene and propylene) to drive the various reboilers and for much of the condensation and intercooling as well.

Improving energy consumption in the distillation columns by use of vapor recompression was not considered for this study since many ethylene plants have already implemented such schemes.

A more fruitful "break-through" concept was based on the recognition that there is a large ethane recycle flow from product separation back to the cracking section because the conversion of ethane to ethylene is equilibrium-limited. Therefore, a design based on removing hydrogen as it is formed by means of a high temperature membrane separation device, in order to drive the cracking to a higher conversion per pass was chosen for evaluation. This concept has been considered by the industry but not yet implemented, in large measure due to the difficulty in engineering and fabricating high temperature membrane systems. Some work has been performed on a laboratory scale, and a patent (US 5,202,517) was found describing such work, the data from which guided our development of a material balance around the cracking section for the alternative technology case.

If an adequate membrane device could be fabricated, it would ideally be located in the tubes of the cracker, so that hydrogen could be removed as formed, maximizing the driving force of the cracking reaction. Alternatively, two cracking furnaces might operate in series, with hydrogen separation taking place between the two. For purposes of modeling, the data from the above-mentioned patent were employed along with some judgments regarding separation factors for species not included in the patent case. The cracking reaction was modeled such that the permeate left at lower pressure but at reaction temperature, while the remaining cracker outlet was at chemical equilibrium. The permeate was fed to its own transfer line exchanger, after which the cooled stream joined the main reactor effluent after its transfer line exchanger.

B. Results of Aspen Simulation/Exergy Analysis

Figures 1A and 1B below indicate the flows of energy and exergy into and out of the base case and alternative case processes. The figures in black are energy flows and the figures in red are exergy flows, with the exception that the figure in red for Q_W equaling the useful work entering or leaving the process is the same for both energy and exergy. This useful work represents the energy either absorbed (endothermic) or exported (exothermic) by the reaction(s) modeled. An arrow leaving the process represents work done by the reaction (endothermic).

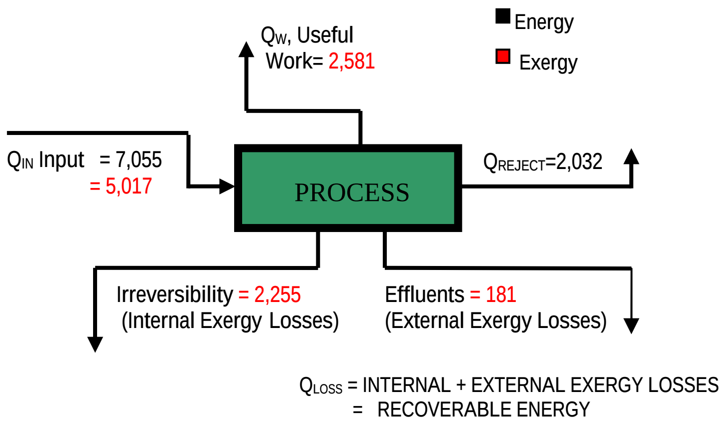


Figure 1A: Energy and Exergy Losses in Alternative Ethylene Process Technology (Btu/lb of Ethylene)

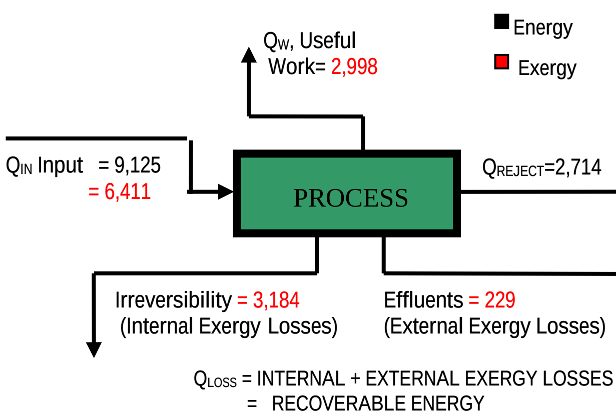


Figure 1B: Energy and Exergy Losses in Base Ethylene Process (Btu/lb of Ethylene)

As part of the output from the analysis, the energy and exergy balance around every process unit was calculated. The results of these calculations for each process unit modeled are tabulated in Table 1A in Appendix 1 - Ethylene. The figures are also totaled for each Process Section and presented below in Table 1A for the Modified Ethylene Process and 1B for the Base Ethylene Process.

Table 1A: Losses of Energy and Exergy: Alternative Ethylene Process Technology

	Energy Loss = Btu/lb		Exergy Loss = Btu/lb			
Process Sub-Section	Total = 2,799	%	Total External = 181	Total Internal = 2,255	Total = 2,436	%
Cracking	395	14	22	919	941	39
Compression	1,059	37	115	328	443	18
Refrigeration	1,340	45	32	427	459	19
Demethanization	0	3	12	189	200	8
Deethanization	4	0	0	51	51	2

Table 1B: Losses of Energy and Exergy: Base Ethylene Process

	Energy Loss = Btu/lb		Exergy Loss = Btu/lb			
Process Sub-Section	Total = 3,630	%	Total External = 229	Total Internal = 3,184	Total = 3,413	%
Cracking	494	14	40	1,601	1,640	48
Compression	1,244	34	121	338	459	13
Refrigeration	1,888	52	68	890	957	28
Demethanization	0	0	0	102	102	3
Deethanization	4	0	0	101	101	3
Product Purification	0	0	0	152	152	4

The results suggest that the proposed alternative process technology would lead to a significant mass and energy utilization improvement in producing ethylene from ethane since the lower ethane recycle translates to lower cracking load, and lower compression and refrigeration duties.

Other outputs from the Aspen simulations are a listing of process conditions and compositions of each stream shown in Table 1B in Appendix 1, and flow sheets of the process as simulated, shown as Figure 1A, 1B, 1C, 1D, and 1E in Appendix 1. Figures 1F, 1G, 1H, 1I and 1J are flowsheets for the Base Ethylene case, originally developed in the Bandwidth Study.

C. Results of CPAT Simulation and Conclusions

The simulation of the alternative case gave flow rates around the process from which the capital cost was estimated, by proration from the base case. The one missing item was the cost for the membrane separation system. That cost was parameterized, by running CPAT at different membrane system costs and choosing that which just allowed market penetration. That figure was in the range of $60 to $80 million dollars for an ethane to ethylene plant costing $400 million dollars with a capacity of 1,764 million lbs/year (800 thousand tonnes/yr) of ethylene. At a cost of $60 million, CPAT projected one unit deployed by 2020 and two units by 2030, with total annual U.S. energy savings of 3.94 TBtu/yr and 7.88 TBtu/yr respectively.

2. Chlorine - Caustic

A. Introduction

The Bandwidth Study included an analysis of the production of chlorine and caustic soda utilizing a diaphragm cell in the electrolysis section. This technology has generally replaced the original mercury cell process, but is also being slowly replaced by the more efficient membrane technology. Estimated costs and results for conversion of a diaphragm cell plant to utilize membrane cells were obtained by review of various literature sources dealing with each of the technologies as well as different approaches to converting or retrofitting one type of cell to another. The alternative process selected for this study was the retrofitting of a diaphragm cell plant with membranes.

B. Results of Aspen Simulation/Exergy Analysis

Figures 2A and 2B below indicate the flows of energy and exergy into and out of each of the two processes.

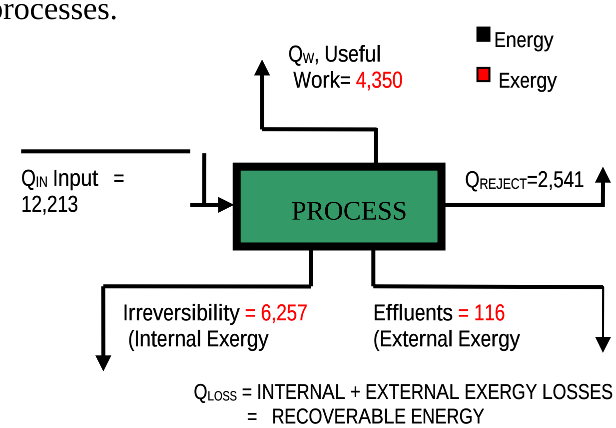


Figure 2A: Summary of Energy and Exergy Losses in Alternative Chlorine-Caustic Technology (Membrane Retrofit of Diaphragm Process Btu/lb of Cl2)

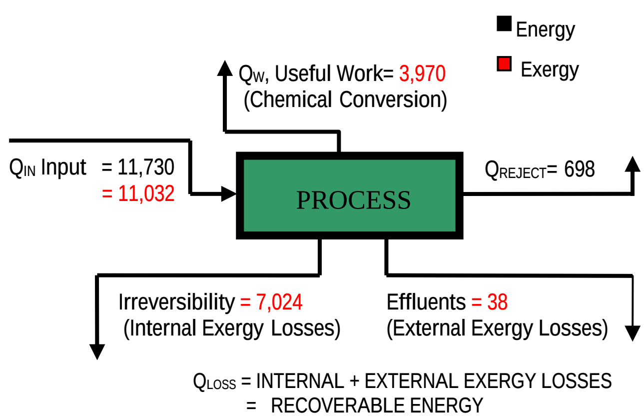


Figure 2B: Energy and Exergy Losses- Base Chlorine-Caustic Diaphragm Cell Process (Btu/lb of Cl2)

The results of the calculation of the energy and exergy balance around every process unit modeled are tabulated in Table 2A in Appendix 2 – Chlorine – Caustic Soda. The figures are also totaled for each Process Section and presented in Table 2A for the Modified Chlorine-Caustic Process and 2B for the Base Chlorine-Caustic Process.

Table 2A: Losses of Energy and Exergy in Alternative Chlorine Process Technology

	Energy Loss = Btu/lb		Exergy Loss = Btu/lb			
Process Sub-Section	Total = 1,505	%	Total External = 124	Total Internal = 6,243	Total = 6,367	%
Brine	868	58	43	24	67	1
Electrolysis	408	27	63	6058	6122	96
Gas Treatment	229	15	17	161	178	3

Table 2B: Losses of Energy and Exergy in Base Chlorine Process

	Energy Loss = Btu/lb		Total Exergy Loss = Btu/lb			
Process Sub-Section	Total = 969	%	Total External = 38 Btu/lb	Total Internal = 7,024	Total = 7,062	%
Brine	664	68	24	39	63	1
Electrolysis	0	0	0	6,395	6,395	91
Gas Treatment	228	24	14	231	245	3
Liquor	76	8	0	359	359	5

The energy/exergy input and loses in the two processes are comparable according to the analyses. The energy/exergy demand of the membrane process electrolytic cell is slightly lower because unreacted NaCl exists in the recycled brine solution but in the diaphragm process unreacted NaCl must be crystallized out of the liquor before it can be recycled. However, unlike the diaphragm process, the membrane requires stream heating to separate the desorbed chlorine from the product sodium hydroxide and compressor duty is required to compress the released chlorine to the pressure of the main chlorine product stream. In addition, the recycled brine solution is at about 160 ^{o}F and some of its heat content could be recovered for process heat by heat integration with other process streams.

One distinct advantage of the membrane process is that no sodium chloride passes to the catholyte, which offers the prospect of high purity sodium hydroxide product.

It must be noted that the model analyses (the base and the alternative cases), were not able to account for over-voltage losses, anodic or other electrolytic losses. These loses are dependent on the type of cell. In practice, membrane cells are more efficient but such details are not captured in the analyses.

Other outputs from the Aspen simulations are a listing of process conditions and compositions of each stream shown in Table 2B in Appendix 2 – Chlorine – Caustic Soda, and flow sheets of the process as simulated, shown as Figure 2A, 2B, 2C, and 2D in Appendix 2. Figures 2E, 2F, 2G, 2H, 2I and 2J are flow sheets for the Base Chlorine-Caustic Soda case, originally developed in the Bandwidth Study.

C. Results of CPAT Simulation and Conclusions

For a plant producing 287 million lb/year of chlorine, with the associated production of caustic soda and hydrogen, it was estimated that the retrofit cost was about 17% of the total investment cost, and that there was about a 10% savings in electrical power and a 50% savings in steam. The exergy analysis also indicated reductions in energy and exergy losses, but it was not possible to model the electrolytic cell itself in Aspen.

CPAT was run with figures developed from the above information, and the result was a forecast of a deployment of two retrofits by 2020 and a total of 4 retrofits by 2030. The corresponding energy savings were 2.44 TBtu/yr by 2020 and 4.87 TBtu/yr by 2030.

3. Ethylene Oxide

A. Introduction

The Bandwidth Study utilized an Ethylene Oxide (EO) flowsheet that produced 50% of its product as purified EO and the other 50% as an aqueous EO stream, intended to be fed to a downstream ethylene glycol (EG) unit (not included in the simulation). This caused a distortion (increase) in the energy and exergy losses as compared to those that would have been computed were only purified EO produced, but in fact, producing EO and EG at the same plant site is the norm.

The reactor performance in conventional EO production is limited by the flammability limit of oxygen in the hydrocarbon-rich reactor feed gas. Microchannel reaction technology has been recognized as allowing operation within the flammability envelope, provided the oxygen is mixed with the hydrocarbon within the microchannel assembly. The alternative technology studied in this work included the use of such a reaction system, with higher ethylene and oxygen concentrations fed into the reactor and a higher concentration of ethylene oxide in the reactor effluent.

In the course of running an Aspen simulation and exergy analysis of this alternative technology, it was discovered that the original base case simulation of the ethylene oxide flowsheet was seriously flawed. Therefore, a new base case was developed for EO for comparison against the alternative case employing microchannel reactor technology.

B. Results of Aspen Simulation/Exergy Analysis

Figures 3A and 3B below indicate the flows of energy and exergy into and out of each of the two processes.

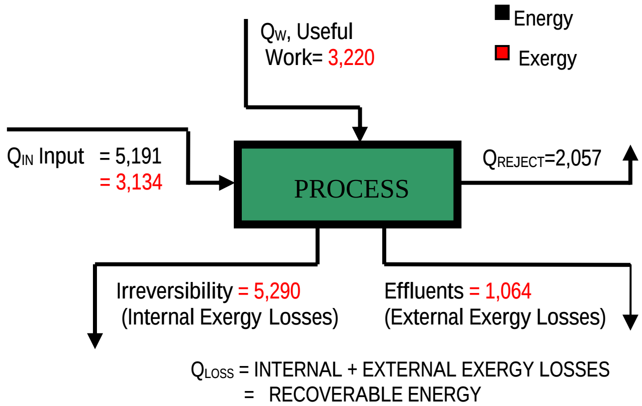


Figure 3A: Energy and Exergy Losses in Alternative Ethylene Oxide Process Technology utilizing Microchannel Reaction System (Btu/lb of EO)

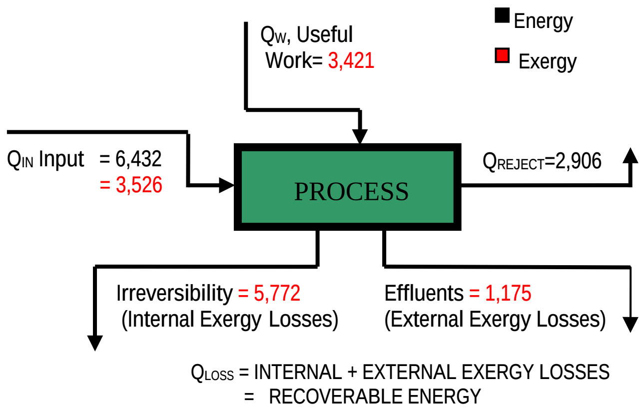


Figure 3B: Energy and Exergy Losses in NEW Base Ethylene Oxide Process (Btu/lb of EO)

The results of the calculation of the energy and exergy balance around every process unit modeled are tabulated in Appendix 3. The figures are totaled for each process section and presented in Table 3A for the alternative case and 3B for the new base case.

Table 3A: Losses of Energy and Exergy: Alternative EO Process Technology

Process Sub-Section	Energy Loss = Btu/lb		Exergy Loss = Btu/lb			
	Total = 7,125	%	Total External = 1,064	Total Internal = 5,290	Total = 6,355	%
Feed Pre-treat	0	0	0	148	148	2
CO2 -Recovery	1,784	25	307	1,027	1,334	21
Exothermic Reactor	751	11	184	2,598	2,782	44
EO Absorber	1,844	26	302	1,262	1,564	25
EO Stripper	2,589	36	263	242	505	8
EO Purification	157	2	9	13	22	0

Table 3B: Losses of Energy and Exergy: NEW Base EO Process

Process Sub-Section	Total Energy Loss = Btu/lb		Total Exergy Loss = Btu/lb			
	Total= 8,345	%	Total External = 1,175	Total Internal = 5,772	Total = 6,947	%
Feed Pre-treat	0	0	0	203	203	3
CO2 –Recovery	1,524	18	197	1,142	1,339	19
Exothermic Reactor	1,186	14	252	2,733	2,986	43
EO Absorber	1,937	23	324	1,382	1,707	25
EO Stripper	3,549	43	394	297	691	10
EO Purification	149	2	7	14	21	0

As shown in Figures 3A and 3B (also Tables 3A and 3B), the differences in energy/exergy input and losses between the two models are indicative of the enhanced efficiency of the alternative case which allows for higher reactant oxygen and ethylene concentration and lower reactor stream recycle rate. The improvement is most significant in the energy losses in the reactor and the EO stripper sections. However, since operating temperatures are relatively low, the savings in exergy losses are low.

Details of the energy/exergy losses in each section are shown in Tables 3A for the alternative EO case and 3B for the new base case. Other outputs from the Aspen simulations are a listing of process conditions and compositions of each stream shown in Table 3A for the alternative case and 3B for the new base case in Appendix 3 – Ethylene Oxide, and flow sheets of the process as simulated, shown as Figure 3A and 3B for the alternative case, and Figures 3C and 2D for the new base case, all in Appendix 3.

C. Results of CPAT Simulation and Conclusions

The higher ethylene oxide concentration in the EO reactor exit, caused by the higher ethylene and oxygen concentrations permitted by use of the microchannel reactor concept, results in a reduction of the total reactor and recycle gases, with accompanying savings in capital cost in the front end of the plant, and some recovery savings. The microchannel reaction assembly was assumed to also integrate the large gas-gas exchangers and reaction effluent cooler-steam generators as well as the boiling water cooling of the reactor itself, with this adding to the capital cost savings.

Capital cost and utilities savings were estimated based on the energy and exergy analyses of the two cases, with the only major question mark being the cost of a large microreaction assembly (modular construction). It is estimated that the total cost of the reaction section will be lower by 10%, since the large heat exchangers and steam generators in the conventional reaction loop are integrated into the microchannel reactor assembly. The cost of an industrial scale microchannel reactor system, of the complexity assumed here, is an important unknown, but as mentioned, it is assumed to replace many large pieces of equipment as well as the base case shell-and-tube reactor.

The results of this analysis were run in CPAT and resulted in expected deployment of the new technology with one plant by 2020 and a total of 8 plants by 2030, with an energy savings in 2030 of 5.13 TBtu/yr.

4. Ammonia

A. Introduction

All conventional ammonia technologies are recycle processes, with product ammonia removed in two stages of cooling/refrigeration, but with about 10% of the ammonia in the reactor effluent remaining in the gas to be recycled to the synthesis reactor. The ammonia synthesis is an equilibrium reaction, so that the maximum concentration of ammonia in the reactor effluent is related to the concentrations of unconverted hydrogen and unconverted nitrogen in the reactor effluent. Thus, any ammonia recycled to the inlet of the reactor reduces the conversion per pass of the syngas components, and therefore increases the recycle flow.

The energy saving concept in this study was to find a way to remove ammonia from the reaction system effluent gases down to very low levels, thereby reducing the size of the recycle stream and therefore the size of all of the equipment in the synthesis loop this would also result in proportionate energy savings.

The first concept attempted was to scrub the remaining ammonia from the reactor effluent (after one or two stages of cooling) with water at synthesis reaction pressure, and stripping the ammonia out of the water at close to atmospheric pressure. Based on physical data for the ammonia-water system, an absorber-stripper system was designed, but the estimated energy savings in the synthesis loop were not as great as the additional energy required by the new ammonia stripper.

A second approach was to use PSA (pressure swing adsorption) to remove the ammonia. Thermodynamic data was not readily available for ammonia-adsorbent systems, but the required process equipment, based on extrapolation from other adsorption systems, appeared quite large. The energy savings appeared to be real, however, so CPAT was used to back-calculate how much capital could be spent on an adsorption system while still having superior economics leading to deployment of the new concept. An Aspen simulation and exergy analysis were run for the case where all of the ammonia in the reactor effluent, after normal ammonia removal, was assumed to be removed in a PSA system.

B. Results of Aspen Simulation/Exergy Analysis

Figures 4A and 4B below indicate the flows of energy and exergy into and out of each of the two processes.

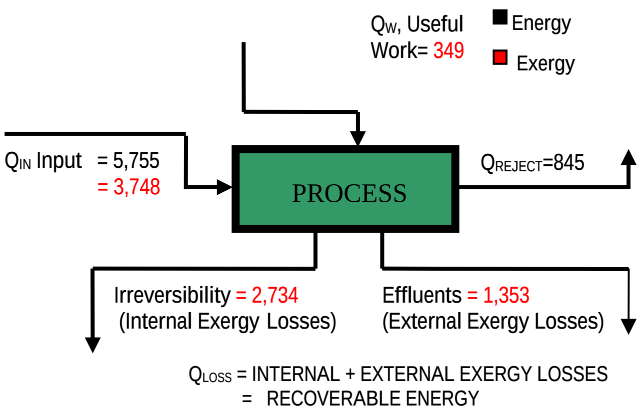


Figure 4A: Summary of Energy and Exergy Losses for Alternative Ammonia Process Technology with PSA Elimination of Recycle NH3 (Btu/lb of NH3)

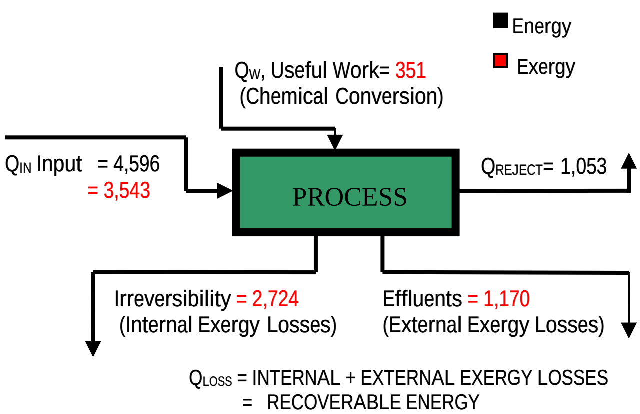


Figure 4b: Energy and Exergy Losses- Base Ammonia Process (Btu/lb of Ammonia)

The results of the calculation of the energy and exergy balance around every process unit modeled are tabulated in Table 4A in Appendix 4 - Ammonia. The figures are also totaled for each process section and presented in Table 4A for the alternative case and 4B for the base case.

Table 4A: Losses of Energy and Exergy in Modified (Absorption/Stripping) Ammonia Process

	Energy Loss = Btu/lb		Exergy Loss = Btu/lb			
Process Sub-Section	Total = 5,725	%	Total External = 1,353	Total Internal = 2,734	Total = 4,087	%
Preheating/Reforming	561	10	169	1,311	1,480	36
Shift	19	0	8	158	165	4
Gas Upgrading	2,507	44	590	175	765	19
Ammonia Synthesis	1,708	30	272	1,048	1,319	32
Residual NH_3 Removal	673	12	236	18	254	6
Heat Recovery	257	4	79	25	104	3

Table 4B: Losses of Energy and Exergy in Base Ammonia Process

	Energy Loss = Btu/lb		Exergy Loss = Btu/lb			
Process Sub-Section	Total = 5,324	%	Total External = 1,170 Btu/lb	Total Internal = 2,724 Btu/lb	Total = 3,893	%
Preheating/Reforming	556	10	206	1272	1,478	38
Shift	0	0	0	164	164	4
Gas Upgrading	2,608	49	614	182	796	20
Ammonia Synthesis	1,897	36	269	1081	1,350	35
Heat Recovery	263	5	81	25	106	3

The alternative process produces a higher ammonia yield per pass because of the more favorable equilibrium conditions provided by the reduced ammonia in the reactants. However, the first alternative process tried was more energy intensive than the base case because of the adsorption/stripping section that was first modeled to remove the residual ammonia in the recycle stream. The high energy demand in the new section was due to the high solubility of ammonia in water making it energetically expensive to recover the ammonia from the water absorbent. Another fluid with less ammonia solubility would be preferable.

The alternative flowsheet finally chosen, as explained above, used PSA to remove the ammonia. Unfortunately, this cyclical process could not be modeled using Aspen nor could its exergy balance be computed. As an estimate of the results of the use of PSA, the line in Table 4A above named “Residual NH_3 Removal” can be deleted, and new totals computed resulting in a Total Energy Loss of 5,052 Btu/lb of ammonia and a Total Exergy Loss of 3,833 Btu/lb of ammonia, both figures slightly lower than the respective figures in the base case.

Other outputs from the Aspen simulations are a listing of process conditions and compositions of each stream shown in Table 4B in Appendix 4 – Ammonia, and flow sheets of the process as simulated, shown as Figure 4A and 4B, also in Appendix 4. Figure 4C is a flowsheet for the base case.

C. Results of CPAT Simulation and Conclusions

For a 2.2 billion lbs/year ammonia plant, it was estimated that the capital cost would be reduced by $9 million (out of an ISBL of $330 million including the syngas plant). The energy savings were calculated to be surprisingly modest – about a 6% reduction in electric power and a 2% reduction in steam. At these savings, it was computed utilizing CPAT that one could afford to spend $5 million on the PSA system and get an adequate return to begin to penetrate the market. It is unlikely that this capital would be adequate, but the concept merits further review, with real adsorption data. For the case as run, one new ammonia plant was forecast by 2020 but no others by 2030, and the energy savings was a modest 0.21 TBtu/yr in each of those years.

5. Terephthalic Acid

A. Introduction

The Bandwidth study simulated a technology similar to the BP Amoco Mid-Century Process, with pure p-xylene being oxidized in the liquid phase to produce purified terephthalic acid, via crystallization. There is a similar process for producing isophthalic acid by liquid phase oxidation of m-xylene, also utilizing crystallization, and there are patents teaching a difference in solubility versus temperature for the two acids in acetic acid and in water.

Conventionally, p-xylene is obtained by feeding a mixed xylenes stream to a UOP Parex-Isomar system, or its equivalent, which converts the other xylenes to p-xylene and recovers pure p-xylene via adsorption. The mixed xylene stream itself is a co-product of using Sulfolane or another extraction process to recovery benzene from reformate. The three xylene isomers in the mixed xylene stream are at equilibrium, containing about 25% each of p-xylene and o-xylene, and about 50% of m-xylene. Since the other xylenes are recycled to extinction, there are no substantial by-products for either the p-x production or the PTA production.

The alternative technology was conceived as being fed the same mixed xylene stream to a xylenes splitter (a part of the Parex-Isomar system), which takes primarily p-x and m-x overhead, leaving o-xylene as a bottoms co-product stream. The overhead p-x/m-x mixture is fed directly to an oxidation reactor where the xylenes are converted to a mixture of terephthalic acid and isophthalic acid. Then, through a series of crystallizations at lower and lower temperatures a product stream of each acid can be separated from the other.

B. Results of Aspen Simulation/Exergy Analysis

Figures 5A and 5B below indicate the flows of energy and exergy into and out of each of the two processes.

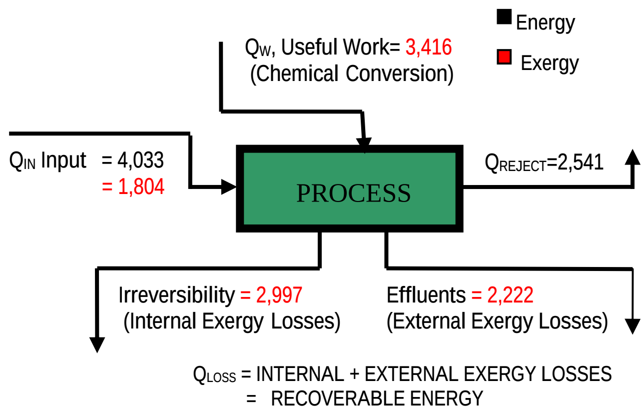


Figure 5A: Summary of Energy and Exergy Losses for Alternative Terephthalic/Isophthalic Process Technology (Btu/lb of PTA+IPA)

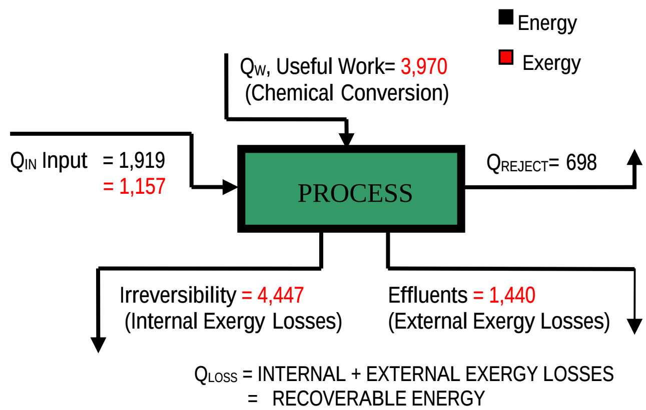


Figure 5b: Energy and Exergy Losses- Base PTA (Purified Terephthalic Acid Process (Btu/lb of PTA)

The results of the calculation of the energy and exergy balance around every process unit modeled are tabulated in Table 5A in Appendix 5 – Terephthalic Acid. The figures are also totaled for each process section and presented below in Table 5A for the alternative case (combined PTA/IPA process) and 5B for the base case.

Table 5A: Losses of Energy and Exergy in Alternative PTA/IPA Process Technology

	Energy Loss = Btu/lb PTA+IPA		Exergy Loss = Btu/lb PTA+IPA			
Process Sub-Section	Total = 9,551	%	Total External = 2, 337	Total Internal = 2,999	Total = 5,336	%
Feed Prep	1976	21	547	85	632	12
Oxidation	1808	19	642	1882	2524	47
CTA Crystallizer	2068	22	306	324	631	12
Hydrogenation	60	1	17	456	473	9
PTA/IPA Purification	1493	16	413	4	417	8
Product Purification	2145	22	412	248	659	12

Table 5B: Losses of Energy and Exergy in Base PTA Process

	Energy Loss = Btu/lb		Exergy Loss = Btu/lb			
Process Sub-Section	Total = 5,374	%	Total External = 1,440 Btu/lb	Total Internal = 4,447 Btu/lb	Total = 5,887	%
Feed Prep	0	0	0	0	0	0
Oxidation	1,943	36	657	3,635	4,292	73
CTA Crystallizer	1,766	33	288	273	561	10
Hydrogenation	49	1	11	435	446	8
PTA	1,616	30	484	104	588	10
Product Purification	0	0	0	0	0	0

Unlike the almost pure p-xylene feedstock in the base case, the alternative case feed is a commercial cut which contains light and heavy ends in addition to the equilibrium mixture of xylenes. The alternative process also differs because it produces isophthalic acid (IPA) simultaneously with PTA.

The differences in the feed and products account for the variations in energy/exergy utilization in both processes. In the front end, the alternative case requires extra energy/exergy to remove the light ends and the o-xylene (and the heavy ends); o-xylene removal from the feed is particularly energy intensive as shown by the Table 5A and Table 5B.

Furthermore, there are two aspects to the relative energy/exergy utilization between the two processes in the back end as shown by Table 5A and Table 5B. Oxidation of m-xylene to IPA is less exothermic than p-xylene to PTA and the potential energy/exergy from the alternative case reactor is therefore less than the base case. On the down side, the product purification in the alternative process requires more energy/exergy input because the process requires two series of crystallizations - the first series produces crude PTA/IPA slurry and the next stage involves slurry dissolution/and re-crystallization to produce pure PTA and IPA.

Finally, it should be recognized that the alternative case avoids the production of p-x from mixed xylenes, and there should be energy and exergy credits applied to the figures in Table 5A. These credits were not obtainable from the original Aspen simulation of mixed xylene to p-x in the Bandwidth study, as that simulation covered only a portion of the process.

Other outputs from the Aspen simulations are a listing of process conditions and compositions of each stream shown in Table 5B in Appendix 2 – Alternative PTA/IPA, and flow sheets of the process as simulated, shown as Figure 5A, 5B and 5C.also in Appendix 5. Figures 5D, 5E and 5F are flow sheets for the base case.

C. Results of CPAT Simulation and Conclusions

Because the alternative process separates the o-xylene as a co-product, the mixed xylene stream is substantially larger than that to produce the same amount of PTA via the conventional p-X and PTA combined processes. Also, the capital cost of the PTA/IPA process, for the same total acid make, is slightly larger than the conventional due to the need for at least one extra stage of crystallization.

CPAT was run to compare the base case (the combined p-X/PTA processes) against the alternative case consisting of a xylene splitter followed by the oxidation of the p-X and m-X to PTA/IPA, with o-Xylene as a co-product. The results of the run indicate deployment of the new technology with five plants by 2020 and a total of 14 plants by 2030, with an energy savings in 2030 of 19.5 TBtu/yr.

Conclusions and Recommendations

1. Ethylene

This case illustrated that a process scheme in which the cracking equilibrium was pushed to higher conversion per pass by removing hydrogen as it is formed would give a substantial energy intensity advantage. This seems to represent a fruitful avenue for future research. Commercial implementation would be possible if a viable separation technology, such as a ceramic or other high-temperature material membrane, could be deployed for less than about $60 million in a grass-roots ethane to ethylene plant of about 1.7 billion lbs/year capacity; in addition such a grass roots facility would also save substantial capital due to the lower recycle flow of ethane. A retrofit would save energy but probably would not be economical at an installed capital cost of $60 million.

The Bandwidth Study on ethylene from propane, naphtha and ethane contained other avenues of potentially valuable research, such as replacement of the pyrolysis reaction by a lower-temperature reaction not requiring quenching (ethane dehydrogenation and oxydehydrogenation are obvious possibilities for ethane to ethylene and propane to propylene, but it is unclear what might transpire if one would attempt such a step on naphtha feedstock). Applying some of the novel separation technologies to the distillation section of olefin crackers is another obvious choice. Research work in all of the above areas has been funded in recent years by DOE, with the exception of the hydrogen-separation proposal studied here.

Using other feedstocks to produce ethylene such as methanol or ethanol was also noted in the Bandwidth Study, and both are actively being commercialized at this time (although ethanol to ethylene has been practiced in Brazil and India for many years).

2. Chlorine – Caustic

Developing alternative routes to produce chlorine is a difficult challenge. The conversion of the diaphragm cell to higher efficiency membrane cells was evaluated as the alternative technology because there are still a number of U.S. plants using either mercury cell or diaphragm cell technology. Energy savings can clearly be achieved by a conversion to membrane technology, and the cost of conversion is paid off reasonably rapidly, particularly in these recent years with escalating energy costs. It is not certain that a "break-through" cell concept with substantial energy savings in comparison to membrane cells is possible – no evidence of research work in this direction has been detected.

The only commercialized alternative technology to produce chlorine that has been found in the patent and technical literature is the conversion of HCl to chlorine, but since HCl is itself a product of the use of chlorine, this is not a "breakthrough". In fact, it is possible to use HCl and oxygen as a substitute for chlorine in certain reactions, such as oxychlorination. In the Bandwidth Study, it was noted that a great deal of chlorine is utilized in chemical reactions but often little or none is found in the final product. This leads to a large consumption of chlorine in the US, essentially downgrading it to HCl or a salt by-product (or waste product).

The objectives of future research in this area ought to be based not only on seeking a more energy-efficient way to produce chlorine from brine, preferably without a co-product, but also to seek process innovations that either use chlorine the moment it is formed, to eliminate the hazardous storage and shipment of chlorine, or even better, to find alternative ways to produce those products not containing chlorine, and alternative products to replace chlorine-containing products (most notably PVC).

3. Ethylene Oxide

This case illustrates that finding a way to increase the ethylene oxide concentration in the reactor effluent gases of this low conversion/pass process can have a large beneficial effect on process economics and energy intensity. The use of a microchannel reactor design or a fluidized bed reactor allows operating with the reactor feed gases within the flammable envelope, which increases reaction rate and allows higher outlet concentrations of EO at lower ethylene conversions, resulting in higher selectivity and EO yield and lowered costs of EO recovery and purification. There has been some work on using fluidized bed reactors in the past, but there are issues of catalyst attrition (silver losses) and adverse effects of back mixing. Both these problems can be averted by use of microchannel reactor designs, and some efforts are underway in this direction. There are different issues that need to be solved – mechanical ones in terms of reaction system design and scale up, and in safely feeding oxygen uniformly into the individual microchannels but this approach has great merit.

Other promising avenues of research that could lead to a new, more energy-efficient production of EO including use of novel separation schemes that could reduce the energy consumption associated with the lean reaction gases, by performing the oxidation (epoxidation) in the liquid phase using a hydroperoxide (or hydrogen peroxide, if its cost of production could be sufficiently reduced). Finally, there has been work in the past seeking a biocatalytic route to produce EO – this is an idea that is still worth pursuing, although current bio routes produce even more dilute product streams than does the conventional process.

4. Ammonia

The conventional process to produce ammonia is another case where the product concentration is limited by equilibrium, and the reduction of recycle ammonia has traditionally been accomplished in two stages of product recovery by condensation, the second under substantial refrigeration. The current study has illustrated the benefit to process economics and energy-efficiency of being able to fully remove product ammonia from the recycle gases, but the barrier to success is the capital and utility costs of alternative ways to remove ammonia.

In this study, water absorption was studied and rejected, and the use of a PSA-type adsorption-desorption system appeared to be theoretically feasible, although inadequate thermodynamic data, as well as adsorption isotherms for ammonia in candidate adsorbents, made it impossible to quantify the costs of the alternative process. Rather, it was illustrated that below a certain cost, such a system would be economically viable. It is known that PSA routes are being studied but there is a serious issue regarding the physical and chemical properties of potential adsorbents particularly if they are required to operate under very high swings in pressure and if high temperatures are required for adequate desorption. Despite these factors this route bears watching.

The Bandwidth Study recognized that much work had been expended through the years in improving the equipment and the catalysts associated with ammonia synthesis, and that the relatively poor growth prospects in the U.S. did not justify high levels of expenditure to research improved or alternative technology concepts. Nonetheless, given the growth in biotechnology being applied to chemical production, it is intriguing to remember that nitrogen-fixing is accomplished in nature, and one wonders whether there could be a biocatalytic route to ammonia from nitrogen in the air that is awaiting invention.

5. Terephthalic Acid

The conventional technology to produce terephthalic acid from p-xylene oxidation is a half a century old, but economical improvements have been made through the years, some of which have reduced its energy intensity as well. The alternative process studied in this report recognizes that the production of p-xylene should rightly be integrated with the production of PTA, as the only real use of the former is to produce the latter. It further recognizes that the separation of p-xylene from mixed xylene streams from refineries and crackers is a very energy-intensive step in its own right. Finally, it was recognized that the production of isophthalic acid from m-xylene utilizes essentially the same processing steps, with the major differences being in the solubility of the product in water and in acetic acid as a function of temperature.

The present study therefore started with mixed xylenes, made a first cut removing o-xylene, and then feeds the mixed m- and p-xylene stream to oxidation, and separates the isophthalic acid and PTA product by fractional crystallization. Quantitative solubility information of the two products was not available, but the patent literature suggests that the two products differ in their solubilities versus temperature, so the flowsheet evaluated used three stages of crystallization with appropriate recycling of streams versus two in the classical PTA process. It is believed that work is going forward on such a scheme by one organization at least, but no published work has been found.

The third xylene isomer, o-xylene, is used exclusively to produce phthalic anhydride, but by a vapor-phase catalytic oxidation. There is no evidence that the other phthalic acids could be produced by vapor phase oxidation. It is more probable that a liquid phase oxidation of o-Xylene could be used, though this scenario is also unlikely.

The Bandwidth Study suggested novel separations to replace the energy-intensive crystallization steps for PTA recovery and a search for an alternative oxidation chemistry that would not require halides and acetic acid solvent. Obviously, a better way to isolation p-xylene from the mixed xylene stream would also be beneficial.

6. Final Conclusions

The cases studied illustrate that even though a technology may be old and well-developed, there can still be room for economically justifiable energy efficiency improvements. Based on commercialization assessments conducted with DOE's CPAT software, the alternative technologies discussed in this report have the potential to compete with and improve on prevailing technologies in US industry. These technologies may become increasingly viable if fuel and feedstock prices continue increasing (calculations in this study were based on 2006 fuel/feedstock prices, as shown in Appendix 6). The important message is that researchers and process developers must be well-acquainted with current technologies and their short-comings and with the continuing series of emerging technological concepts coming out of innovative organizations. They must also be capable of developing conceptual economics around new process concepts in order to establish technical and economic hurdles that new concepts must clear in order for commercialization to be a reality. It is important for process developers to continuously revisit the old, and to see whether lessons learned in one area might have application in another. The DOE ITP program provides a unique opportunity for researchers to do just that, and it is hoped that the Bandwidth Studies and this report on Alternative Process Technologies can help achieve that goal.

Appendix 1 – Ethylene

Table 1A: Alternative Ethylene from Ethane Production Process Technology – Energy and Exergy Loss Profile

Unit OP	Type	Energy Loss = Btu/lb		Exergy Loss = Btu/lb			
		Total = 2,799	%	Total External = 181	Total Internal = 2,255	Total = 2,436	%
CRACKING							
CRACKING..F-101-9	Cracking Furnace	0	0	0	484	484	19.86
CRACKING..E-115	Steam Generator	0	0	0	1	1	0.03
CRACKING..M-2	Mixer	0	0	0	2	2	0.1
CRACKING..M-3	Mixer	0	0	0	32	32	1.31
CRACKING..E-114	Steam Generator	0	0	0	0	0	-0.01
CRACKING..M-5	Mixer	0	0	0	0	0	0.01
CRACKING..M-6	Mixer	0	0	0	11	11	0.44
CRACKING..E-113-1	Process Exchanger	0	0	0	10	10	0.4
CRACKING..P-101	Pump	0	0	0	0	0	0
CRACKING..E-101-9	Transfer Line Exchanger	0	0	0	201	201	8.24
CRACKING..SEP-10	Separator	0	0	0	-1	-1	-0.05
CRACKING..V-SEP2	Separator	0	0	0	0	0	0
CRACKING..SPL-OIL	Flow Splitter	0	0	0	0	0	0
CRACKING..C-102	Dissolved Gas Splitter	0	0	0	3	3	0.13
CRACKING..FSP-11	Flow Splitter	0	0	0	0	0	0
CRACKING..E-110A	Water Cooler	387	13.82	22	24	46	1.9
CRACKING..C-101	Gasoline Fractionator	0	0	0	48	48	1.95
CRACKING..MIX-OIL	Mixer	0	0	0	0	0	0
CRACKING..ZE-EFF1	Cooler	1	0.04	0	0	0	0.01
CRACKING..ZE-EFF3	Cooler	7	0.25	0	1	1	0.06
CRACKING..E-BFW	BFW Heater	0	0	0	104	104	4.26
CRACKING..MIX-10	Mixer	0	0	0	62	62	2.56
CRACKING..E-BFW2	BFW Heater	0	0	0	38	38	1.56
CRACKING..E-101-9B	Boiler	0	0	0	72	72	2.95
COMPRESSION							
COMPRESS..E-201	Heater	0	0	0	13	13	0.55
COMPRESS..R-201A	Acetylene Hydrogenator	53	1.9	21	21	42	1.71
COMPRESS..E-202-3	Water Cooler	403	14.41	38	54	92	3.76
COMPRESS..E-204	Water Cooler	172	6.16	20	10	30	1.22
COMPRESS..V-204	Flash Drum	0	0	0	0	0	0
COMPRESS..E-205	Water Cooler	192	6.85	10	19	29	1.18

Table 1A: Alternative Ethylene from Ethane Production Process Technology – Energy and Exergy Loss Profile (Cont'd)

Unit OP	Type	Energy Loss = Btu/lb		Exergy Loss = Btu/lb			
		Total	%	Total External	Total Internal	Total	%
COMPRESS..M-1	Mixer	0	0	0	0	0	0.02
COMPRESS..M-2	Mixer	0	0	0	0	0	0.01
COMPRESS..V-206	Separator	0	0	0	0	0	0.01
COMPRESS..C-202-4	Dehydrator	5	0.19	0	0	0	0
COMPRESS..V-203	Separator	0	0	0	0	0	0.01
COMPRESS..V-201	Separator	0	0.02	0	0	0	-0.01
COMPRESS..V-207	Knock-Out Drum	2	0.06	0	0	0	-0.02
COMPRESS..V-202							
COMPRESS..K-204	4th Stage Comp.	127	4.55	3	34	37	1.51
COMPRESS..K-202A	2nd STAGE COMP	38	1.37	10	34	44	1.82
COMPRESS..K-203A	3rd Stage Comp	52	1.87	13	32	45	1.85
COMPRESS..C-201	Caustic Wash Column	0	0	0	0	0	0.02
COMPRESS..K-201	1st Stage Compressor	0	0	0	31	31	1.27
COMPRESS..ZE-EFF5	Cooler	13	0.47	0	0	0	0.01
COMPRESS..ZE-EFF6	Cooler	0	0	0	0	0	0
REFRIGER							
REFRIGER..E-312	Process Exchanger	0	0	0	9	9	0.39
REFRIGER..M-1	Mixer	0	0	0	0	0	0
REFRIGER..E-309-11	Process Exchanger	0	0	0	7	7	0.27
REFRIGER..M-2	Mixer	0	0	0	0	0	0
REFRIGER..M-3	Mixer	0	0	0	0	0	0
REFRIGER..S-1	Flow-Splitter	0	0	0	0	0	0
REFRIGER..E-306-8	Process Exchanger	0	0	0	32	32	1.31
REFRIGER..S-2	Flow-Splitter	0	0	0	0	0	0
REFRIGER..M-4	Mixer	0	0	0	0	0	0
REFRIGER..M-5	Mixer	0	0	0	8	8	0.33
REFRIGER..V-1	Valve	0	0	0	16	16	0.64
REFRIGER..V-2	Valve	0	0	0	3	3	0.11
REFRIGER..V-3	Valve	0	0	0	28	28	1.15
REFRIGER..E-320-2	Process Exchanger	0	0	0	10	10	0.41
REFRIGER..E-317	Process Exchanger	0	0	0	0	0	0.01
REFRIGER..E-207	Process Exchanger	0	0	0	1	1	0.02
REFRIGER..M-7	Mixer	0	0	0	0	0	0
REFRIGER..M-8	Mixer	0	0	0	0	0	0
REFRIGER..M-9	Mixer	0	0	0	0	0	0

Table 1A: Alternative Ethylene from Ethane Production Process Technology – Energy and Exergy Loss Profile (Cont'd)

Unit OP	Type	Energy Loss = Btu/lb		Exergy Loss = Btu/lb			
		Total	%	Total External	Total Internal	Total	%
REFRIGER..S-3	Flow-Splitter	0	0	0	0	0	0
REFRIGER..S-4	Flow-Splitter	0	0	0	0	0	0
REFRIGER..S-5	Flow-Splitter	0	0	0	0	0	0
REFRIGER..E-404-10	Process Exchanger	1205	43.06	29	48	77	3.16
REFRIGER..V-7	Valve	0	0	0	12	12	0.48
REFRIGER..V-6	Valve	0	0	0	14	14	0.56
REFRIGER..S-6	Flow-Splitter	0	0	0	0	0	0
REFRIGER..V-5	Valve	0	0	0	23	23	0.95
REFRIGER..M-10	Mixer	0	0	0	7	7	0.27
REFRIGER..V-4	Valve	0	0	0	19	19	0.8
REFRIGER..M-11	Mixer	0	0	0	8	8	0.32
REFRIGER..V-401	Flash Drum	0	0	0	0	0	0
REFRIGER..V-402	Flash Drum	0	0	0	0	0	0.01
REFRIGER..V-403	Flash Drum	0	0	0	0	0	0
REFRIGER..V-404	Flash Drum	0	0	0	0	0	0
REFRIGER..V-405	Flash Drum	0	0	0	0	0	0
REFRIGER..V-406	Flash Drum	0	0	0	0	0	0
REFRIGER..M-15	Mixer	0	0	0	0	0	0
REFRIGER..E-402-3A	Process Exchanger	0	0	0	69	69	2.82
REFRIGER..E-401A	Process Exchanger	0	0	0	20	20	0.82
REFRIGER..K-401A	Methane Comp	0	0	0	15	15	0.62
REFRIGER..K-402A	Ethylene Comp	0	0	0	12	12	0.5
REFRIGER..K-403A	Ethylene Comp	46	1.63	3	67	70	2.89
REFRIGER..K-404A	Propylene Comp	0	0	0	78	78	3.19
REFRIGER..K-405A	Propylene Comp	25	0.9	2	98	100	4.11
REFRIGER..K-406A	Propylene Comp	64	2.29	10	53	63	2.59
DEMETHANIZATION							
PURIFICA..C-301	Demethanizer	0	0	0	36	36	1.47
PURIFICA..E-301A	Process Exchanger	0	0	0	1	1	0.06
PURIFICA..V-301	Knock-Out Drum	0	0	0	0	0	0
PURIFICA..V-302	Knock-Out Drum	0	0	0	0	0	0
PURIFICA..M-1	Mixer	0	0	0	1	1	0.04
DEETHANIZER							
PURIFICA..C-302	De-ethanizer	0	0	0	50	50	2.07
PURIFICA..E-319	Process Exchanger	4	0.15	0	0	1	0.02
PURIFICA..E-314-16	Process Exchanger	0	0	0	0	0	0
PURIFICA..DRUM	Knock-Out Drum	0	0	0	0	0	0
PRODUCT PURIFICATION							
PURIFICA..C-303	Ethylene Column	0	0	0	170	170	6.97

Table 1B: Alternative Ethylene from Ethane Production Process Technology – Stream Tables

Stream ID	COMPRES S.->10	COMPRES S.->10A	COMPRES S.->10B	COMPRES S.->14	COMPRES S.->14A	COMPRES S.->14B	COMPRES S.->14C	COMPRES S.->14D
Temperature F	125.76	243.30	428.00	109.00	105.00	109.88	157.68	-459.67
Pressure psi	18.00	44.00	44.00	44.00	219.00	98.00	98.00	44.00
Vapor Frac	0.98	1.00	1.00	0.05	0.00	0.05	0.00	0.00
MoleFlow lbmol/hr	5956.	5956.	5956.	389.	198.	389.	170.	0.
MassFlow lb/hr	101838.	101838.	101838.	7531.	3571.	7531.	3065.	0.
H2	4573.	4573.	4573.	1.	0.	1.	0.	0.
METHA-01	4109.	4109.	4109.	8.	0.	8.	0.	0.
ACETY-01	269.	269.	269.	0.	0.	0.	0.	0.
ETHYL-01	65352.	65352.	65352.	208.	0.	208.	0.	0.
ETHAN-01	10721.	10721.	10721.	60.	0.	60.	0.	0.
PROPY-01	1885.	1885.	1885.	26.	0.	26.	0.	0.
PROPA-01	539.	539.	539.	17.	0.	17.	0.	0.
1-BUT-01	1895.	1895.	1895.	202.	0.	202.	0.	0.
2-MET-01	1177.	1177.	1177.	373.	0.	373.	0.	0.
OIL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	11317.	11317.	11317.	6636.	3571.	6636.	3065.	0.
SODIU-01	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	2036564.42	1018993.14	1289296.13	2861.98	58.47	1270.15	51.73	0.00
Enthalpy MMBtu/hr	-33.58	-24.64	-12.68	-45.79	-24.51	-45.79	-20.86	0.00
Stream ID	COMPRES S.->15	COMPRES S.->16	COMPRES S.->17	COMPRES S.->20	COMPRES S.->20A	COMPRES S.->20B	COMPRES S.->20C	COMPRES S.->20D
Temperature F	109.00	109.00	109.00	148.62	428.00	133.00	263.00	147.00
Pressure psi	44.00	44.00	44.00	44.00	44.00	44.00	98.00	98.00
Vapor Frac	0.75	0.72	0.00	1.00	1.00	0.94	1.00	0.96
MoleFlow lbmol/hr	14.	9.	366.	5672.	5908.	5908.	5672.	5672.
MassFlow lb/hr	393.	523.	6615.	97581.	101838.	101838.	97581.	97581.
H2	0.	1.	0.	4453.	4453.	4453.	4453.	4453.
METHA-01	0.	8.	0.	4288.	4288.	4288.	4288.	4288.
ACETY-01	0.	0.	0.	0.	0.	0.	0.	0.
ETHYL-01	187.	19.	2.	64283.	64283.	64283.	64283.	64283.
ETHAN-01	59.	1.	0.	12179.	12179.	12179.	12179.	12179.
PROPY-01	0.	0.	26.	1853.	1853.	1853.	1853.	1853.
PROPA-01	0.	0.	17.	572.	572.	572.	572.	572.
1-BUT-01	81.	121.	0.	2520.	2520.	2520.	2520.	2520.
2-MET-01	0.	373.	0.	373.	373.	373.	373.	373.
OIL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	66.	0.	6570.	7060.	11317.	11317.	7060.	7060.
SODIU-01	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	1400.57	851.75	254.80	838276.08	1278756.20	796459.76	447374.34	359434.93
Enthalpy MMBtu/hr	-0.37	-0.36	-45.08	-9.07	-16.07	-41.78	-2.64	-13.64

Table 1B: Alternative Ethylene from Ethane Production Process Technology – Stream Tables – Cont'd

Stream ID	COMPRES S.->20E	COMPRES S.->20F	COMPRES S.->20G	COMPRES S.->21	COMPRES S.->21A	COMPRES S.->21C	COMPRES S.->21D	COMPRES S.->22
Temperature F	157.68	254.80	105.00	96.41	105.00	90.00	60.00	100.00
Pressure psi	98.00	219.00	219.00	219.00	219.00	505.00	505.00	219.00
Vapor Frac	1.00	1.00	0.96	1.00	1.00	1.00	1.00	0.00
MoleFlow lbmol/hr	5502.	5502.	5502.	5298.	5303.	5298.	5298.	94.
MassFlow lb/hr	94516.	94516.	94516.	90844.	90945.	90844.	90844.	1900.
H2	4453.	4453.	4453.	4453.	4453.	4453.	4453.	0.
METHA-01	4288.	4288.	4288.	4288.	4288.	4288.	4288.	0.
ACETY-01	0.	0.	0.	0.	0.	0.	0.	0.
ETHYL-01	64282.	64282.	64282.	64282.	64282.	64282.	64282.	0.
ETHAN-01	12179.	12179.	12179.	12179.	12179.	12179.	12179.	0.
PROPY-01	1853.	1853.	1853.	1853.	1853.	1853.	1853.	0.
PROPA-01	572.	572.	572.	572.	572.	572.	572.	0.
1-BUT-01	2520.	2520.	2520.	2520.	2520.	2520.	2520.	0.
2-MET-01	373.	373.	373.	373.	373.	373.	373.	0.
OIL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	3994.	3994.	3994.	323.	423.	323.	323.	1520.
SODIU-01	0.	0.	0.	0.	0.	0.	0.	380.
VolFlow cuft/hr	369462.62	191500.83	144162.92	141584.65	144104.46	59043.12	55117.34	29.43
Enthalpy MMBtu/hr	8.89	14.13	1.90	26.56	26.41	25.33	23.93	-11.91
Stream ID	COMPRES S.->22A	COMPRES S.->23A	COMPRES S.->24	COMPRES S.->25	COMPRES S.->26	COMPRES S.->27	COMPRES S.->27A	COMPRES S.->DRAIN
Temperature F	104.97	85.00	60.00	60.00	-459.67	60.00	60.00	105.53
Pressure psi	219.00	219.00	505.00	505.00	0.00	505.00	505.00	14.70
Vapor Frac	0.00	0.00	1.00	0.06	0.00	1.00	0.00	0.00
MoleFlow lbmol/hr	1421.	1321.	5278.	20.	0.	5260.	18.	1421.
MassFlow lb/hr	25801.	23800.	89950.	894.	0.	89627.	323.	25800.
H2	0.	0.	4452.	1.	0.	4452.	0.	0.
METHA-01	0.	0.	4280.	8.	0.	4280.	0.	0.
ACETY-01	0.	0.	0.	0.	0.	0.	0.	0.
ETHYL-01	0.	0.	64074.	208.	0.	64074.	0.	0.
ETHAN-01	0.	0.	12119.	60.	0.	12119.	0.	0.
PROPY-01	0.	0.	1827.	26.	0.	1827.	0.	0.
PROPA-01	0.	0.	555.	17.	0.	555.	0.	0.
1-BUT-01	0.	0.	2319.	202.	0.	2319.	0.	0.
2-MET-01	0.	0.	0.	373.	0.	0.	0.	0.
OIL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	25420.	23800.	323.	0.	0.	0.	323.	25420.
SODIU-01	380.	0.	0.	0.	0.	0.	0.	380.
VolFlow cuft/hr	419.17	385.39	54966.57	38.80	0.00	54844.91	5.16	419.28
Enthalpy MMBtu/hr	-175.99	-163.93	24.23	-0.42	0.00	26.12	-2.23	-175.99

Table 1B: Alternative Ethylene from Ethane Production Process Technology – Stream Tables – Cont'd

Stream ID	COMPRESS.->DRAIN-EF	COMPRESS.->VENT	COMPRESS.->VENT-EFF	COMPRESS.->WASTE	CRACKING.->1	CRACKING.->2	CRACKING.->2A	CRACKING.->3
Temperature F	77.00	105.53	77.00	148.62	50.00	17.29	247.44	60.00
Pressure psi	14.70	14.70	14.70	44.00	80.00	270.00	270.00	80.00
Vapor Frac	0.00	1.00	0.96	0.00	1.00	0.57	1.00	0.00
MoleFlow lbmol/hr	1421.	0.	0.	236.	2609.	420.	420.	197.
MassFlow lb/hr	25800.	0.	0.	4257.	78595.	12851.	12851.	3554.
H2	0.	0.	0.	0.	0.	0.	0.	0.
METHA-01	0.	0.	0.	0.	0.	0.	0.	0.
ACETY-01	0.	0.	0.	0.	0.	0.	0.	0.
ETHYL-01	0.	0.	0.	0.	584.	64.	64.	0.
ETHAN-01	0.	0.	0.	0.	77400.	12056.	12056.	0.
PROPY-01	0.	0.	0.	0.	611.	638.	638.	0.
PROPA-01	0.	0.	0.	0.	0.	94.	94.	0.
1-BUT-01	0.	0.	0.	0.	0.	0.	0.	0.
2-MET-01	0.	0.	0.	0.	0.	0.	0.	0.
OIL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	25420.	0.	0.	4257.	0.	0.	0.	3554.
SODIU-01	380.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	413.46	6.61	6.04	71.47	169455.07	3601.21	11121.00	56.79
Enthalpy MMBtu/hr	-176.83	0.00	0.00	-29.01	-93.42	-15.78	-13.48	-24.59
Stream ID	CRACKING.->4	CRACKING.->4A	CRACKING.->4B	CRACKING.->5	CRACKING.->6	CRACKING.->6A	CRACKING.->7-IN	CRACKING.->7-OUT
Temperature F	314.09	227.69	227.28	314.09	186.71	78.13	500.00	500.00
Pressure psi	80.00	80.00	18.00	80.00	80.00	80.00	23.00	23.00
Vapor Frac	1.00	0.00	0.00	0.66	0.89	1.00	1.00	1.00
MoleFlow lbmol/hr	573.	573.	573.	770.	3800.	3030.	3634.	3634.
MassFlow lb/hr	10318.	10318.	10318.	13872.	105319.	91447.	90010.	90010.
H2	0.	0.	0.	0.	0.	0.	482.	482.
METHA-01	0.	0.	0.	0.	0.	0.	2055.	2055.
ACETY-01	0.	0.	0.	0.	0.	0.	269.	269.
ETHYL-01	0.	0.	0.	0.	648.	648.	61335.	61335.
ETHAN-01	0.	0.	0.	0.	89456.	89456.	5331.	5331.
PROPY-01	0.	0.	0.	0.	1249.	1249.	1885.	1885.
PROPA-01	0.	0.	0.	0.	94.	94.	539.	539.
1-BUT-01	0.	0.	0.	0.	0.	0.	1815.	1815.
2-MET-01	0.	0.	0.	0.	0.	0.	2428.	2428.
OIL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	10318.	10318.	10318.	13872.	13872.	0.	13872.	13872.
SODIU-01	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	57564.27	181.90	181.85	51447.81	284343.67	209283.40	1625086.08	1625086.08
Enthalpy MMBtu/hr	-58.52	-69.37	-69.37	-83.10	-190.01	-106.91	-24.00	-24.00

Table 1B: Alternative Ethylene from Ethane Production Process Technology – Stream Tables – Cont'd

Stream ID	CRACKING.->7A	CRACKING.->7A1	CRACKING.->7A2	CRACKING.->7A2-1	CRACKING.->8B	CRACKING.->9-OUT	CRACKING.->9C	CRACKING.->9F
Temperature F	1512.00	1512.00	1512.00	500.00	490.71	295.21	276.99	257.00
Pressure psi	23.00	23.00	18.00	18.00	600.00	18.00	18.00	18.00
Vapor Frac	1.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00
MoleFlow lbmol/hr	6106.	3634.	2472.	2472.	4725.	1167.	1167.	1167.
MassFlow lb/hr	105319.	90010.	15309.	15309.	85126.	285855.	285855.	285855.
H2	4573.	482.	4092.	4092.	0.	0.	0.	0.
METHA-01	4109.	2055.	2055.	2055.	0.	2.	2.	2.
ACETY-01	269.	269.	0.	0.	0.	1.	1.	1.
ETHYL-01	65167.	61335.	3832.	3832.	0.	136.	136.	136.
ETHAN-01	10662.	5331.	5331.	5331.	0.	15.	15.	15.
PROPY-01	1885.	1885.	0.	0.	0.	11.	11.	11.
PROPA-01	539.	539.	0.	0.	0.	3.	3.	3.
1-BUT-01	1815.	1815.	0.	0.	0.	22.	22.	22.
2-MET-01	2428.	2428.	0.	0.	0.	56.	56.	56.
OIL	0.	0.	0.	0.	0.	285236.	285236.	285236.
WATER	13872.	13872.	0.	0.	85126.	373.	373.	373.
SODIU-01	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	5619481.45	3344514.56	2906186.44	1414910.11	68991.52	4722.55	4679.22	4633.12
Enthalpy MMBtu/hr	66.57	41.53	25.03	1.07	-479.14	-376.34	-378.64	-381.12
Stream ID	CRACKING.->10	CRACKING.->10-OUT	CRACKING.->10Z	CRACKING.->11ZZ	CRACKING.->12	CRACKING.->15	CRACKING.->16	CRACKING.->17
Temperature F	125.76	109.95	109.95	124.41	90.00	109.00	109.00	109.00
Pressure psi	18.00	18.00	18.00	18.00	18.00	44.00	44.00	44.00
Vapor Frac	0.98	0.87	0.03	0.00	0.00	0.75	0.72	0.00
MoleFlow lbmol/hr	5956.	3485.	646.	144.	3.	14.	9.	366.
MassFlow lb/hr	101838.	86529.	12597.	2601.	800.	393.	523.	6615.
H2	4573.	482.	0.	0.	0.	0.	1.	0.
METHA-01	4109.	2055.	0.	0.	0.	0.	8.	0.
ACETY-01	269.	269.	0.	0.	0.	0.	0.	0.
ETHYL-01	65352.	61521.	0.	0.	0.	187.	19.	2.
ETHAN-01	10721.	5390.	0.	0.	0.	59.	1.	0.
PROPY-01	1885.	1885.	0.	0.	0.	0.	0.	26.
PROPA-01	539.	539.	0.	0.	0.	0.	0.	17.
1-BUT-01	1895.	1895.	0.	0.	0.	81.	121.	0.
2-MET-01	1177.	1177.	1249.	0.	0.	0.	373.	0.
OIL	0.	0.	28.	0.	800.	0.	0.	0.
WATER	11317.	11317.	11320.	2601.	0.	66.	0.	6570.
SODIU-01	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	2036564.42	1021554.46	6203.55	43.06	12.00	1400.57	851.75	254.80
Enthalpy MMBtu/hr	-33.58	-34.66	-78.80	-17.80	-1.12	-0.37	-0.36	-45.08

Table 1B: Alternative Ethylene from Ethane Production Process Technology – Stream Tables – Cont'd

Stream ID	CRACKING.->18	CRACKING.->COND-IN	CRACKING.->COND-OUT	CRACKING.->EF-VAP	CRACKING.->LIQ	CRACKING.->LIQ11	CRACKING.->LIQ13A	CRACKING.->LO-EFF
Temperature F	76.66	270.23	270.24	77.00	295.21	124.41	124.41	77.00
Pressure psi	18.00	39.70	39.70	14.70	18.00	18.00	18.00	14.70
Vapor Frac	0.38	0.00	0.20	0.05	0.00	0.00	0.00	0.00
MoleFlow lbmol/hr	27.	700.	700.	22.	1171.	628.	18.	3.
MassFlow lb/hr	1810.	12618.	12618.	418.	286655.	11310.	1287.	800.
H2	1.	0.	0.	0.	0.	0.	0.	0.
METHA-01	8.	0.	0.	0.	2.	0.	0.	0.
ACETY-01	0.	0.	0.	0.	1.	0.	0.	0.
ETHYL-01	19.	0.	0.	2.	137.	0.	0.	0.
ETHAN-01	1.	0.	0.	0.	15.	0.	0.	0.
PROPY-01	0.	0.	0.	26.	11.	0.	0.	0.
PROPA-01	0.	0.	0.	17.	3.	0.	0.	0.
1-BUT-01	121.	0.	0.	0.	22.	0.	0.	0.
2-MET-01	1622.	0.	0.	0.	56.	0.	1249.	0.
OIL	28.	0.	0.	0.	286035.	0.	28.	798.
WATER	10.	12618.	12618.	373.	374.	11310.	10.	1.
SODIU-01	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	3187.57	228.97	27246.82	430.96	4735.77	187.20	34.45	11.96
Enthalpy MMBtu/hr	-1.77	-84.20	-81.73	-2.59	-377.40	-77.39	-1.40	-1.12
Stream ID	CRACKING.->LOST-OIL	CRACKING.->OIL	CRACKING.->OIL2	CRACKING.->STM	CRACKING.->STM-OUT2	CRACKING.->VAP	CRACKING.->VAP10	CRACKING.->VP10C
Temperature F	295.21	256.57	256.57	300.15	491.55	224.71	183.55	110.00
Pressure psi	18.00	18.00	18.00	64.70	600.00	18.00	18.00	18.00
Vapor Frac	0.00	0.00	0.00	1.00	1.00	1.00	1.00	0.74
MoleFlow lbmol/hr	3.	1170.	1171.	84.	1726.	22.	4117.	4117.
MassFlow lb/hr	800.	286670.	286655.	1520.	31100.	418.	98733.	98733.
H2	0.	0.	0.	0.	0.	0.	482.	482.
METHA-01	0.	2.	2.	0.	0.	0.	2055.	2055.
ACETY-01	0.	1.	1.	0.	0.	0.	269.	269.
ETHYL-01	0.	136.	136.	0.	0.	2.	61334.	61334.
ETHAN-01	0.	15.	15.	0.	0.	0.	5331.	5331.
PROPY-01	0.	11.	11.	0.	0.	26.	1885.	1885.
PROPA-01	0.	3.	3.	0.	0.	17.	539.	539.
1-BUT-01	0.	21.	22.	0.	0.	0.	1814.	1814.
2-MET-01	0.	54.	56.	0.	0.	0.	2426.	2426.
OIL	798.	286063.	286036.	0.	0.	0.	28.	28.
WATER	1.	364.	373.	1520.	31100.	373.	22571.	22571.
SODIU-01	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	13.22	4645.24	4645.08	10348.50	25241.43	8807.90	1570015.97	1024440.85
Enthalpy MMBtu/hr	-1.05	-382.22	-382.24	-8.63	-175.04	-2.14	-88.41	-113.09

Table 1B: Alternative Ethylene from Ethane Production Process Technology – Stream Tables – Cont'd

Stream ID	CRACKING .->W1	CRACKING .->WA-IN	CRACKING .->WA-IN2	CRACKING .->WA-OUT	CRACKING .->WA-OUT2	PURIFICA .->2	PURIFICA .->2A	PURIFICA .->2B
Temperature F	124.41	90.00	90.00	484.04	484.04	17.29	15.66	17.81
Pressure psi	18.00	600.00	600.00	600.00	600.00	270.00	270.00	270.00
Vapor Frac	0.00	0.00	0.00	0.00	0.00	0.57	0.00	0.67
MoleFlow lbmol/hr	483.	4725.	1726.	4725.	1726.	420.	420.	420.
MassFlow lb/hr	8709.	85126.	31100.	85126.	31100.	12851.	12851.	12851.
H2	0.	0.	0.	0.	0.	0.	0.	0.
METHA-01	0.	0.	0.	0.	0.	0.	0.	0.
ACETY-01	0.	0.	0.	0.	0.	0.	0.	0.
ETHYL-01	0.	0.	0.	0.	0.	64.	64.	64.
ETHAN-01	0.	0.	0.	0.	0.	12056.	12056.	12056.
PROPY-01	0.	0.	0.	0.	0.	638.	638.	638.
PROPA-01	0.	0.	0.	0.	0.	94.	94.	94.
1-BUT-01	0.	0.	0.	0.	0.	0.	0.	0.
2-MET-01	0.	0.	0.	0.	0.	0.	0.	0.
OIL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	8709.	85126.	31100.	85126.	31100.	0.	0.	0.
SODIU-01	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	144.15	1382.22	504.99	1863.30	680.75	3601.21	480.49	4197.47
Enthalpy MMBtu/hr	-59.59	-585.75	-214.00	-544.67	-198.99	-15.78	-16.84	-15.58
Stream ID	PURIFICA.->3OD	PURIFICA.->27	PURIFICA.->27A	PURIFICA.->27B	PURIFICA.->27C	PURIFICA .->28	PURIFICA .->28A	PURIFICA .->28B
Temperature F	12.29	60.00	-25.00	-90.00	35.80	-101.58	-147.50	-147.50
Pressure psi	390.00	505.00	505.00	505.00	505.00	465.00	465.00	465.00
Vapor Frac	1.00	1.00	0.92	0.54	1.00	1.00	0.86	1.00
MoleFlow lbmol/hr	3217.	5260.	5260.	5260.	5260.	3133.	3133.	2685.
MassFlow lb/hr	91554.	89627.	89627.	89627.	89627.	25341.	25341.	13613.
H2	0.	4452.	4452.	4452.	4452.	4472.	4472.	4459.
METHA-01	136.	4280.	4280.	4280.	4280.	6401.	6401.	5523.
ACETY-01	0.	0.	0.	0.	0.	0.	0.	0.
ETHYL-01	75179.	64074.	64074.	64074.	64074.	14468.	14468.	3632.
ETHAN-01	15026.	12119.	12119.	12119.	12119.	0.	0.	0.
PROPY-01	1035.	1827.	1827.	1827.	1827.	0.	0.	0.
PROPA-01	176.	555.	555.	555.	555.	0.	0.	0.
1-BUT-01	1.	2319.	2319.	2319.	2319.	0.	0.	0.
2-MET-01	0.	0.	0.	0.	0.	0.	0.	0.
OIL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.	0.	0.
SODIU-01	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	28863.16	54844.91	40795.31	24273.22	51569.21	25337.56	19672.02	19318.37
Enthalpy MMBtu/hr	37.27	26.12	19.79	7.54	24.85	-5.59	-8.84	-12.51

Table 1B: Alternative Ethylene from Ethane Production Process Technology – Stream Tables – Cont'd

Stream ID	PURIFICA. ->28C	PURIFICA. ->28D	PURIFICA. ->28E	PURIFICA. ->28F	PURIFICA. ->29	PURIFICA. ->30	PURIFICA.->30A	PURIFICA.->30B
Temperature F	-214.00	-214.00	-214.00	-147.50	20.48	7.43	8.48	7.47
Pressure psi	465.00	465.00	465.00	465.00	465.00	390.00	390.00	390.00
Vapor Frac	0.92	1.00	0.00	0.00	0.00	1.00	1.00	1.00
MoleFlow lbmol/hr	2685.	2474.	211.	447.	2785.	2697.	3217.	2706.
MassFlow lb/hr	13613.	8802.	4811.	11728.	80825.	76623.	91554.	76866.
H2	4459.	4452.	6.	13.	0.	0.	0.	0.
METHA-01	5523.	4151.	1372.	878.	129.	129.	136.	129.
ACETY-01	0.	0.	0.	0.	0.	0.	0.	0.
ETHYL-01	3632.	199.	3433.	10837.	63876.	63705.	75179.	63876.
ETHAN-01	0.	0.	0.	0.	12119.	12056.	15026.	12119.
PROPY-01	0.	0.	0.	0.	1827.	638.	1035.	639.
PROPA-01	0.	0.	0.	0.	555.	94.	176.	102.
1-BUT-01	0.	0.	0.	0.	2319.	0.	1.	0.
2-MET-01	0.	0.	0.	0.	0.	0.	0.	0.
OIL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.	0.	0.
SODIU-01	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	14128.64	13981.56	147.07	353.65	3253.48	23484.05	28115.11	23560.12
Enthalpy MMBtu/hr	-14.77	-13.22	-1.55	3.67	22.89	32.22	37.07	32.27
Stream ID	PURIFICA. ->30C	PURIFICA. ->31	PURIFICA. ->31A	PURIFICA. ->32	PURIFICA. ->RFXA	PURIFICA. ->RFXB1	REFRIGER. ->24G	REFRIGER. ->33
Temperature F	7.47	100.00	196.10	-25.42	7.47	-168.40	-146.23	-214.35
Pressure psi	390.00	390.00	390.00	270.00	390.00	465.00	19.00	76.00
Vapor Frac	0.84	0.00	0.00	1.00	0.00	0.00	0.13	1.00
MoleFlow lbmol/hr	3217.	80.	80.	2277.	511.	659.	1650.	1427.
MassFlow lb/hr	91554.	3959.	3959.	63771.	14688.	16539.	46300.	22900.
H2	0.	0.	0.	0.	0.	20.	0.	0.
METHA-01	136.	0.	0.	129.	7.	2250.	0.	22900.
ACETY-01	0.	0.	0.	0.	0.	0.	0.	0.
ETHYL-01	75179.	0.	0.	63641.	11303.	14270.	46300.	0.
ETHAN-01	15026.	0.	0.	0.	2908.	0.	0.	0.
PROPY-01	1035.	1187.	1187.	0.	396.	0.	0.	0.
PROPA-01	176.	454.	454.	0.	74.	0.	0.	0.
1-BUT-01	1.	2318.	2318.	0.	1.	0.	0.	0.
2-MET-01	0.	0.	0.	0.	0.	0.	0.	0.
OIL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.	0.	0.
SODIU-01	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	24130.69	118.68	145.57	29619.78	570.57	502.98	38269.09	44195.00
Enthalpy MMBtu/hr	35.23	-0.82	-0.54	47.30	2.97	2.12	25.51	-49.30

Table 1B: Alternative Ethylene from Ethane Production Process Technology – Stream Tables – Cont'd

Stream ID	REFRIGER .->33A	REFRIGER .->33B	REFRIGER .->33C	REFRIGER .->33D	REFRIGER .->33E	REFRIGER .->33F	REFRIGER .->34	REFRIGER .->34A
Temperature F	-214.35	-214.35	-214.35	-214.35	-130.00	29.88	-147.96	-147.96
Pressure psi	76.00	76.00	76.00	76.00	600.00	600.00	18.00	18.00
Vapor Frac	0.00	1.00	1.00	0.51	0.00	1.00	0.97	0.96
MoleFlow lbmol/hr	700.	700.	727.	1427.	1427.	1427.	1650.	1426.
MassFlow lb/hr	11231.	11231.	11669.	22900.	22900.	22900.	46300.	39999.
H2	0.	0.	0.	0.	0.	0.	0.	0.
METHA-01	11231.	11231.	11669.	22900.	22900.	22900.	0.	0.
ACETY-01	0.	0.	0.	0.	0.	0.	0.	0.
ETHYL-01	0.	0.	0.	0.	0.	0.	46300.	39999.
ETHAN-01	0.	0.	0.	0.	0.	0.	0.	0.
PROPY-01	0.	0.	0.	0.	0.	0.	0.	0.
PROPA-01	0.	0.	0.	0.	0.	0.	0.	0.
1-BUT-01	0.	0.	0.	0.	0.	0.	0.	0.
2-MET-01	0.	0.	0.	0.	0.	0.	0.	0.
OIL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.	0.	0.
SODIU-01	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	471.30	21672.93	22522.06	22993.37	1540.04	11299.22	286696.24	246356.55
Enthalpy MMBtu/hr	-26.43	-24.18	-25.12	-51.56	-51.56	-46.81	33.50	28.90
Stream ID	REFRIGER .->34B	REFRIGER .->34C	REFRIGER .->34D	REFRIGER .->34E	REFRIGER .->34F	REFRIGER .->34H	REFRIGER .->34J	REFRIGER .->35A
Temperature F	-147.96	-147.96	-147.96	-147.96	-147.96	-1.24	-147.96	-100.23
Pressure psi	18.00	18.00	18.00	18.00	18.00	80.00	18.00	65.00
Vapor Frac	0.97	1.00	0.00	0.00	0.00	1.00	0.96	0.00
MoleFlow lbmol/hr	575.	225.	575.	851.	1426.	1650.	851.	1650.
MassFlow lb/hr	16120.	6301.	16120.	23880.	39999.	46300.	23880.	46300.
H2	0.	0.	0.	0.	0.	0.	0.	0.
METHA-01	0.	0.	0.	0.	0.	0.	0.	0.
ACETY-01	0.	0.	0.	0.	0.	0.	0.	0.
ETHYL-01	16120.	6301.	16120.	23880.	39999.	46300.	23880.	46300.
ETHAN-01	0.	0.	0.	0.	0.	0.	0.	0.
PROPY-01	0.	0.	0.	0.	0.	0.	0.	0.
PROPA-01	0.	0.	0.	0.	0.	0.	0.	0.
1-BUT-01	0.	0.	0.	0.	0.	0.	0.	0.
2-MET-01	0.	0.	0.	0.	0.	0.	0.	0.
OIL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.	0.	0.
SODIU-01	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	100136.34	40339.69	453.45	671.73	1125.17	96155.52	146220.21	1422.76
Enthalpy MMBtu/hr	11.67	4.60	8.43	12.48	20.91	35.77	17.22	25.51

Table 1B: Alternative Ethylene from Ethane Production Process Technology – Stream Tables – Cont'd

Stream ID	REFRIGER .->35B	REFRIGER .->35C	REFRIGER .->35D	REFRIGER .->35E	REFRIGER .->35F	REFRIGER .->35G	REFRIGER .->35H	REFRIGER .->35I
Temperature F	-100.23	-100.23	-100.23	-100.23	-100.23	-18.00	-100.23	-71.99
Pressure psi	65.00	65.00	65.00	65.00	65.00	310.00	65.00	65.00
Vapor Frac	0.00	1.00	1.00	1.00	0.00	0.00	0.31	1.00
MoleFlow lbmol/hr	2305.	2305.	1748.	4053.	3955.	5703.	5703.	5703.
MassFlow lb/hr	64661.	64661.	49039.	113700.	110961.	160000.	160000.	160000.
H2	0.	0.	0.	0.	0.	0.	0.	0.
METHA-01	0.	0.	0.	0.	0.	0.	0.	0.
ACETY-01	0.	0.	0.	0.	0.	0.	0.	0.
ETHYL-01	64661.	64661.	49039.	113700.	110961.	160000.	160000.	160000.
ETHAN-01	0.	0.	0.	0.	0.	0.	0.	0.
PROPY-01	0.	0.	0.	0.	0.	0.	0.	0.
PROPA-01	0.	0.	0.	0.	0.	0.	0.	0.
1-BUT-01	0.	0.	0.	0.	0.	0.	0.	0.
2-MET-01	0.	0.	0.	0.	0.	0.	0.	0.
OIL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.	0.	0.
SODIU-01	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	1986.99	124823.76	94695.95	219519.72	3409.75	6292.99	98107.88	339575.42
Enthalpy MMBtu/hr	35.62	47.87	36.31	84.18	61.13	97.44	97.44	119.95
Stream ID	REFRIGER .->35J	REFRIGER .->36A	REFRIGER .->36B	REFRIGER .->36D	REFRIGER .->36F	REFRIGER .->36G	REFRIGER .->36H	REFRIGER .->36I
Temperature F	120.00	-38.68	-47.60	-47.60	-47.60	-47.60	-40.95	-40.47
Pressure psi	310.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00
Vapor Frac	1.00	1.00	1.00	0.00	0.00	0.00	1.00	1.00
MoleFlow lbmol/hr	5703.	3921.	1768.	5780.	9701.	3921.	11470.	5780.
MassFlow lb/hr	160000.	165000.	74412.	243238.	408238.	165000.	482650.	243238.
H2	0.	0.	0.	0.	0.	0.	0.	0.
METHA-01	0.	0.	0.	0.	0.	0.	0.	0.
ACETY-01	0.	0.	0.	0.	0.	0.	0.	0.
ETHYL-01	160000.	0.	0.	0.	0.	0.	0.	0.
ETHAN-01	0.	0.	0.	0.	0.	0.	0.	0.
PROPY-01	0.	165000.	74412.	243238.	408238.	165000.	482650.	243238.
PROPA-01	0.	0.	0.	0.	0.	0.	0.	0.
1-BUT-01	0.	0.	0.	0.	0.	0.	0.	0.
2-MET-01	0.	0.	0.	0.	0.	0.	0.	0.
OIL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.	0.	0.
SODIU-01	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	102996.51	1008819.30	444426.97	6353.31	10663.07	4309.76	2933559.61	1480254.70
Enthalpy MMBtu/hr	129.13	26.51	11.75	-7.64	-12.82	-5.18	77.21	38.95

Table 1B: Alternative Ethylene from Ethane Production Process Technology – Stream Tables – Cont'd

Stream ID	REFRIGER .->36K	REFRIGER .->36L	REFRIGER .->36M	REFRIGER .->36Z	REFRIGER .->37A	REFRIGER .->37B	REFRIGER .->37C	REFRIGER .->37D
Temperature F	-47.60	6.27	66.62	-47.60	6.27	6.27	6.27	6.27
Pressure psi	17.00	54.00	54.00	17.00	54.00	54.00	54.00	54.00
Vapor Frac	0.15	0.00	1.00	0.11	0.00	0.36	1.00	0.00
MoleFlow lbmol/hr	11470.	11470.	11470.	5780.	773.	773.	3772.	12242.
MassFlow lb/hr	482650.	482650.	482650.	243238.	32522.	32522.	158747.	515172.
H2	0.	0.	0.	0.	0.	0.	0.	0.
METHA-01	0.	0.	0.	0.	0.	0.	0.	0.
ACETY-01	0.	0.	0.	0.	0.	0.	0.	0.
ETHYL-01	0.	0.	0.	0.	0.	0.	0.	0.
ETHAN-01	0.	0.	0.	0.	0.	0.	0.	0.
PROPY-01	482650.	482650.	482650.	243238.	32522.	32522.	158747.	515172.
PROPA-01	0.	0.	0.	0.	0.	0.	0.	0.
1-BUT-01	0.	0.	0.	0.	0.	0.	0.	0.
2-MET-01	0.	0.	0.	0.	0.	0.	0.	0.
OIL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.	0.	0.
SODIU-01	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	455100.24	13644.65	1132657.99	165521.71	919.39	24257.94	321240.72	14564.05
Enthalpy MMBtu/hr	-1.07	-1.07	93.45	-2.57	-0.07	1.96	27.28	-1.14

Stream ID	REFRIGER .->37E	REFRIGER .->37F	REFRIGER .->37G	REFRIGER .->37H	REFRIGER .->37K	REFRIGER .->37KB	REFRIGER .->37N	REFRIGER .->37O
Temperature F	6.27	35.14	120.00	120.00	57.72	57.72	6.27	6.27
Pressure psi	54.00	54.00	128.00	128.00	128.00	128.00	54.00	54.00
Vapor Frac	0.89	1.00	1.00	1.00	0.14	0.31	0.31	0.18
MoleFlow lbmol/hr	4545.	16015.	16015.	7129.	7129.	7129.	7129.	8886.
MassFlow lb/hr	191269.	673919.	673919.	300000.	300000.	300000.	300000.	373919.
H2	0.	0.	0.	0.	0.	0.	0.	0.
METHA-01	0.	0.	0.	0.	0.	0.	0.	0.
ACETY-01	0.	0.	0.	0.	0.	0.	0.	0.
ETHYL-01	0.	0.	0.	0.	0.	0.	0.	0.
ETHAN-01	0.	0.	0.	0.	0.	0.	0.	0.
PROPY-01	191269.	673919.	673919.	300000.	300000.	300000.	300000.	373919.
PROPA-01	0.	0.	0.	0.	0.	0.	0.	0.
1-BUT-01	0.	0.	0.	0.	0.	0.	0.	0.
2-MET-01	0.	0.	0.	0.	0.	0.	0.	0.
OIL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.	0.	0.
SODIU-01	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	345498.65	1469033.60	697709.90	310590.64	45923.78	87484.91	192196.05	143608.67
Enthalpy MMBtu/hr	29.24	122.70	140.96	62.75	15.36	23.00	15.36	10.78

Table 1B: Alternative Ethylene from Ethane Production Process Technology – Stream Tables – Cont'd

Stream ID	REFRIGER .->37P	REFRIGER .->38A	REFRIGER .->38B	REFRIGER .->38C	REFRIGER .->38D	REFRIGER .->38E	REFRIGER .->38F	REFRIGER .->38G
Temperature F	6.27	120.00	84.36	150.00	90.00	57.72	57.72	57.72
Pressure psi	54.00	128.00	128.00	270.00	270.00	128.00	128.00	128.00
Vapor Frac	0.24	1.00	1.00	1.00	0.00	0.14	0.00	1.00
MoleFlow lbmol/hr	16015.	8886.	11335.	11335.	11335.	11335.	9772.	1564.
MassFlow lb/hr	673919.	373919.	477000.	477000.	477000.	477000.	411192.	65808.
H2	0.	0.	0.	0.	0.	0.	0.	0.
METHA-01	0.	0.	0.	0.	0.	0.	0.	0.
ACETY-01	0.	0.	0.	0.	0.	0.	0.	0.
ETHYL-01	0.	0.	0.	0.	0.	0.	0.	0.
ETHAN-01	0.	0.	0.	0.	0.	0.	0.	0.
PROPY-01	673919.	373919.	477000.	477000.	477000.	477000.	411192.	65808.
PROPA-01	0.	0.	0.	0.	0.	0.	0.	0.
1-BUT-01	0.	0.	0.	0.	0.	0.	0.	0.
2-MET-01	0.	0.	0.	0.	0.	0.	0.	0.
OIL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.	0.	0.
SODIU-01	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	335804.76	387119.14	450913.58	218822.51	16062.68	70414.37	12847.60	57566.78
Enthalpy MMBtu/hr	26.14	78.21	92.78	100.81	23.95	23.95	11.85	12.10
Stream ID	REFRIGER .->38H	REFRIGER .->38J	REFRIGER .->38K	REFRIGER .->38L				
Temperature F	57.72	57.72	57.72	57.72				
Pressure psi	128.00	128.00	128.00	128.00				
Vapor Frac	0.73	0.00	0.24	0.00				
MoleFlow lbmol/hr	2450.	886.	886.	8886.				
MassFlow lb/hr	103081.	37273.	37273.	373919.				
H2	0.	0.	0.	0.				
METHA-01	0.	0.	0.	0.				
ACETY-01	0.	0.	0.	0.				
ETHYL-01	0.	0.	0.	0.				
ETHAN-01	0.	0.	0.	0.				
PROPY-01	103081.	37273.	37273.	373919.				
PROPA-01	0.	0.	0.	0.				
1-BUT-01	0.	0.	0.	0.				
2-MET-01	0.	0.	0.	0.				
OIL	0.	0.	0.	0.				
WATER	0.	0.	0.	0.				
SODIU-01	0.	0.	0.	0.				
VolFlow cuft/hr	66358.13	1164.59	8791.35	11683.01				
Enthalpy MMBtu/hr	14.57	1.07	2.48	10.78				

Figure 1A – Alternative Ethylene – part 1

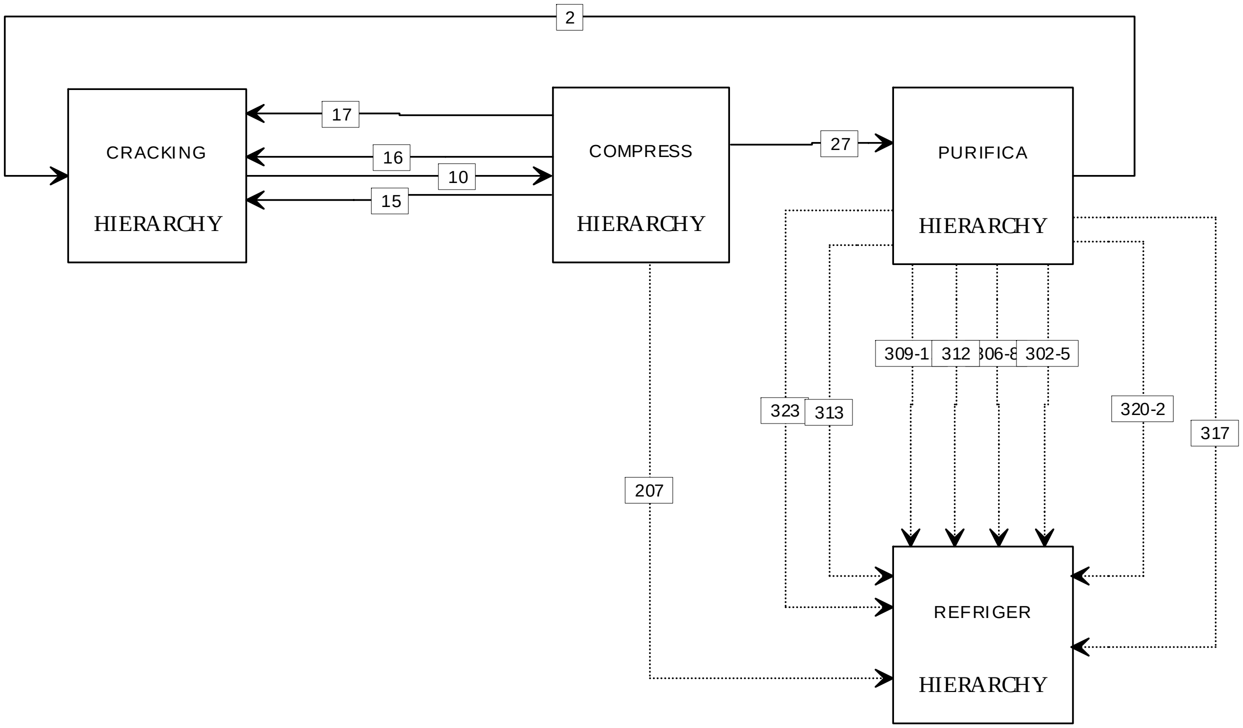


Figure 1B – Alternative Ethylene – part 2

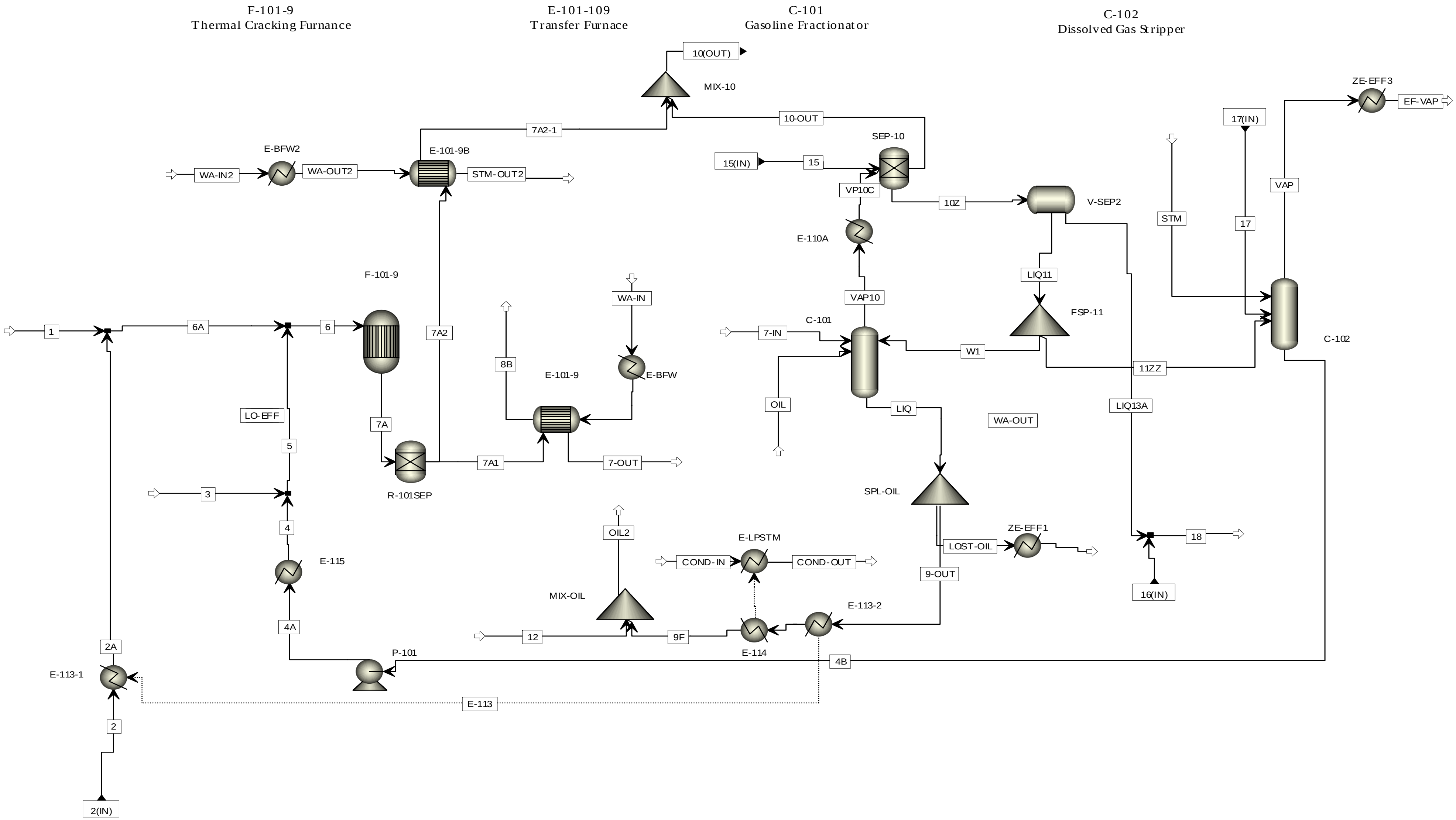


Figure 1C – Alternative Ethylene – part 3

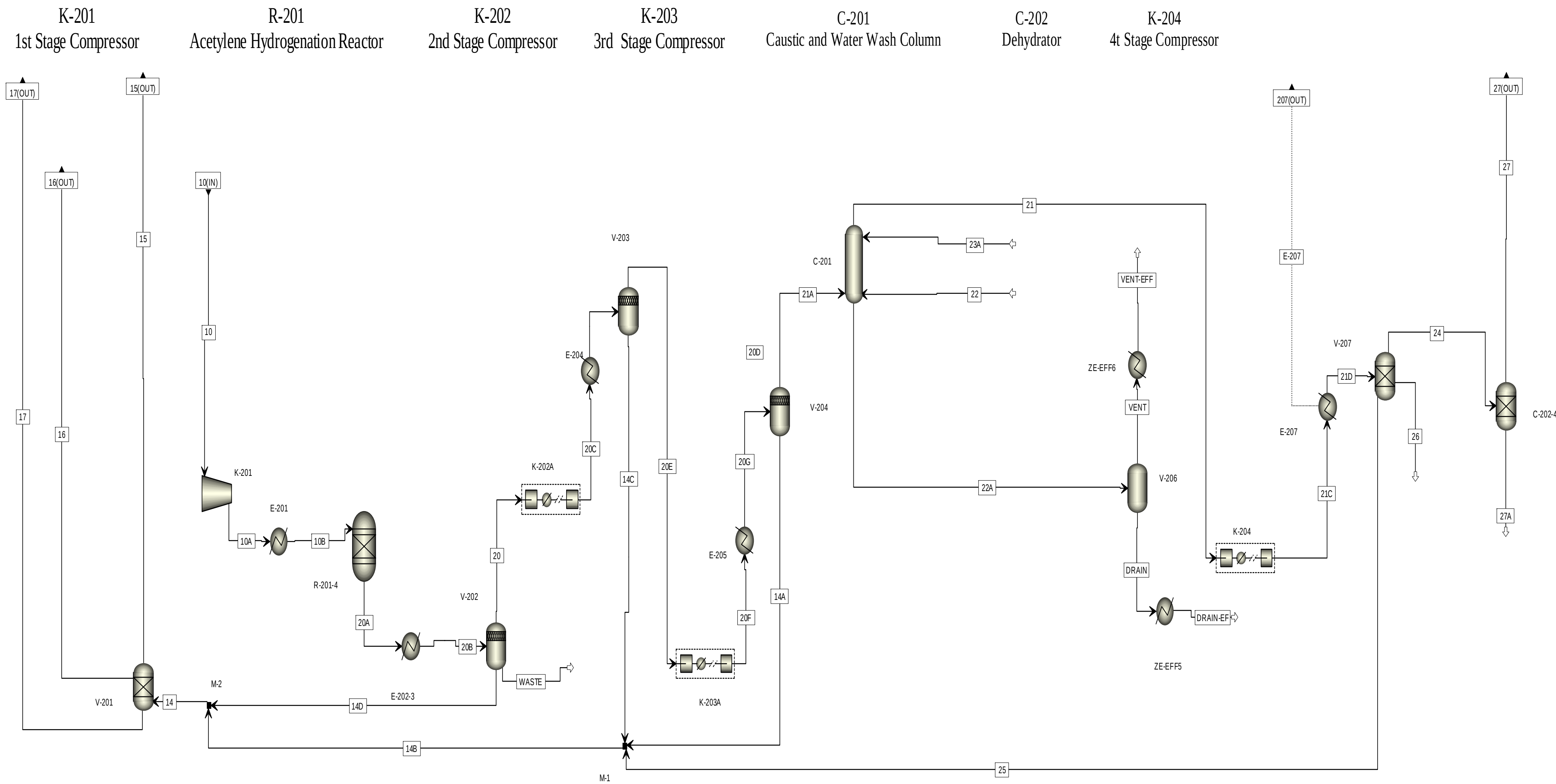


Figure 1D – Alternative Ethylene – part 4

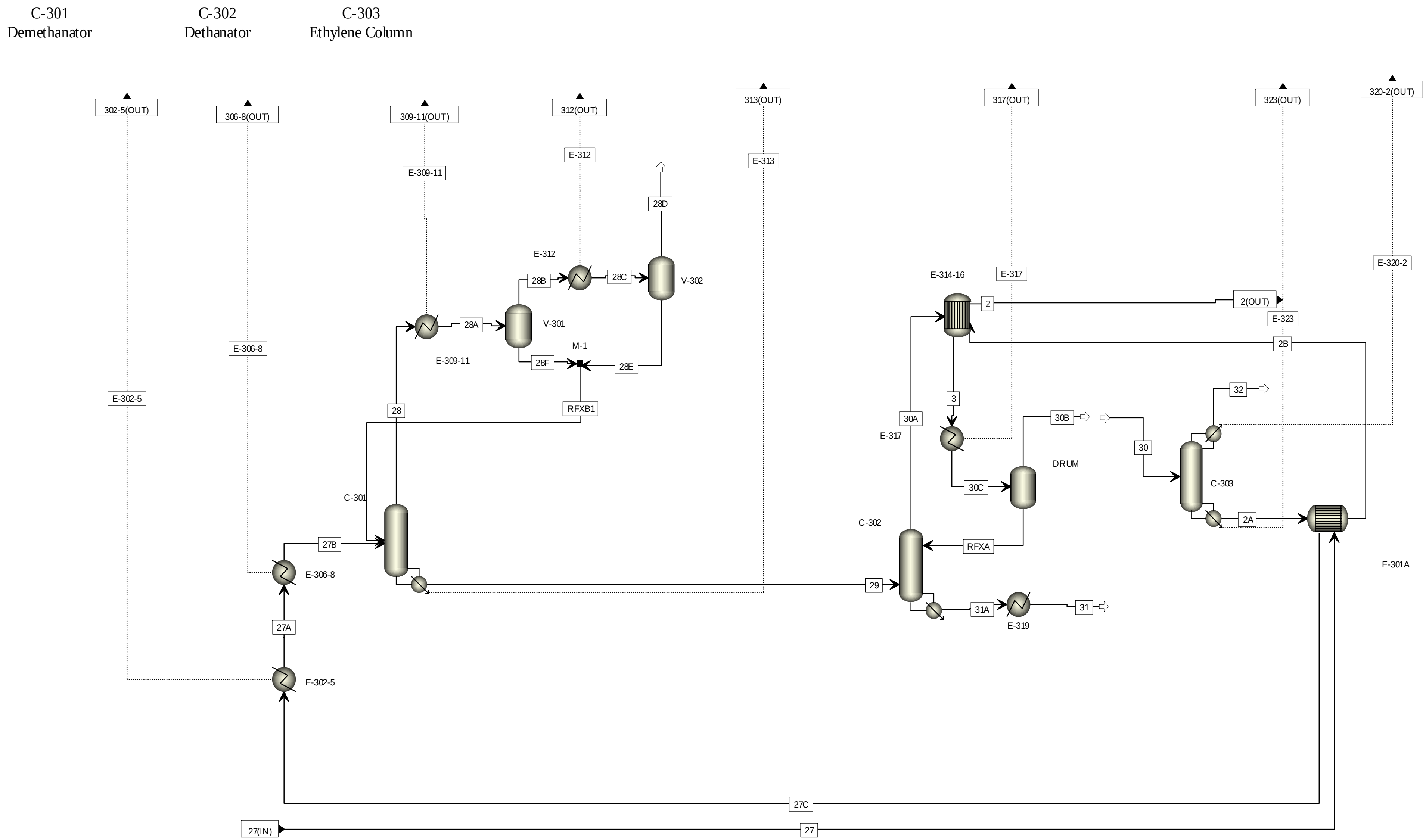


Figure 1E – Alternative Ethylene – part 5

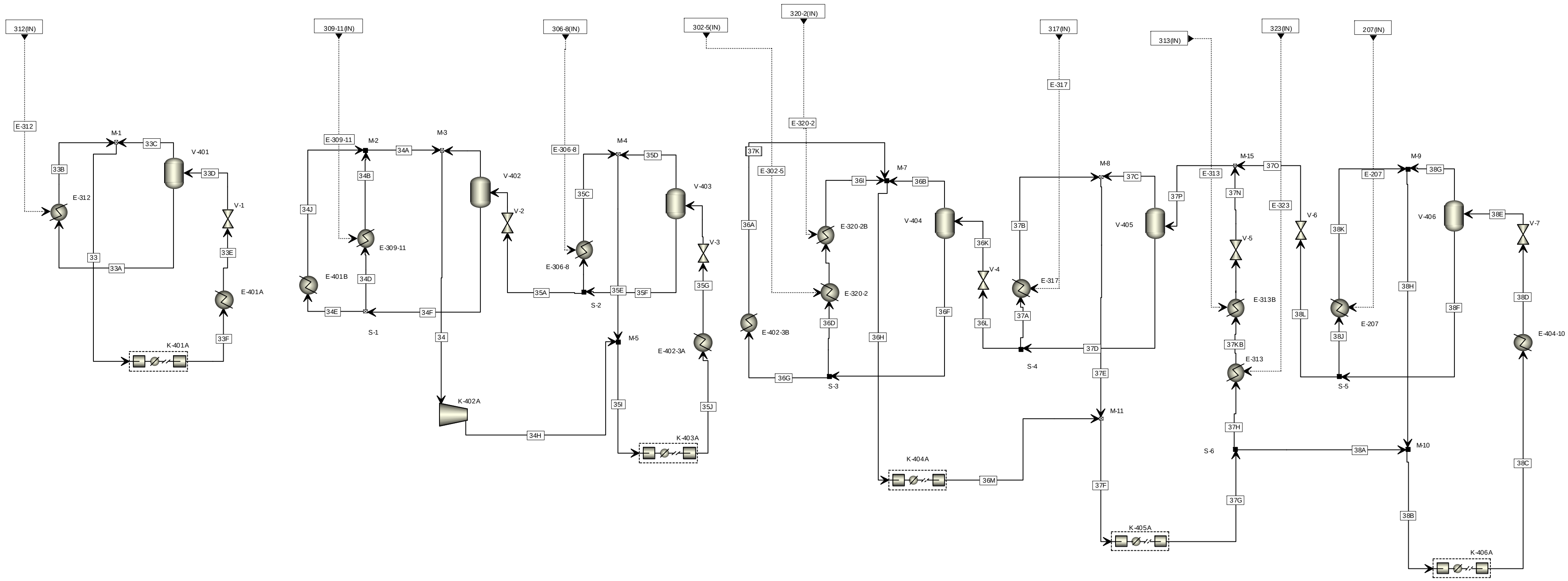


Figure 1F – Base Case Ethylene – part 1

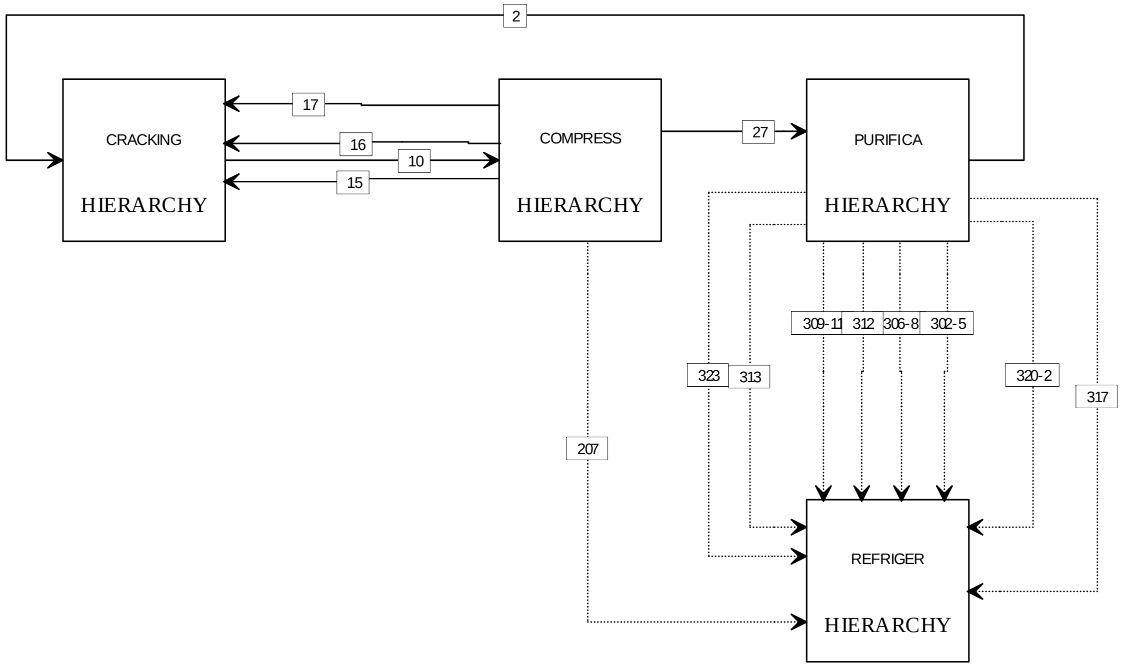


Figure 1G – Base Case Ethylene – part 2

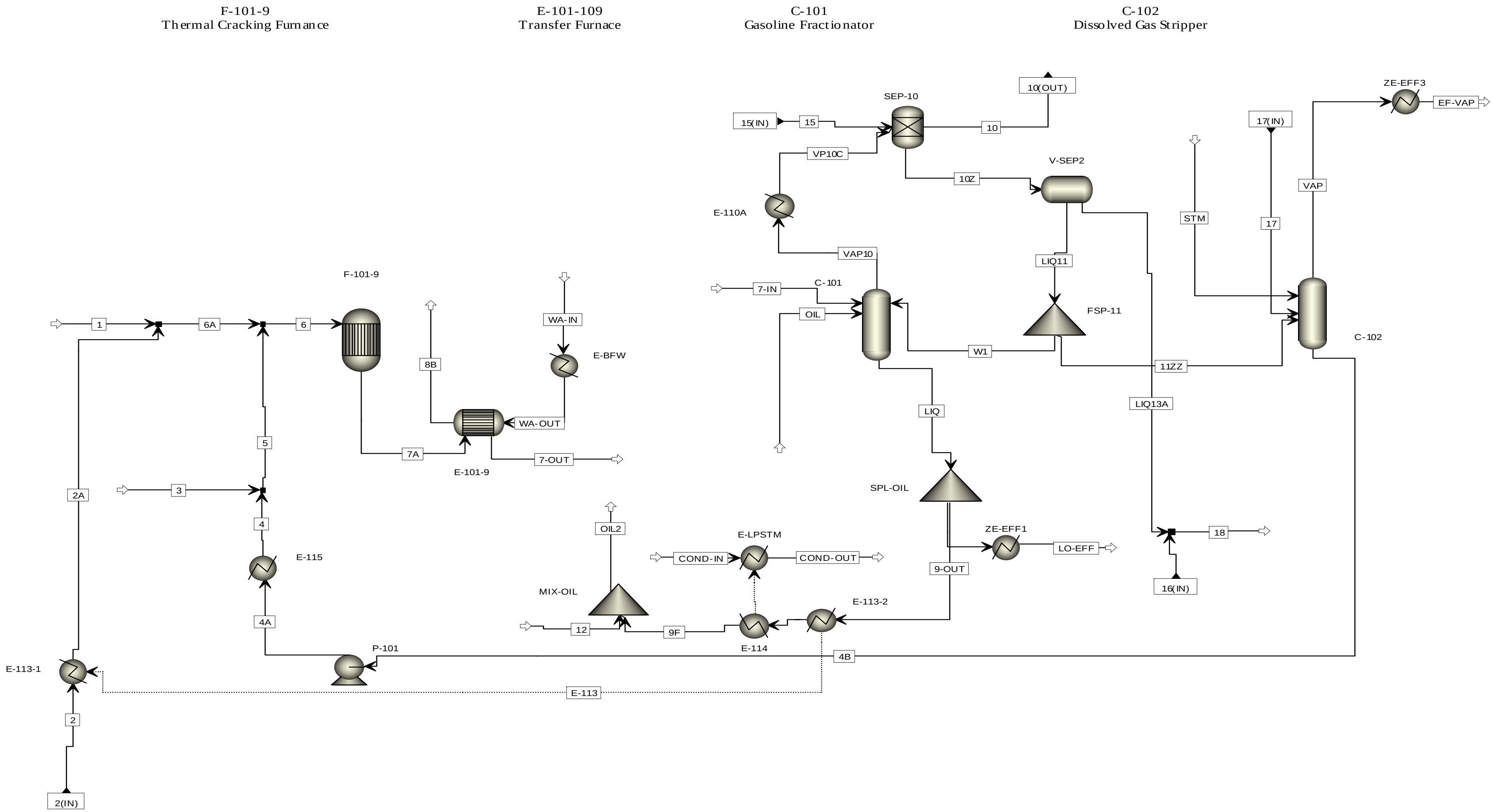


Figure 1H – Base Case Ethylene – part 3

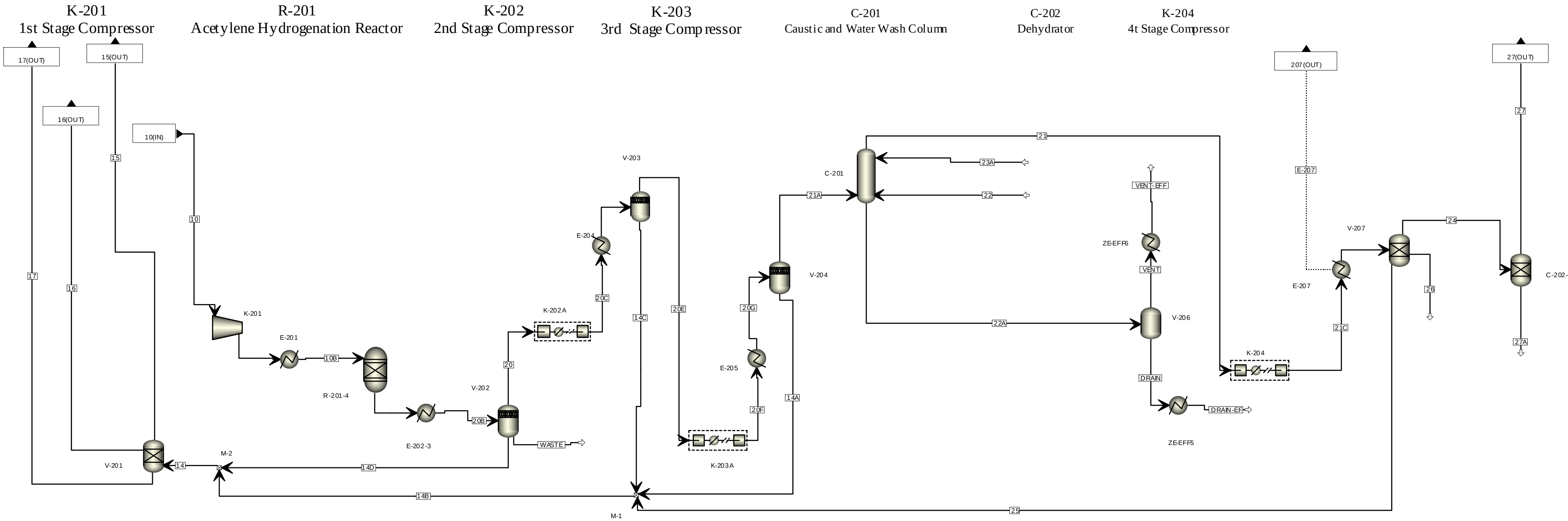


Figure 1I – Base Case Ethylene – part 4

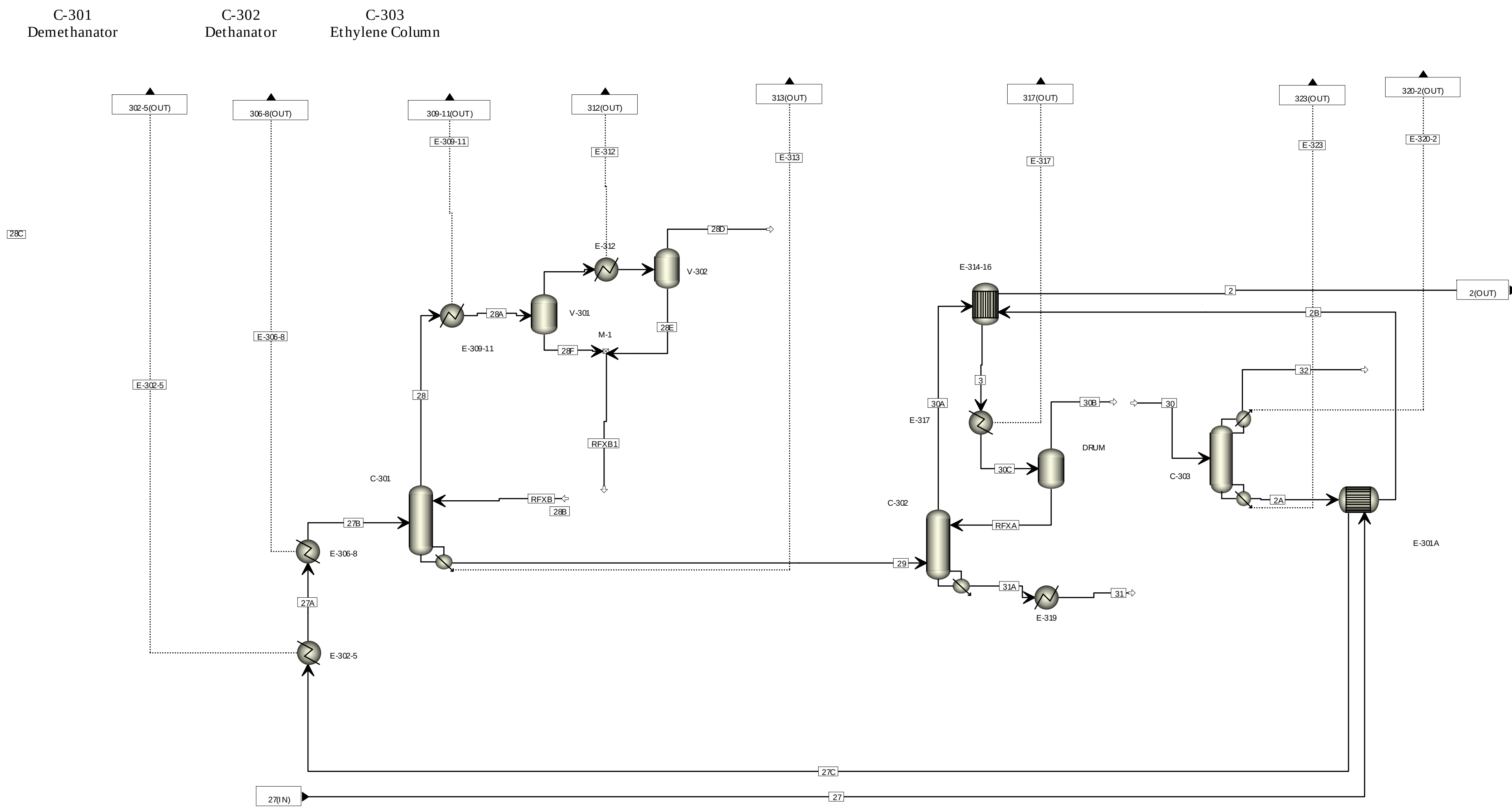
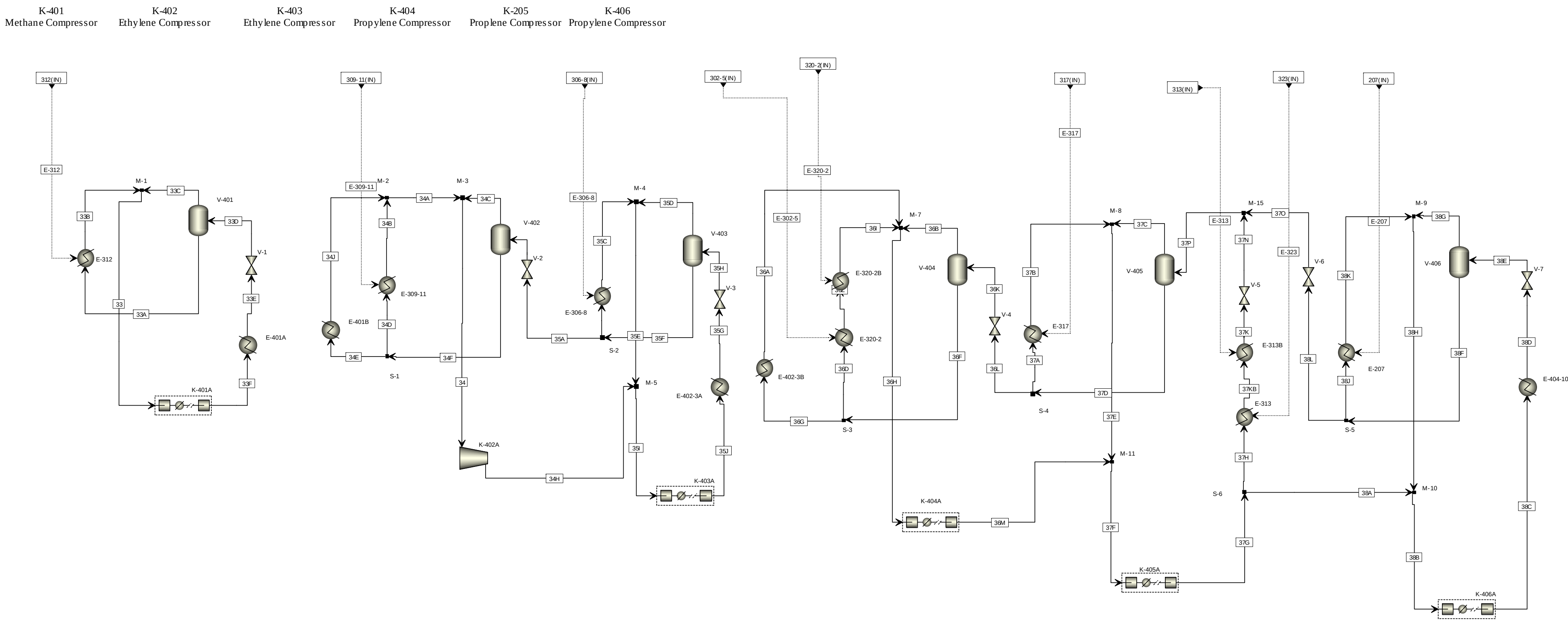


Figure 1J – Base Case Ethylene – part 5



Appendix 2 – Chlorine-Caustic Soda

Table 2A: Alternative Chlorine-Caustic Production Process Technology – Energy and Exergy Loss Profile

Unit OP	Type	Energy Loss = Btu/lb		Exergy Loss = Btu/lb			
		Total = 1,505	%	Total External = 124	Total Internal = 6,243	Total = 6,367	%
BRINE							
BRINE..M-2-4	Salt Washer	0	0	0	0	0	-0.01
BRINE..S-1	Reactor Settler	1	0.06	0	1	1	0.02
BRINE..S-2	Mud Separator	0	0	0	0	0	0
BRINE..E-1	Water Heater	0	0	0	1	1	0.01
BRINE..M-6A	Dissolver2	0	0	0	0	0	0
BRINE..DISSOLVE	Dissolve1	0	0.02	0	0	0	0
BRINE..MIX4	Mixer	0	0	0	19	19	0.29
BRINE..M-6	Dissolver	867	57.6	43	3	46	0.72
BRINE..T-9	Ph Adjusting Tank	0	0	0	2	2	0.03
ELECTROLYSIS							
ELECTROL..E-201	Heater	0	0	0	0	0	0
ELECTROL..NACL-H2O	Electrolysis Cell #1	0	0	0	557	557	8.74
ELECTROL..C-PROD	Electrolysis Cell #1	0	0	0	5,306	5,306	83.33
ELECTROL..SEP-N	Separator	408	27.09	63	0	63	1
ELECTROL..V-201	Flash Drum	0	0	0	34	34	0.54
ELECTROL..S-V202	Flash Drum	0	0	0	0	0	0
ELECTROL..K-201	Compressor	0	0	0	30	30	0.47
ELECTROL..MIX-24	Mixer	0	0	0	1	1	0.01
ELECTROL..MIX-22	Mixer	0	0	0	27	27	0.43
ELECTROL..S-301	Separator	0	0	0	77	77	1.21
ELECTROL..S-302	Separator	0	0	0	0	0	0
ELECTROL..E-S301	Heater	0	-0.01	0	1	1	0.01
ELECTROL..E-S302	Heater	0	0	0	0	0	0
ELECTROL..E-302	Heater	0	0	0	21	21	0.33
ELECTROL..MIX-17	Mixer	0	-0.01	0	0	0	0
ELECTROL..P-20	Pump	0	0	0	5	5	0.08
ELECTROL..E-STEAM	Heater	0	0	0	0	0	0

Table 2A: Alternative Chlorine-Caustic Production Process Technology – Energy and Exergy Loss Profile (Cont'd)

Unit OP	Type	Energy Loss = Btu/lb		Exergy Loss = Btu/lb			
		Total = 1,505	%	Total External = 124	Total Internal = 6,243	Total = 6,367	%
GAS TREATMENT							
GASTREAT..C-5	Drying Column	5	0.32	0	0	1	0.01
GASTREAT..K-1	Chlorine Compressor	0	0	0	6	6	0.09
GASTREAT..C-6	Washing Column	0	0	0	1	1	0.01
GASTREAT..E-9	Refrigerated Condenser	191	12.71	12	33	45	0.71
GASTREAT..V-4	Flash Drum	0	0	0	0	0	0
GASTREAT..S-1	Mixer	0	0	0	0	0	0
GASTREAT..C-4	Drying Column	2	0.16	0	0	0	0
GASTREAT..C-2	Cooling Column	0	0.01	0	104	104	1.64
GASTREAT..C-3	Chlorine Stripping Column	0	0	0	6	6	0.09
GASTREAT..K-3	Compressor	0	0	0	0	0	0
GASTREAT..C-7A	Absorption	0	0	0	4	4	0.06
GASTREAT..C-1	Cooling Column	0	0	0	6	6	0.1
GASTREAT..E-23-1	E-23-1	29	1.95	5	0	5	0.08
GASTREAT..K-2	K-2	1	0.07	0	0	0	0.01

Table 2B: Alternative Chlorine-Caustic Production Process Technology – Stream Tables

Stream ID	BRINE.->1	BRINE.->2	BRINE.->3	BRINE.->4	BRINE.->4A	BRINE.->5-1	BRINE.->5-2	BRINE.->5-3
Temperature F	65.00	65.00	64.99	64.99	146.77	65.00	65.00	65.00
Pressure psi	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70
Vapor Frac	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MoleFlow lbmol/hr	354.	50.	45.	359.	6375.	6369.	6370.	6379.
MassFlow lb/hr	18738.	900.	897.	18741.	139342.	139086.	139086.	139342.
H2O	954.	900.	800.	1054.	103161.	103011.	103011.	103161.
NACL	0.	0.	0.	0.	0.	0.	0.	0.
CASO4	0.	0.	0.	0.	0.	0.	0.	0.
MGSO4	0.	0.	0.	0.	0.	0.	0.	0.
NAOH	0.	0.	0.	0.	0.	0.	0.	0.
NA2CO3	0.	0.	0.	0.	0.	0.	0.	0.
MGOH2	0.	0.	0.	0.	0.	0.	0.	0.
CACO3	0.	0.	0.	0.	0.	0.	0.	0.
HCL	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
H2	0.	0.	0.	0.	0.	0.	0.	0.
CL2	0.	0.	0.	0.	0.	0.	0.	0.
H2SO4	0.	0.	0.	0.	0.	0.	0.	0.
MG++	0.	0.	0.	0.	0.	0.	2.	0.
CA++	0.	0.	0.	0.	0.	0.	5.	0.
NA+	8.	0.	0.	8.	816.	910.	910.	910.
H+	0.	0.	0.	0.	0.	0.	0.	0.
MGOH+	0.	0.	0.	0.	0.	0.	0.	0.
NASO4(S)	285.	0.	70.	215.	430.	430.	430.	430.
MGSO4(S)	38.	0.	27.	11.	11.	11.	0.	11.
CASO4(S)	73.	0.	0.	73.	73.	17.	0.	73.
NACL(S)	17368.	0.	0.	17368.	33594.	33304.	33304.	33354.
CACO3(S)	0.	0.	0.	0.	0.	0.	0.	0.
NA2CO(S)	0.	0.	0.	0.	0.	0.	0.	0.
MGOH2(S)	0.	0.	0.	0.	0.	0.	0.	0.
CL-	12.	0.	0.	12.	1198.	1344.	1344.	1344.
SO4--	0.	0.	0.	0.	21.	21.	42.	21.
CO3--	0.	0.	0.	0.	38.	38.	38.	38.
OH-	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.
VolFlow cuft/hr	15.40	14.44	12.83	17.00	1693.51	1662.66	1662.67	1665.07
Enthalpy MMBtu/hr	-126.64	-6.15	-6.13	-126.79	-931.28	-939.43	-939.35	-941.17

Table 2B: Alternative Chlorine-Caustic Production Process Technology – Stream Tables - Cont'd

Stream ID	BRINE.->6	BRINE.->7	BRINE.->8	BRINE.->8-1	BRINE.->9	BRINE.->9-2	BRINE.->27A	BRINE.->29
Temperature F	65.00	65.00	65.00	65.00	65.10	65.00	176.00	65.00
Pressure psi	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70
Vapor Frac	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MoleFlow lbmol/hr	45.	3.	7.	6413.	6420.	6416.	4462.	1555.
MassFlow lb/hr	880.	72.	120.	139893.	140013.	139966.	92594.	28007.
H2O	800.	45.	74.	103766.	103840.	103811.	74100.	28007.
NACL	0.	0.	0.	0.	0.	0.	0.	0.
CASO4	0.	0.	0.	0.	0.	0.	0.	0.
MGSO4	0.	0.	0.	0.	0.	0.	0.	0.
NAOH	0.	0.	0.	0.	0.	0.	0.	0.
NA2CO3	0.	0.	0.	0.	0.	0.	0.	0.
MGOH2	0.	0.	0.	0.	0.	0.	0.	0.
CACO3	0.	0.	0.	0.	0.	0.	0.	0.
HCL	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
H2	0.	0.	0.	0.	0.	0.	0.	0.
CL2	0.	0.	0.	0.	0.	0.	0.	0.
H2SO4	0.	0.	0.	0.	0.	0.	0.	0.
MG++	0.	0.	0.	2.	2.	2.	0.	0.
CA++	0.	0.	0.	0.	0.	0.	0.	0.
NA+	0.	0.	0.	945.	945.	945.	808.	0.
H+	0.	0.	1.	0.	1.	0.	0.	0.
MGOH+	0.	0.	0.	0.	0.	0.	0.	0.
NASO4(S)	0.	0.	0.	430.	430.	430.	215.	0.
MGSO4(S)	0.	0.	0.	0.	0.	0.	0.	0.
CASO4(S)	0.	0.	0.	0.	0.	0.	0.	0.
NACL(S)	0.	15.	0.	33289.	33289.	33304.	16227.	0.
CACO3(S)	0.	12.	0.	0.	0.	12.	0.	0.
NA2CO(S)	80.	0.	0.	0.	0.	0.	0.	0.
MGOH2(S)	0.	0.	0.	0.	0.	0.	0.	0.
CL-	0.	0.	45.	1344.	1388.	1344.	1186.	0.
SO4--	0.	0.	0.	42.	42.	42.	21.	0.
CO3--	0.	0.	0.	76.	76.	76.	38.	0.
OH-	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.
VolFlow cuft/hr	12.83	0.72	1.68	1674.78	1676.39	1675.50	1231.10	449.23
Enthalpy MMBtu/hr	-6.02	-0.50	-0.59	-944.70	-945.21	-945.19	-613.77	-191.49

Table 2B: Alternative Chlorine-Caustic Production Process Technology – Stream Tables - Cont'd

Stream ID	BRINE.->29-1	BRINE.->31	ELECTROL.->9	ELECTROL.->13B	ELECTROL.->13C	ELECTROL.->13D	ELECTROL.->13D-2	ELECTROL.->13E
Temperature F	80.00	65.00	65.10	90.32	158.90	159.08	176.00	194.00
Pressure psi	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70
Vapor Frac	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MoleFlow lbmol/hr	1555.	10.	6420.	6420.	6420.	6420.	6420.	8102.
MassFlow lb/hr	28007.	256.	140013.	140013.	140013.	140013.	140013.	159693.
H2O	28007.	150.	103840.	103840.	103840.	103840.	103840.	118169.
NACL	0.	0.	0.	0.	0.	0.	0.	0.
CASO4	0.	0.	0.	0.	0.	0.	0.	0.
MGSO4	0.	0.	0.	0.	0.	0.	0.	0.
NAOH	0.	0.	0.	0.	0.	0.	0.	0.
NA2CO3	0.	0.	0.	0.	0.	0.	0.	0.
MGOH2	0.	0.	0.	0.	0.	0.	0.	0.
CACO3	0.	0.	0.	0.	0.	0.	0.	0.
HCL	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
H2	0.	0.	0.	0.	0.	0.	0.	0.
CL2	0.	0.	0.	0.	0.	0.	0.	0.
H2SO4	0.	0.	0.	0.	0.	0.	0.	0.
MG++	0.	0.	2.	2.	2.	2.	2.	2.
CA++	0.	0.	0.	0.	0.	0.	0.	0.
NA+	0.	0.	945.	945.	945.	945.	945.	7669.
H+	0.	0.	1.	1.	1.	1.	1.	300.
MGOH+	0.	0.	0.	0.	0.	0.	0.	0.
NASO4(S)	0.	0.	430.	430.	430.	430.	430.	430.
MGSO4(S)	0.	0.	0.	0.	0.	0.	0.	0.
CASO4(S)	0.	56.	0.	0.	0.	0.	0.	0.
NACL(S)	0.	50.	33289.	33289.	33289.	33289.	33289.	16195.
CACO3(S)	0.	0.	0.	0.	0.	0.	0.	0.
NA2CO(S)	0.	0.	0.	0.	0.	0.	0.	0.
MGOH2(S)	0.	0.	0.	0.	0.	0.	0.	0.
CL-	0.	0.	1388.	1388.	1388.	1388.	1388.	11758.
SO4--	0.	0.	42.	42.	42.	42.	42.	42.
CO3--	0.	0.	76.	76.	76.	76.	76.	76.
OH-	0.	0.	0.	0.	0.	0.	0.	5051.
N2	0.	0.	0.	0.	0.	0.	0.	0.
O2	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	450.10	2.41	1676.39	1682.53	1712.82	1712.92	1722.94	2088.56
Enthalpy MMBtu/hr	-191.07	-1.75	-945.21	-941.79	-932.49	-932.46	-930.16	-984.77

Table 2B: Alternative Chlorine-Caustic Production Process Technology – Stream Tables - Cont'd

Stream ID	ELECTROL.->13F	ELECTROL.->14A	ELECTROL.->15A	ELECTROL.->17-OLD	ELECTROL.->17G1	ELECTROL.->17G2	ELECTROL.->17N	ELECTROL.->20
Temperature F	194.00	176.00	194.00	202.45	119.30	123.17	194.00	226.57
Pressure psi	14.70	14.70	14.70	14.70	1.21	1.28	14.70	14.70
Vapor Frac	0.12	0.00	1.00	0.71	1.00	1.00	0.00	0.25
MoleFlow lbmol/hr	7507.	1092.	198.	1213.	675.	116.	1635.	1635.
MassFlow lb/hr	159693.	19680.	1188.	29739.	12165.	2092.	35984.	35984.
H2O	118169.	19680.	887.	19165.	12165.	2092.	24105.	24105.
NACL	0.	0.	0.	0.	0.	0.	0.	0.
CASO4	0.	0.	0.	0.	0.	0.	0.	0.
MGSO4	0.	0.	0.	0.	0.	0.	0.	0.
NAOH	11879.	0.	0.	0.	0.	0.	11879.	11879.
NA2CO3	0.	0.	0.	0.	0.	0.	0.	0.
MGOH2	0.	0.	0.	0.	0.	0.	0.	0.
CACO3	0.	0.	0.	0.	0.	0.	0.	0.
HCL	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
H2	301.	0.	301.	0.	0.	0.	0.	0.
CL2	10574.	0.	0.	10574.	0.	0.	0.	0.
H2SO4	0.	0.	0.	0.	0.	0.	0.	0.
MG++	2.	0.	0.	0.	0.	0.	0.	0.
CA++	0.	0.	0.	0.	0.	0.	0.	0.
NA+	841.	0.	0.	0.	0.	0.	0.	0.
H+	0.	0.	0.	0.	0.	0.	0.	0.
MGOH+	0.	0.	0.	0.	0.	0.	0.	0.
NASO4(S)	430.	0.	0.	0.	0.	0.	0.	0.
MGSO4(S)	0.	0.	0.	0.	0.	0.	0.	0.
CASO4(S)	0.	0.	0.	0.	0.	0.	0.	0.
NACL(S)	16195.	0.	0.	0.	0.	0.	0.	0.
CACO3(S)	0.	0.	0.	0.	0.	0.	0.	0.
NA2CO(S)	0.	0.	0.	0.	0.	0.	0.	0.
MGOH2(S)	0.	0.	0.	0.	0.	0.	0.	0.
CL-	1184.	0.	0.	0.	0.	0.	0.	0.
SO4--	42.	0.	0.	0.	0.	0.	0.	0.
CO3--	76.	0.	0.	0.	0.	0.	0.	0.
OH-	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.
VolFlow cuft/hr	408578.37	324.44	94663.83	412091.31	3475316.42	566922.71	773.65	207710.36
Enthalpy MMBtu/hr	-884.71	-132.38	-4.96	-115.73	-70.02	-12.04	-164.93	-156.75

Table 2B: Alternative Chlorine-Caustic Production Process Technology – Stream Tables - Cont'd

Stream ID	ELECTROL.->20-1	ELECTROL.->20-2	ELECTROL.->20-3	ELECTROL.->20A	ELECTROL.->21	ELECTROL.->21-1	ELECTROL.->22	ELECTROL.->23
Temperature F	119.30	119.30	123.17	194.03	120.02	123.17	194.00	194.00
Pressure psi	1.21	1.28	1.28	14.70	0.71	1.28	14.70	14.70
Vapor Frac	0.00	0.00	0.11	0.00	0.47	0.00	1.00	0.07
MoleFlow lbmol/hr	1076.	1076.	1076.	1635.	960.	960.	72.	5601.
MassFlow lb/hr	25912.	25912.	25912.	35984.	23820.	23820.	3379.	119143.
H2O	14033.	14033.	14033.	24105.	11940.	11940.	590.	92587.
NACL	0.	0.	0.	0.	0.	0.	0.	0.
CASO4	0.	0.	0.	0.	0.	0.	0.	0.
MGSO4	0.	0.	0.	0.	0.	0.	0.	0.
NAOH	11879.	11879.	11879.	11879.	11879.	11879.	0.	0.
NA2CO3	0.	0.	0.	0.	0.	0.	0.	0.
MGOH2	0.	0.	0.	0.	0.	0.	0.	0.
CACO3	0.	0.	0.	0.	0.	0.	0.	0.
HCL	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
H2	0.	0.	0.	0.	0.	0.	0.	0.
CL2	0.	0.	0.	0.	0.	0.	2789.	7785.
H2SO4	0.	0.	0.	0.	0.	0.	0.	0.
MG++	0.	0.	0.	0.	0.	0.	0.	2.
CA++	0.	0.	0.	0.	0.	0.	0.	0.
NA+	0.	0.	0.	0.	0.	0.	0.	841.
H+	0.	0.	0.	0.	0.	0.	0.	0.
MGOH+	0.	0.	0.	0.	0.	0.	0.	0.
NASO4(S)	0.	0.	0.	0.	0.	0.	0.	430.
MGSO4(S)	0.	0.	0.	0.	0.	0.	0.	0.
CASO4(S)	0.	0.	0.	0.	0.	0.	0.	0.
NACL(S)	0.	0.	0.	0.	0.	0.	0.	16195.
CACO3(S)	0.	0.	0.	0.	0.	0.	0.	0.
NA2CO(S)	0.	0.	0.	0.	0.	0.	0.	0.
MGOH2(S)	0.	0.	0.	0.	0.	0.	0.	0.
CL-	0.	0.	0.	0.	0.	0.	0.	1184.
SO4--	0.	0.	0.	0.	0.	0.	0.	42.
CO3--	0.	0.	0.	0.	0.	0.	0.	76.
OH-	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.
VolFlow cuft/hr	596.08	596.08	567491.04	773.66	3925879.70	562.62	34160.99	166455.85
Enthalpy MMBtu/hr	-98.77	-98.77	-96.55	-164.93	-76.26	-84.51	-3.34	-724.71

Table 2B: Alternative Chlorine-Caustic Production Process Technology – Stream Tables - Cont'd

Stream ID	ELECTROL.->24	ELECTROL.->24-2	ELECTROL.->24-3	ELECTROL.->25	ELECTROL.->27-2	ELECTROL.->28	GASTREAT.->15	GASTREAT.->16
Temperature F	194.00	194.00	169.59	194.00	194.00	219.64	194.00	90.00
Pressure psi	7.00	14.70	7.00	14.70	14.70	19.91	14.70	14.70
Vapor Frac	1.00	0.01	0.64	0.00	0.00	0.68	1.00	0.00
MoleFlow lbmol/hr	710.	431.	1141.	4891.	4460.	1141.	198.	8326.
MassFlow lb/hr	18549.	7811.	26360.	100593.	92783.	26360.	1188.	150000.
H2O	10838.	7737.	18575.	81750.	74013.	18575.	887.	150000.
NACL	0.	0.	0.	0.	0.	0.	0.	0.
CASO4	0.	0.	0.	0.	0.	0.	0.	0.
MGSO4	0.	0.	0.	0.	0.	0.	0.	0.
NAOH	0.	0.	0.	0.	0.	0.	0.	0.
NA2CO3	0.	0.	0.	0.	0.	0.	0.	0.
MGOH2	0.	0.	0.	0.	0.	0.	0.	0.
CACO3	0.	0.	0.	0.	0.	0.	0.	0.
HCL	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
H2	0.	0.	0.	0.	0.	0.	301.	0.
CL2	7712.	74.	7785.	74.	0.	7785.	0.	0.
H2SO4	0.	0.	0.	0.	0.	0.	0.	0.
MG++	0.	0.	0.	2.	2.	0.	0.	0.
CA++	0.	0.	0.	0.	0.	0.	0.	0.
NA+	0.	0.	0.	841.	841.	0.	0.	0.
H+	0.	0.	0.	0.	0.	0.	0.	0.
MGOH+	0.	0.	0.	0.	0.	0.	0.	0.
NASO4(S)	0.	0.	0.	430.	430.	0.	0.	0.
MGSO4(S)	0.	0.	0.	0.	0.	0.	0.	0.
CASO4(S)	0.	0.	0.	0.	0.	0.	0.	0.
NACL(S)	0.	0.	0.	16195.	16195.	0.	0.	0.
CACO3(S)	0.	0.	0.	0.	0.	0.	0.	0.
NA2CO(S)	0.	0.	0.	0.	0.	0.	0.	0.
MGOH2(S)	0.	0.	0.	0.	0.	0.	0.	0.
CL-	0.	0.	0.	1184.	1184.	0.	0.	0.
SO4--	0.	0.	0.	42.	42.	0.	0.	0.
CO3--	0.	0.	0.	76.	76.	0.	0.	0.
OH-	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.
VolFlow cuft/hr	709296.21	1719.81	703584.71	2716.88	1237.99	280930.87	94663.83	2436.77
Enthalpy MMBtu/hr	-61.92	-51.86	-113.78	-665.09	-613.18	-112.39	-4.96	-1028.55

Table 2B: Alternative Chlorine-Caustic Production Process Technology – Stream Tables - Cont'd

Stream ID	GASTREAT.->17	GASTREAT.->18	GASTREAT.->18A	GASTREAT.->19	GASTREAT.->21	GASTREAT.->22A	GASTREAT.->22R	GASTREAT.->23
Temperature F	202.45	95.03	94.99	218.69	95.12	112.44	114.73	100.88
Pressure psi	14.70	39.70	39.70	15.70	14.70	14.70	14.70	14.70
Vapor Frac	0.71	0.00	0.00	1.00	1.00	0.00	0.00	1.00
MoleFlow lbmol/hr	1213.	8342.	8341.	67.	172.	14.	11.	165.
MassFlow lb/hr	29739.	151141.	151040.	1200.	11731.	848.	789.	11557.
H2O	19165.	149998.	149998.	1200.	146.	107.	65.	59.
NACL	0.	0.	0.	0.	0.	0.	0.	0.
CASO4	0.	0.	0.	0.	0.	0.	0.	0.
MGSO4	0.	0.	0.	0.	0.	0.	0.	0.
NAOH	0.	0.	0.	0.	0.	0.	0.	0.
NA2CO3	0.	0.	0.	0.	0.	0.	0.	0.
MGOH2	0.	0.	0.	0.	0.	0.	0.	0.
CACO3	0.	0.	0.	0.	0.	0.	0.	0.
HCL	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	1.	0.	1.	0.	0.	1.
H2	0.	0.	0.	0.	0.	0.	0.	0.
CL2	10574.	1143.	1041.	0.	11584.	86.	69.	11498.
H2SO4	0.	0.	0.	0.	0.	655.	655.	0.
MG++	0.	0.	0.	0.	0.	0.	0.	0.
CA++	0.	0.	0.	0.	0.	0.	0.	0.
NA+	0.	0.	0.	0.	0.	0.	0.	0.
H+	0.	0.	0.	0.	0.	0.	0.	0.
MGOH+	0.	0.	0.	0.	0.	0.	0.	0.
NASO4(S)	0.	0.	0.	0.	0.	0.	0.	0.
MGSO4(S)	0.	0.	0.	0.	0.	0.	0.	0.
CASO4(S)	0.	0.	0.	0.	0.	0.	0.	0.
NACL(S)	0.	0.	0.	0.	0.	0.	0.	0.
CACO3(S)	0.	0.	0.	0.	0.	0.	0.	0.
NA2CO(S)	0.	0.	0.	0.	0.	0.	0.	0.
MGOH2(S)	0.	0.	0.	0.	0.	0.	0.	0.
CL-	0.	0.	0.	0.	0.	0.	0.	0.
SO4--	0.	0.	0.	0.	0.	0.	0.	0.
CO3--	0.	0.	0.	0.	0.	0.	0.	0.
OH-	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.
VolFlow cuft/hr	412091.31	2454.78	3031.51	30614.16	68687.82	8.92	7.96	67028.64
Enthalpy MMBtu/hr	-115.73	-1032.56	-1027.68	-6.86	-0.83	-3.08	-2.79	-0.32

Table 2B: Alternative Chlorine-Caustic Production Process Technology – Stream Tables - Cont'd

Stream ID	GASTREAT.->23-1	GASTREAT.->23-1A	GASTREAT.->23-2	GASTREAT.->24	GASTREAT.->26	GASTREAT.->26-2	GASTREAT.->26-5	GASTREAT.->26A
Temperature F	93.17	309.31	99.15	50.00	65.00	15.80	90.00	78.60
Pressure psi	39.70	39.70	39.70	14.70	14.70	39.70	39.70	39.70
Vapor Frac	1.00	1.00	0.00	0.00	1.00	1.00	1.00	1.00
MoleFlow lbmol/hr	165.	165.	3.	8.	8.	16.	8.	170.
MassFlow lb/hr	11557.	11557.	89.	675.	232.	1143.	232.	11968.
H2O	59.	59.	35.	20.	0.	0.	0.	25.
NACL	0.	0.	0.	0.	0.	0.	0.	0.
CASO4	0.	0.	0.	0.	0.	0.	0.	0.
MGSO4	0.	0.	0.	0.	0.	0.	0.	0.
NAOH	0.	0.	0.	0.	0.	0.	0.	0.
NA2CO3	0.	0.	0.	0.	0.	0.	0.	0.
MGOH2	0.	0.	0.	0.	0.	0.	0.	0.
CACO3	0.	0.	0.	0.	0.	0.	0.	0.
HCL	0.	0.	0.	0.	0.	0.	0.	0.
CO2	1.	1.	0.	0.	0.	0.	0.	1.
H2	0.	0.	0.	0.	0.	0.	0.	0.
CL2	11498.	11498.	54.	0.	0.	1143.	0.	11943.
H2SO4	0.	0.	0.	655.	0.	0.	0.	0.
MG++	0.	0.	0.	0.	0.	0.	0.	0.
CA++	0.	0.	0.	0.	0.	0.	0.	0.
NA+	0.	0.	0.	0.	0.	0.	0.	0.
H+	0.	0.	0.	0.	0.	0.	0.	0.
MGOH+	0.	0.	0.	0.	0.	0.	0.	0.
NASO4(S)	0.	0.	0.	0.	0.	0.	0.	0.
MGSO4(S)	0.	0.	0.	0.	0.	0.	0.	0.
CASO4(S)	0.	0.	0.	0.	0.	0.	0.	0.
NACL(S)	0.	0.	0.	0.	0.	0.	0.	0.
CACO3(S)	0.	0.	0.	0.	0.	0.	0.	0.
NA2CO(S)	0.	0.	0.	0.	0.	0.	0.	0.
MGOH2(S)	0.	0.	0.	0.	0.	0.	0.	0.
CL-	0.	0.	0.	0.	0.	0.	0.	0.
SO4--	0.	0.	0.	0.	0.	0.	0.	0.
CO3--	0.	0.	0.	0.	0.	0.	0.	0.
OH-	0.	0.	0.	0.	0.	0.	0.	0.
N2	0.	0.	0.	0.	178.	0.	178.	0.
O2	0.	0.	0.	0.	54.	0.	54.	0.
VolFlow cuft/hr	23952.27	33956.31	1.21	6.06	3079.02	1977.87	1193.46	23935.18
Enthalpy MMBtu/hr	-0.34	-0.03	-0.25	-2.50	0.00	-0.01	0.00	-0.16

Table 2B: Alternative Chlorine-Caustic Production Process Technology – Stream Tables - Cont'd

Stream ID	GASTREAT.->26B	GASTREAT.->27A	GASTREAT.->28A	GASTREAT.->30	GASTREAT.->32-1	GASTREAT.->LIQUID	GASTREAT.->RFX	GASTREAT.->TOSEP
Temperature F	15.80	95.00	95.00	15.80	90.00	180.08	15.80	15.80
Pressure psi	39.70	39.70	39.70	39.70	14.70	14.70	39.70	39.70
Vapor Frac	0.10	1.00	0.00	0.00	1.00	0.00	0.00	0.00
MoleFlow lbmol/hr	170.	8.	8326.	147.	155.	9394.	7.	154.
MassFlow lb/hr	11968.	235.	150000.	10325.	412.	169410.	500.	10825.
H2O	25.	2.	150000.	23.	111.	169178.	1.	25.
NACL	0.	0.	0.	0.	0.	0.	0.	0.
CASO4	0.	0.	0.	0.	0.	0.	0.	0.
MGSO4	0.	0.	0.	0.	0.	0.	0.	0.
NAOH	0.	0.	0.	0.	0.	0.	0.	0.
NA2CO3	0.	0.	0.	0.	0.	0.	0.	0.
MGOH2	0.	0.	0.	0.	0.	0.	0.	0.
CACO3	0.	0.	0.	0.	0.	0.	0.	0.
HCL	0.	0.	0.	0.	0.	0.	0.	0.
CO2	1.	0.	0.	0.	0.	0.	0.	0.
H2	0.	0.	0.	0.	301.	0.	0.	0.
CL2	11943.	0.	0.	10301.	0.	232.	499.	10800.
H2SO4	0.	0.	0.	0.	0.	0.	0.	0.
MG++	0.	0.	0.	0.	0.	0.	0.	0.
CA++	0.	0.	0.	0.	0.	0.	0.	0.
NA+	0.	0.	0.	0.	0.	0.	0.	0.
H+	0.	0.	0.	0.	0.	0.	0.	0.
MGOH+	0.	0.	0.	0.	0.	0.	0.	0.
NASO4(S)	0.	0.	0.	0.	0.	0.	0.	0.
MGSO4(S)	0.	0.	0.	0.	0.	0.	0.	0.
CASO4(S)	0.	0.	0.	0.	0.	0.	0.	0.
NACL(S)	0.	0.	0.	0.	0.	0.	0.	0.
CACO3(S)	0.	0.	0.	0.	0.	0.	0.	0.
NA2CO(S)	0.	0.	0.	0.	0.	0.	0.	0.
MGOH2(S)	0.	0.	0.	0.	0.	0.	0.	0.
CL-	0.	0.	0.	0.	0.	0.	0.	0.
SO4--	0.	0.	0.	0.	0.	0.	0.	0.
CO3--	0.	0.	0.	0.	0.	0.	0.	0.
OH-	0.	0.	0.	0.	0.	0.	0.	0.
N2	0.	178.	0.	0.	0.	0.	0.	0.
O2	0.	54.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	2093.65	1226.13	2443.47	110.44	62354.47	2897.76	5.35	115.78
Enthalpy MMBtu/hr	-1.51	-0.01	-1032.56	-1.43	-0.63	-1143.50	-0.07	-1.49

Table 2B: Alternative Chlorine-Caustic Production Process Technology – Stream Tables - Cont'd

Stream ID	GASTREAT.->VAPOR	GASTREAT.->VAPORB	GASTREAT.->VPR	GASTREAT.->WASTE	GASTREAT.->WASTE22			
Temperature F	179.37	109.84	293.76	96.08	185.99			
Pressure psi	8.89	14.70	14.70	14.70	8.89			
Vapor Frac	1.00	1.00	1.00	0.00	0.00			
MoleFlow lbmol/hr	12.	169.	12.	8369.	9449.			
MassFlow lb/hr	362.	11671.	362.	150776.	170248.			
H2O	162.	104.	162.	150776.	170216.			
NACL	0.	0.	0.	0.	0.			
CASO4	0.	0.	0.	0.	0.			
MGSO4	0.	0.	0.	0.	0.			
NAOH	0.	0.	0.	0.	0.			
NA2CO3	0.	0.	0.	0.	0.			
MGOH2	0.	0.	0.	0.	0.			
CACO3	0.	0.	0.	0.	0.			
HCL	0.	0.	0.	0.	0.			
CO2	0.	1.	0.	0.	0.			
H2	0.	0.	0.	0.	0.			
CL2	200.	11566.	200.	0.	32.			
H2SO4	0.	0.	0.	0.	0.			
MG++	0.	0.	0.	0.	0.			
CA++	0.	0.	0.	0.	0.			
NA+	0.	0.	0.	0.	0.			
H+	0.	0.	0.	0.	0.			
MGOH+	0.	0.	0.	0.	0.			
NASO4(S)	0.	0.	0.	0.	0.			
MGSO4(S)	0.	0.	0.	0.	0.			
CASO4(S)	0.	0.	0.	0.	0.			
NACL(S)	0.	0.	0.	0.	0.			
CACO3(S)	0.	0.	0.	0.	0.			
NA2CO(S)	0.	0.	0.	0.	0.			
MGOH2(S)	0.	0.	0.	0.	0.			
CL-	0.	0.	0.	0.	0.			
SO4--	0.	0.	0.	0.	0.			
CO3--	0.	0.	0.	0.	0.			
OH-	0.	0.	0.	0.	0.			
N2	0.	0.	0.	0.	0.			
O2	0.	0.	0.	0.	0.			
VolFlow cuft/hr	9041.88	69555.85	6450.13	2457.57	2923.99			
Enthalpy MMBtu/hr	-0.92	-0.56	-0.91	-1032.88	-1149.44			

Figure 2A – Alternative Chlorine – Caustic Soda – part 1

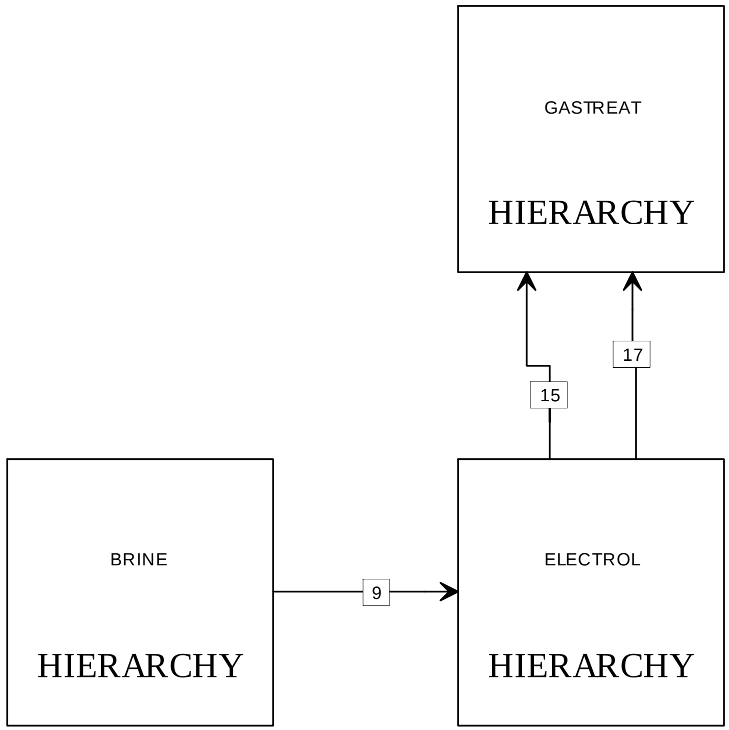


Figure 2B – Alternative Chlorine – Caustic Soda – part 2

M-2-4	M-6	S-1	S-2	T-9
Salt Washers	Dissolver	Reactor-settler	Setttler	PH Adjusting Tank

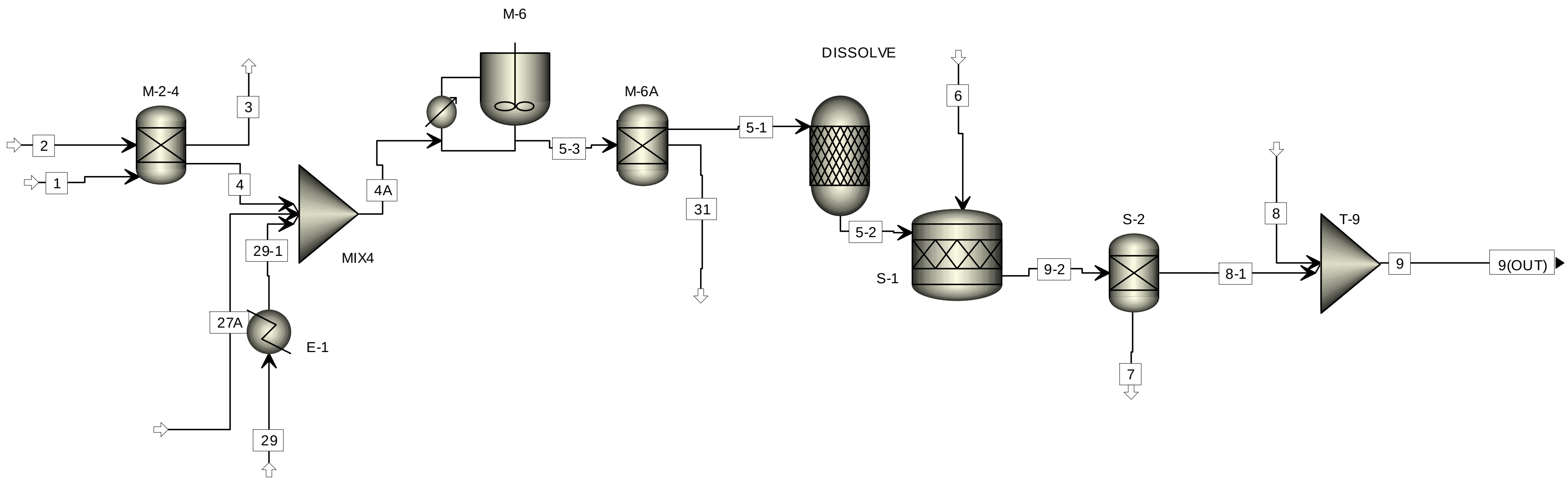


Figure 2C – Alternative Chlorine – Caustic Soda – part 3

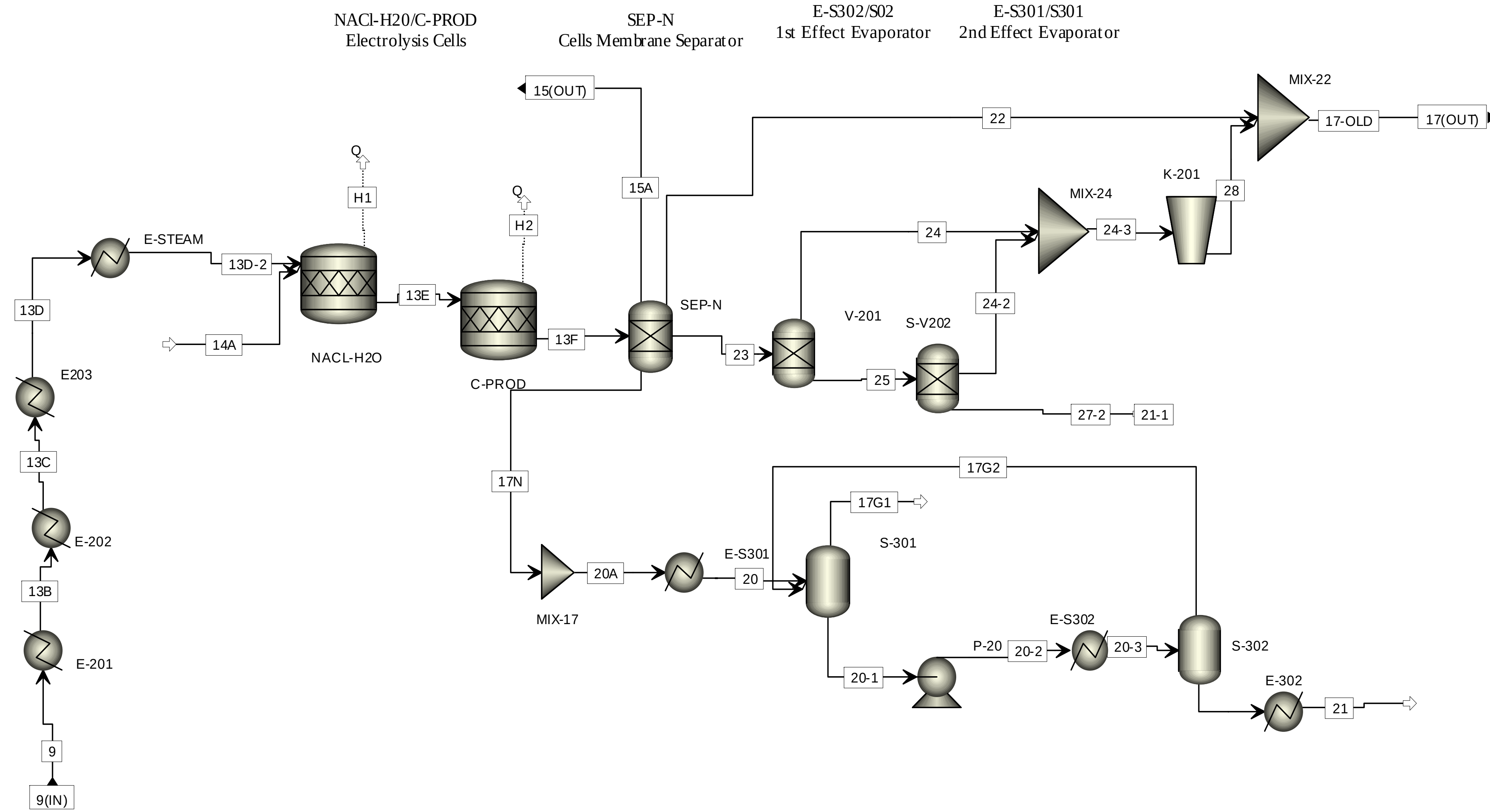


Figure 2D – Alternative Chlorine – Caustic Soda – part 4

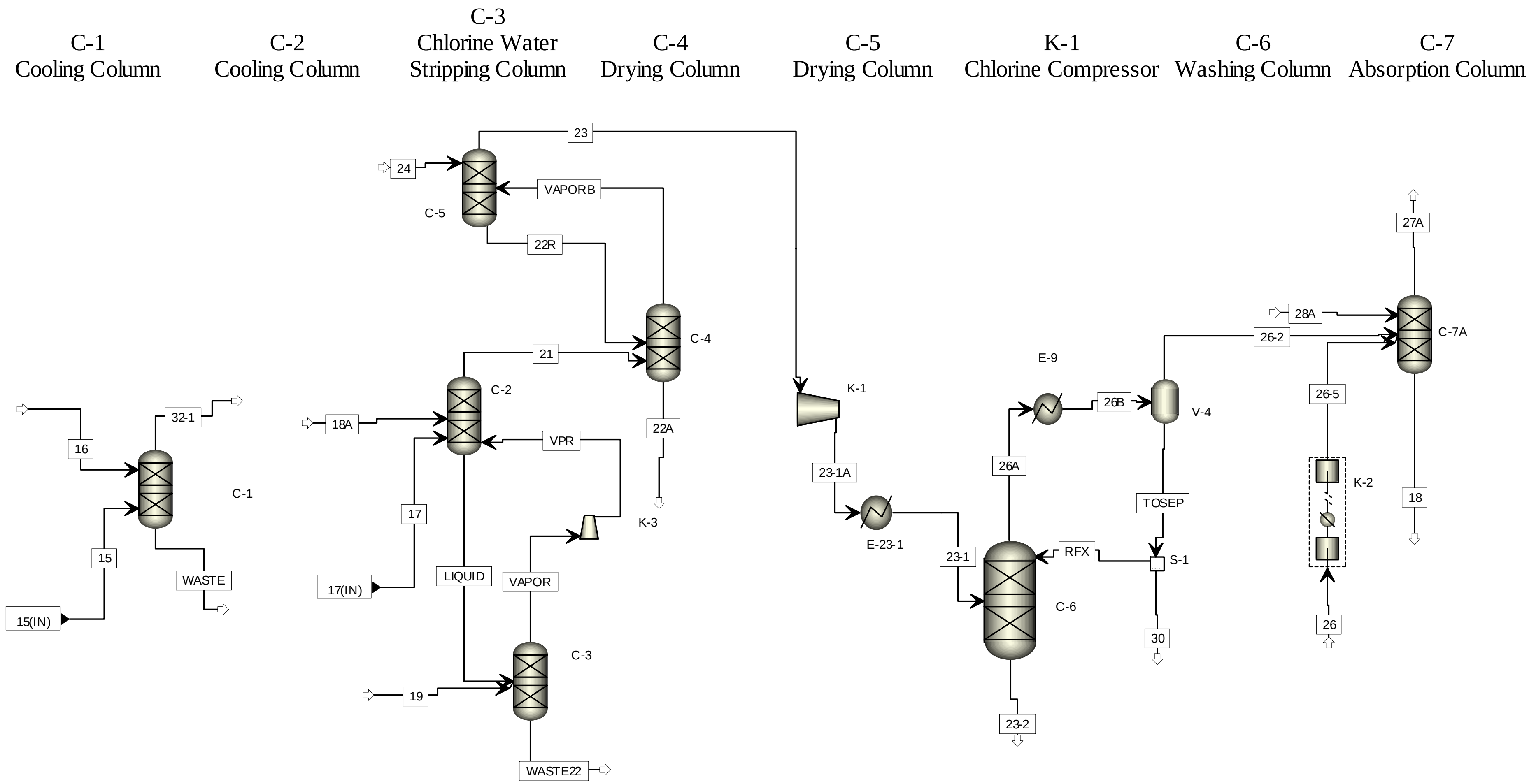


Figure 2E – Base Case Chlorine – Caustic Soda – part 1

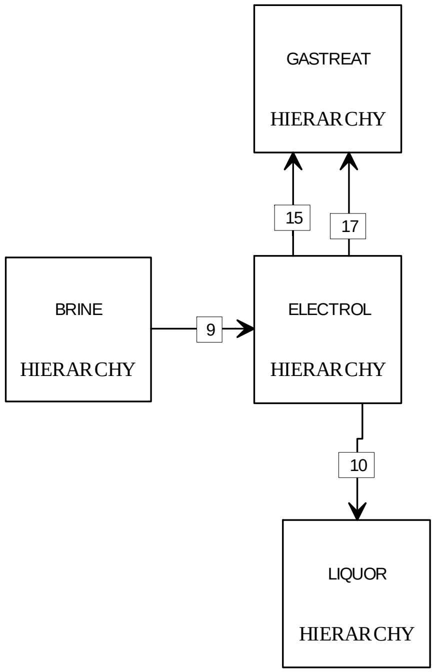


Figure 2F – Base Case Chlorine – Caustic Soda – part 2

M-2-4	M-6	S-1	S-2	T-9
Salt Washers	Dissolver	Reactor-settler	Setttler	PH Adjusting Tank

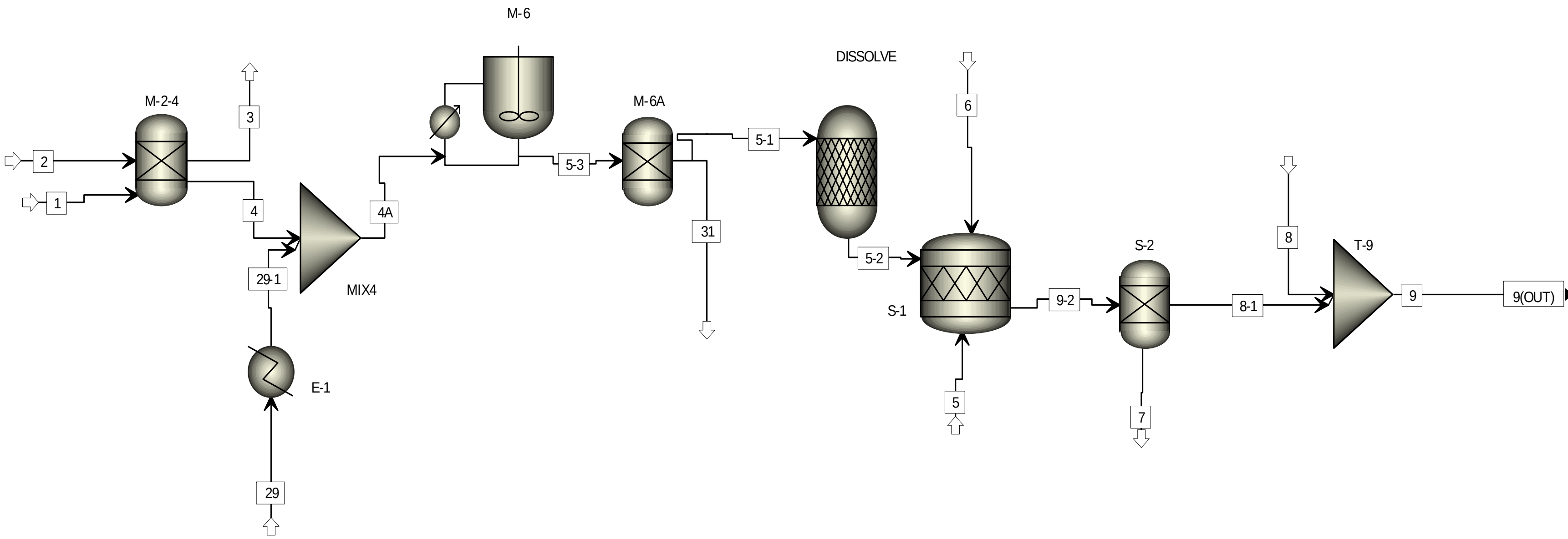


Figure 2G – Base Case Chlorine – Caustic Soda – part 3

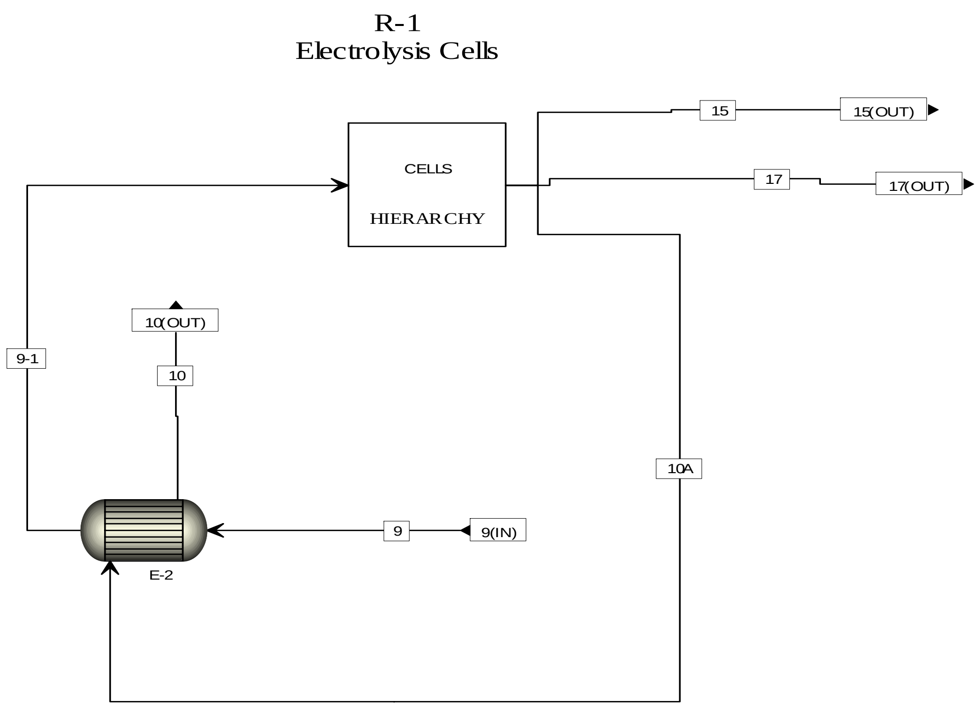


Figure 2H – Base Case Chlorine – Caustic Soda – part 4

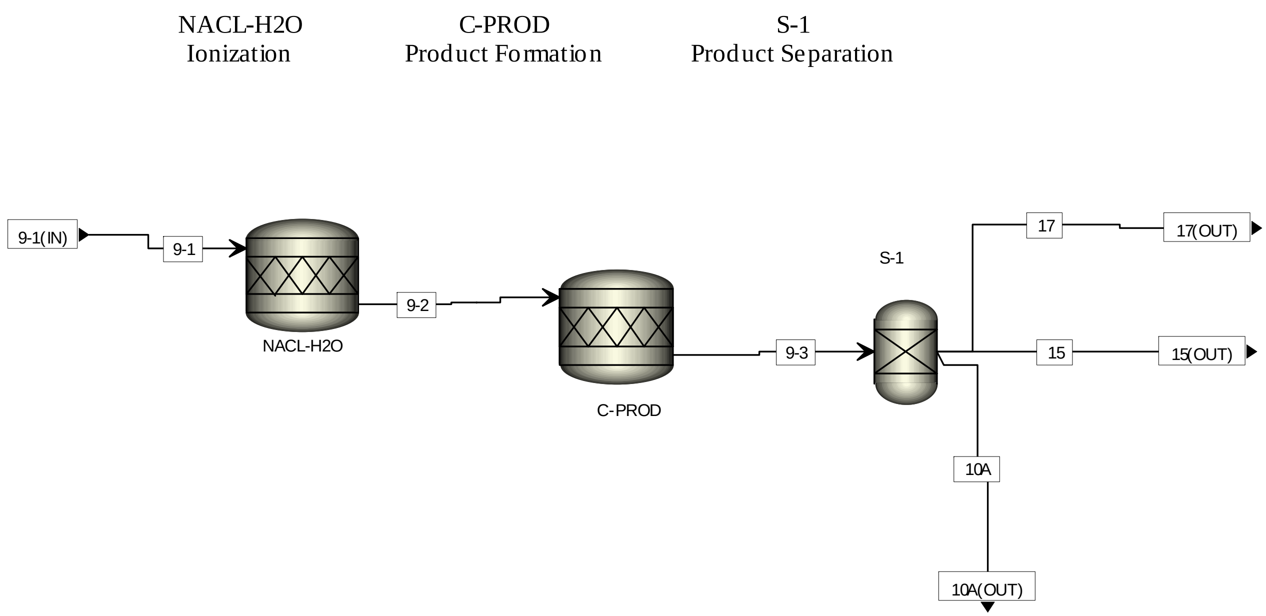


Figure 2I – Base Case Chlorine – Caustic Soda – part 5

C-1	C-2	C-3	C-4	C-5	K-1	C-6	C-7
Cooling Column	Cooling Column	Chlorine Water Stripping Column	Drying Column	Drying Column	Chlorine Compressor	Washing Column	Absorption Column

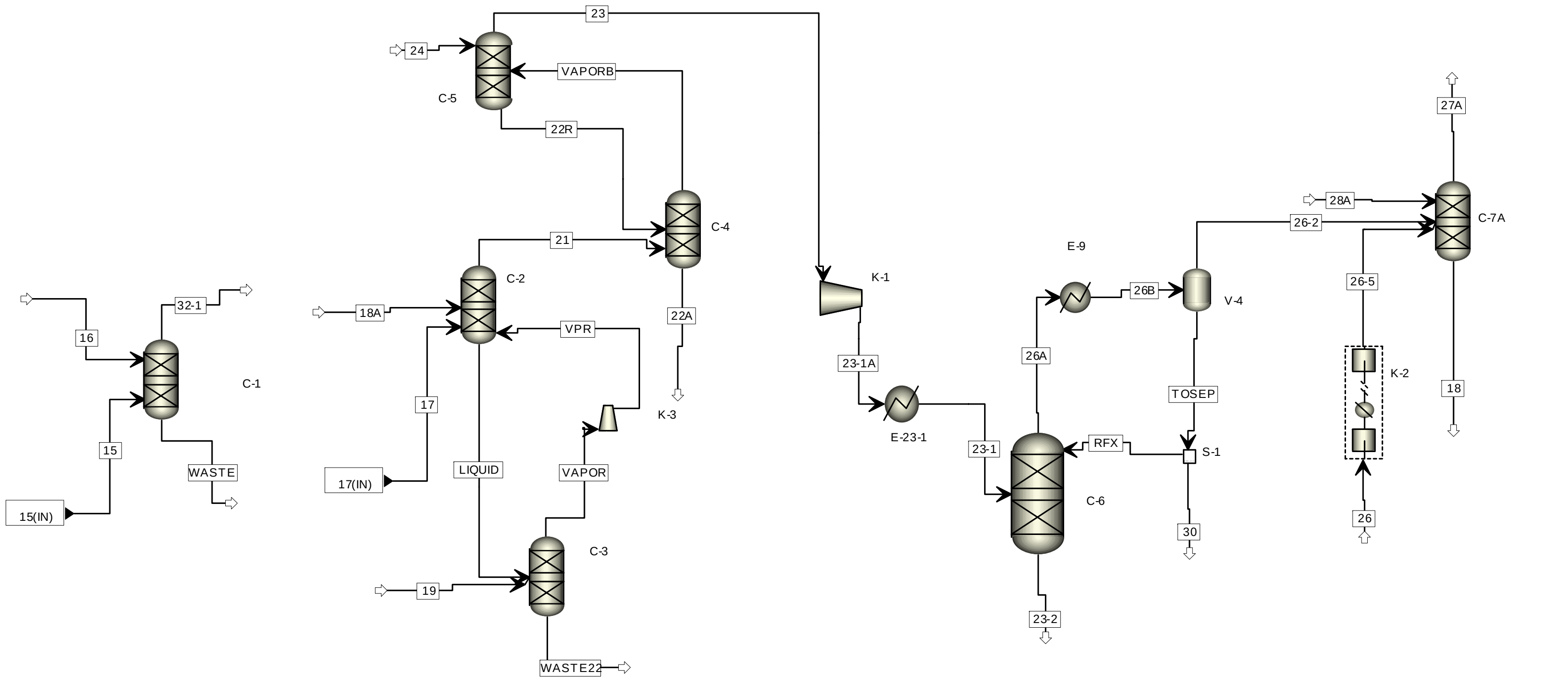
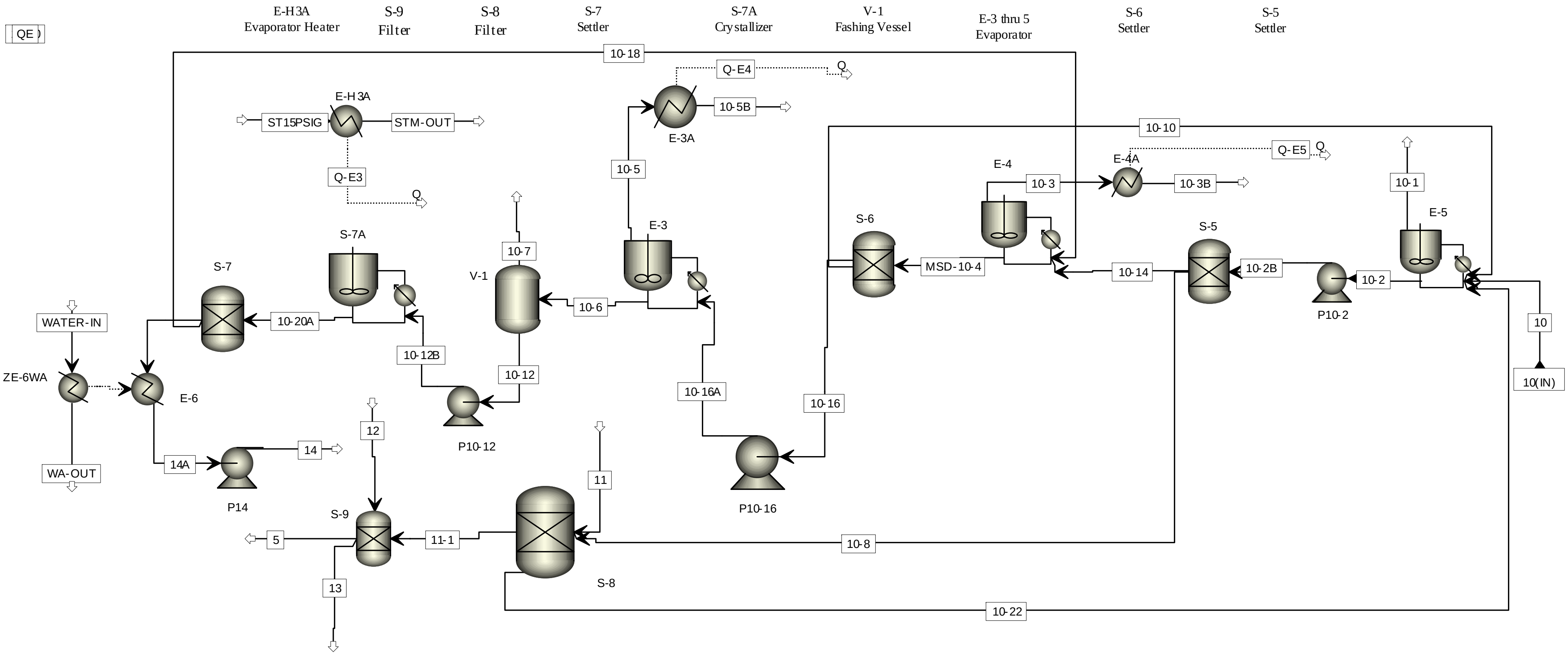


Figure 2J – Base Case Chlorine – Caustic Soda – part 6



Appendix 3 – Ethylene Oxide

Table 3A: Alternative Ethylene Oxide Production Process Technology – Energy and Exergy Loss Profile

Unit OP	Type	Energy Loss = Btu/lb		Exergy Loss = Btu/lb			
		Total = 7,125	%	Total External = 1,064	Total Internal = 5,290	Total = 6,355	%
FEED PRETREATMENT							
..K-101	Compressor	0	0	0	46	46	0.72
..FSP-7	Flow Splitter	0	0	0	0	0	0
..MIX-7	Mixer	0	0	0	101	101	1.59
..MIX11	Mixer	0	0	0	1	1	0.01
EXOTHERMIC REACTOR							
..R-101	Reactor	0	0	0	2,400	2,400	37.77
..FSP5	Flow Splitter	0	0	0	0	0	0
..E-102	Cooler	751	10.54	184	2	186	2.92
..E-101C	Process Exchanger	0	0	0	196	196	3.09
EO ABSORBER							
..MIX-4	Mixer	0	0	0	90	90	1.41
..C-101	Absorber	0	0	0	381	381	5.99
..VLV1	Valve	0	0	0	427	427	6.72
..V-101A	Separator	563	7.9	32	0	32	0.5
..K-102	Compressor	688	9.65	147	339	486	7.64
..E-103	Cooler	594	8.33	123	4	127	1.99
..P-5	Pump	0	0	0	22	22	0.34
EO STRIPPER							
H-200..P8	Pump	0	0	0	1	1	0.02
H-200..E-202	Process Exchanger	802	11.25	133	15	147	2.32
H-200..C-201	Stripping Column	51	0.71	11	15	26	0.4
H-200..E-201C	Cooler	0	0	0	185	185	2.91
H-200..R202V201	EG Reactor	0	0	0	12	12	0.19
H-200..P11	Pump	0	0	0	3	3	0.05
H-200..E-206	Cooler	1,365	19.16	108	6	114	1.79
H-200..FSP-11	Flow Splitter	0	0	0	0	0	0
H-200..V-202	Flash Drum	0	0	0	0	0	0
H-200..V-203	Flash Drum	0	0	0	0	0	0
H-200..E-203A	Cooler	297	4.16	8	0	8	0.12
H-200..E-204	Cooler	67	0.95	3	1	4	0.06
H-200..C-202	Rectifying Column	7	0.1	0	2	2	0.03
H-200..K-201	Compressor	0	0	0	0	0	0
H-200..MIX-12	Mixer	0	0	0	3	3	0.04
H-200..P12	Pump	0	0	0	0	0	0

Table 3A: Alternative Ethylene Oxide Production Process Technology – Energy and Exergy Loss Profile (Cont'd)

Unit OP	Type	Energy Loss = Btu/lb Total = 7,125	Energy Loss %	Exergy Loss = Btu/lb Total External = 1,064	Exergy Loss Total Internal = 5,290	Exergy Loss Total = 6,355	Exergy Loss %
CO2 RECOVERY							
H-300..C-301	Absorber	0	0	0	157	157	2.48
H-300..VLV-301	Valve	0	0	0	531	531	8.36
H-300..MIX15	Mixer	0	0	0	146	146	2.3
H-300..K-201	Compressor	0	0	0	152	152	2.4
H-300..V-301	Flash Drum	0	0	0	0	0	0
H-300..E-301	Ovd Condenser	549	7.71	99	7	106	1.67
H-300..P-C301	Pump	0	0	0	0	0	0
H-300..C-302	Compressor	0	0	0	0	0	0
H-300..MIX-17	Mixer	0	0	0	2	2	0.03
H-300..K-302	Compressor	0	0	0	0	0	0
H-300..E-302C	Process Exchanger	0	0	0	21	21	0.32
H-300..C-303	Desorber	809	11.36	112	0	112	1.77
H-300..E-302B	Heater	0	0	0	0	0	0
H-300..MIX-16	Mixer	0	0	0	0	0	0
H-300..P16	Pump	0	0	0	6	6	0.1
H-300..P15-6	Pump	0	0	0	0	0	0
H-300..E-301A	Heater	0	0	0	4	4	0.06
H-300..V-302	Flash Drum	425	5.97	96	0	96	1.5
EO PURIFICATION							
H-400..C-401	EO Column	157	2.2	9	10	18	0.29
H-400..E-403	Cooler	0	0	0	0	0	0
H-400..V-401	Flash Drum	0	0	0	0	0	0
H-400..FSPT-22	Flow Splitter	0	0	0	0	0	0
H-400..E-401C	Process Exchanger	0	0	0	3	3	0.05

Table 3B: Alternative Ethylene Oxide Production Process Technology – Stream Tables

Stream ID	.->1	.->2	.->3-1	.->3-2	.->3-3	.->3-4	.->4	.->4-1
Temperature F	230.00	230.00	329.35	329.18	480.00	308.11	200.00	175.22
Pressure psi	310.00	310.00	310.00	310.00	310.00	310.00	310.00	310.00
Vapor Frac	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
MoleFlow lbmol/hr	748.	651.	16566.	16575.	16294.	16294.	16294.	21014.
MassFlow lb/hr	21113.	20975.	480370.	480533.	480370.	480370.	480370.	622660.
ETHYLENE	19111.	0.	185697.	185696.	167108.	167108.	167108.	247076.
OXYGEN	0.	20327.	58248.	58255.	38019.	38019.	38019.	39391.
CO2	0.	0.	50980.	50967.	61467.	61467.	61467.	89561.
ARGON	0.	647.	107260.	107297.	107260.	107260.	107260.	110973.
METHANE	0.	0.	57039.	57270.	56990.	56990.	56990.	61302.
ETHANE	2002.	0.	20054.	20054.	20054.	20054.	20054.	44723.
EO	0.	0.	1.	1.	23912.	23912.	23912.	24008.
ACET	0.	0.	0.	0.	29.	29.	29.	29.
FORMAL	0.	0.	17.	23.	107.	107.	107.	107.
WATER	0.	0.	1075.	970.	5422.	5422.	5422.	5490.
EG	0.	0.	0.	0.	0.	0.	0.	0.
EDC	0.	0.	0.	0.	0.	0.	0.	0.
K+	0.	0.	0.	0.	0.	0.	0.	0.
HCO3-	0.	0.	0.	0.	0.	0.	0.	0.
CO3--	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	17853.85	15553.37	452472.12	452634.05	530021.81	433064.68	372087.53	461839.78
Enthalpy MMBtu/hr	14.30	0.70	-150.36	-150.19	-215.27	-246.96	-264.92	-346.06
Stream ID	.->5	.->5-OUT	.->5A	.->6	.->6-1	.->7	.->8	.->8-1
Temperature F	100.79	100.82	100.00	101.23	101.23	132.64	116.23	134.25
Pressure psi	260.00	260.00	60.00	260.00	260.00	310.00	15.00	260.00
Vapor Frac	0.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00
MoleFlow lbmol/hr	38464.	38469.	38469.	39.	15431.	12912.	39287.	44007.
MassFlow lb/hr	719983.	719998.	719998.	1127.	449748.	376327.	749471.	891762.
ETHYLENE	0.	0.	0.	417.	166539.	139265.	150.	80117.
OXYGEN	0.	0.	0.	95.	37897.	31707.	27.	1399.
CO2	0.	0.	0.	152.	60750.	50906.	564.	28658.
ARGON	0.	0.	0.	268.	106897.	89455.	94.	3808.
METHANE	0.	0.	0.	142.	56786.	47525.	62.	4374.
ETHANE	0.	0.	0.	50.	19943.	16678.	60.	24729.
EO	0.	0.	0.	0.	0.	0.	23912.	24008.
ACET	0.	0.	0.	0.	0.	0.	29.	29.
FORMAL	151.	81.	81.	0.	24.	20.	234.	234.
WATER	681804.	681955.	681955.	2.	912.	771.	686310.	686379.
EG	38025.	37959.	37959.	0.	0.	0.	38025.	38025.
EDC	3.	3.	3.	0.	0.	0.	3.	3.
K+	0.	0.	0.	0.	0.	0.	0.	0.
HCO3-	0.	0.	0.	0.	0.	0.	0.	0.
CO3--	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	11692.11	11692.23	11686.93	895.37	357251.53	264743.47	12313.22	16421.86
Enthalpy MMBtu/hr	-4754.11	-4754.79	-4755.33	-0.60	-238.85	-196.62	-4793.86	-4860.73

Table 3B: Alternative Ethylene Oxide Production Process Technology – Stream Tables – Cont'd

Stream ID	.->8-4	.->8-5	.->8C	.->8D	.->12-0	.->12-1	.->14	.->14-2
Temperature F	350.00	100.00	116.23	116.23	62.60	62.60	586.58	713.72
Pressure psi	310.00	310.00	15.00	15.00	25.00	25.00	260.00	260.00
Vapor Frac	1.00	1.00	0.12	1.00	0.00	0.00	1.00	1.00
MoleFlow lbmol/hr	4720.	4720.	44007.	4720.	1853.	1853.	13.	9.
MassFlow lb/hr	142291.	142291.	891762.	142291.	47411.	47411.	404.	261.
ETHYLENE	79967.	79967.	80117.	79967.	125.	125.	46.	25.
OXYGEN	1372.	1372.	1399.	1372.	3.	3.	30.	24.
CO2	28094.	28094.	28658.	28094.	492.	492.	142.	72.
ARGON	3713.	3713.	3808.	3713.	11.	11.	106.	84.
METHANE	4311.	4311.	4374.	4311.	15.	15.	62.	48.
ETHANE	24669.	24669.	24729.	24669.	59.	59.	6.	1.
EO	95.	95.	24008.	95.	22982.	22982.	0.	0.
ACET	0.	0.	29.	0.	29.	29.	0.	0.
FORMAL	0.	0.	234.	0.	150.	150.	0.	0.
WATER	69.	69.	686379.	69.	23546.	23546.	10.	7.
EG	0.	0.	38025.	0.	0.	0.	0.	0.
EDC	0.	0.	3.	0.	0.	0.	0.	0.
K+	0.	0.	0.	0.	0.	0.	0.	0.
HCO3-	0.	0.	0.	0.	0.	0.	0.	0.
CO3--	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	132289.70	91442.91	2213406.79	1944627.34	794.38	794.35	567.31	425.22
Enthalpy MMBtu/hr	-66.94	-81.14	-4860.73	-80.32	-180.36	-180.36	-0.64	-0.34
Stream ID	.->14A6	.->15	.->15-2	.->17	.->21	.->22	.->A-3	.->BFW
Temperature F	101.67	132.64	132.64	114.34	122.12	122.79	135.70	100.00
Pressure psi	260.00	310.00	310.00	310.00	60.00	60.00	310.00	214.70
Vapor Frac	1.00	1.00	1.00	1.00	0.00	0.00	1.00	0.00
MoleFlow lbmol/hr	15444.	2533.	15444.	2264.	1571.	252.	16575.	3089.
MassFlow lb/hr	450152.	73825.	450152.	62118.	35204.	11003.	480533.	55648.
ETHYLENE	166585.	27320.	166585.	27320.	18.	3.	185696.	0.
OXYGEN	37927.	6220.	37927.	6220.	0.	0.	58255.	0.
CO2	60892.	9986.	60892.	61.	69.	11.	50967.	0.
ARGON	107004.	17549.	107004.	17195.	0.	0.	107297.	0.
METHANE	56848.	9323.	56848.	9745.	1.	0.	57270.	0.
ETHANE	19949.	3272.	19949.	1375.	13.	2.	20054.	0.
EO	0.	0.	0.	1.	11491.	10909.	1.	0.
ACET	0.	0.	0.	0.	17.	12.	0.	0.
FORMAL	24.	4.	24.	2.	97.	20.	23.	0.
WATER	922.	151.	922.	199.	23498.	47.	970.	55648.
EG	0.	0.	0.	0.	0.	0.	0.	0.
EDC	0.	0.	0.	0.	0.	0.	0.	0.
K+	0.	0.	0.	0.	0.	0.	0.	0.
HCO3-	0.	0.	0.	0.	0.	0.	0.	0.
CO3--	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	357837.17	51935.32	316678.79	42653.82	601.95	214.05	341617.20	908.56
Enthalpy MMBtu/hr	-239.48	-38.57	-235.20	-0.26	-167.86	-8.38	-181.89	-378.20

Table 3B: Alternative Ethylene Oxide Production Process Technology – Stream Tables – Cont'd

Stream ID	.->C-101-OV	.->STEAM1	H-200.->5-2	H-200.->8	H-200.->8-A	H-200.->8B	H-200.->9	H-200.->10
Temperature F	101.23	387.91	147.93	116.23	222.64	116.27	100.00	258.83
Pressure psi	260.00	214.70	60.00	15.00	25.00	25.00	25.00	34.70
Vapor Frac	1.00	1.00	0.00	0.00	0.03	0.00	0.00	1.00
MoleFlow lbmol/hr	15470.	3089.	38469.	39287.	39287.	39287.	2181.	28.
MassFlow lb/hr	450876.	55648.	719998.	749471.	749471.	749471.	39286.	508.
ETHYLENE	166956.	0.	0.	150.	150.	150.	0.	0.
OXYGEN	37992.	0.	0.	27.	27.	27.	0.	0.
CO2	60902.	0.	0.	564.	564.	564.	0.	0.
ARGON	107165.	0.	0.	94.	94.	94.	0.	0.
METHANE	56928.	0.	0.	62.	62.	62.	0.	0.
ETHANE	19993.	0.	0.	60.	60.	60.	0.	0.
EO	0.	0.	0.	23912.	23912.	23912.	0.	0.
ACET	0.	0.	0.	29.	29.	29.	0.	0.
FORMAL	24.	0.	81.	234.	234.	234.	0.	0.
WATER	914.	55648.	681955.	686310.	686310.	686310.	39286.	508.
EG	0.	0.	37959.	38025.	38025.	38025.	0.	0.
EDC	0.	0.	3.	3.	3.	3.	0.	0.
K+	0.	0.	0.	0.	0.	0.	0.	0.
HCO3-	0.	0.	0.	0.	0.	0.	0.	0.
CO3--	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	358146.90	130865.21	12010.94	12313.22	354338.03	12313.51	641.42	6265.35
Enthalpy MMBtu/hr	-239.44	-313.29	-4722.68	-4793.86	-4698.37	-4793.83	-267.00	-2.89

Stream ID	H-200.->11	H-200.->11-1	H-200.->11-2	H-200.->11-3	H-200.->11-3A	H-200.->12	H-200.->12-1	H-200.->12-2
Temperature F	147.93	239.26	239.39	270.00	147.93	62.60	150.00	62.60
Pressure psi	60.00	25.00	60.00	60.00	60.00	25.00	25.00	25.00
Vapor Frac	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.03
MoleFlow lbmol/hr	1395.	39885.	39885.	39864.	39864.	1853.	592.	1911.
MassFlow lb/hr	26118.	746115.	746115.	746115.	746115.	47411.	23594.	49751.
ETHYLENE	0.	0.	0.	0.	0.	125.	146.	206.
OXYGEN	0.	0.	0.	0.	0.	3.	27.	28.
CO2	0.	0.	0.	0.	0.	492.	552.	783.
ARGON	0.	0.	0.	0.	0.	11.	94.	99.
METHANE	0.	0.	0.	0.	0.	15.	62.	68.
ETHANE	0.	0.	0.	0.	0.	59.	58.	82.
EO	0.	931.	931.	0.	0.	22982.	20982.	24744.
ACET	0.	0.	0.	0.	0.	29.	27.	30.
FORMAL	3.	84.	84.	84.	84.	150.	124.	156.
WATER	24738.	707073.	707073.	706693.	706693.	23546.	1522.	23555.
EG	1377.	38025.	38025.	39336.	39336.	0.	0.	0.
EDC	0.	3.	3.	3.	3.	0.	0.	0.
K+	0.	0.	0.	0.	0.	0.	0.	0.
HCO3-	0.	0.	0.	0.	0.	0.	0.	0.
CO3--	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	435.69	13183.45	13184.60	13458.98	12446.63	794.35	154991.68	13643.67
Enthalpy MMBtu/hr	-171.31	-4823.11	-4823.00	-4798.54	-4894.00	-180.36	-21.50	-182.53

Table 3B: Alternative Ethylene Oxide Production Process Technology – Stream Tables – Cont'd

Stream ID	H-200.->12-3	H-200.->12-4	H-200.->12-5	H-200.->12-6	H-200.->12-7	H-200.->12-8	H-200.->13	H-200.->A-5
Temperature F	150.00	60.00	62.60	77.85	125.36	77.91	95.00	100.00
Pressure psi	25.00	25.00	25.00	17.00	25.00	25.00	25.00	60.00
Vapor Frac	0.00	0.00	1.00	0.00	0.28	0.00	0.00	0.00
MoleFlow lbmol/hr	1019.	1019.	57.	1318.	1911.	1318.	251.	38469.
MassFlow lb/hr	19556.	19556.	2340.	26157.	49751.	26157.	4522.	719998.
ETHYLENE	3.	3.	81.	60.	206.	60.	0.	0.
OXYGEN	0.	0.	25.	1.	28.	1.	0.	0.
CO2	12.	12.	290.	231.	783.	231.	0.	0.
ARGON	0.	0.	88.	4.	99.	4.	0.	0.
METHANE	0.	0.	53.	6.	68.	6.	0.	0.
ETHANE	2.	2.	23.	24.	82.	24.	0.	0.
EO	2000.	2000.	1762.	3762.	24744.	3762.	0.	0.
ACET	3.	3.	1.	4.	30.	4.	0.	0.
FORMAL	25.	25.	7.	32.	156.	32.	0.	81.
WATER	17509.	17509.	9.	22033.	23555.	22033.	4522.	681955.
EG	0.	0.	0.	0.	0.	0.	0.	37959.
EDC	0.	0.	0.	0.	0.	0.	0.	3.
K+	0.	0.	0.	0.	0.	0.	0.	0.
HCO3-	0.	0.	0.	0.	0.	0.	0.	0.
CO3--	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	331.98	314.70	12849.30	427.04	136427.86	427.05	73.63	11686.93
Enthalpy MMBtu/hr	-119.63	-121.24	-2.16	-153.94	-175.43	-153.94	-30.75	-4755.33

Stream ID	H-200.->A-14	H-200.->A-14-1	H-200.->C201-OVH	H-200.->C201OVH1	H-300.->15-2	H-300.->15-3	H-300.->15-4	H-300.->15-4-1
Temperature F	713.72	93.04	217.96	150.00	595.38	285.31	228.42	232.50
Pressure psi	260.00	17.00	25.00	25.00	310.00	310.00	45.00	45.00
Vapor Frac	1.00	1.00	1.00	0.37	1.00	0.00	0.13	0.14
MoleFlow lbmol/hr	9.	9.	1611.	1611.	5675.	40959.	40959.	40959.
MassFlow lb/hr	261.	261.	43150.	43150.	136669.	883926.	883926.	883926.
ETHYLENE	25.	25.	150.	150.	94053.	94053.	94053.	94053.
OXYGEN	24.	24.	27.	27.	976.	976.	976.	976.
CO2	72.	72.	564.	564.	0.	0.	0.	0.
ARGON	84.	84.	94.	94.	1956.	2445.	2445.	2445.
METHANE	48.	48.	62.	62.	5913.	5913.	5913.	5913.
ETHANE	1.	1.	60.	60.	0.	5376.	5376.	5376.
EO	0.	0.	22982.	22982.	0.	3.	3.	3.
ACET	0.	0.	29.	29.	0.	0.	0.	0.
FORMAL	0.	0.	150.	150.	13.	18.	18.	18.
WATER	7.	7.	19031.	19031.	33758.	600822.	600822.	600822.
EG	0.	0.	0.	0.	0.	1.	1.	1.
EDC	0.	0.	0.	0.	0.	0.	0.	0.
K+	0.	0.	0.	0.	0.	81594.	81594.	81594.
HCO3-	0.	0.	0.	0.	0.	59237.	59237.	59237.
CO3--	0.	0.	0.	0.	0.	33489.	33489.	33489.
VolFlow cuft/hr	425.22	3063.34	468587.54	155323.57	203229.62	19286.14	893151.43	959282.75
Enthalpy MMBtu/hr	-0.34	-0.39	-121.96	-141.13	-97.91	-4575.12	-4575.12	-4566.88

Table 3B: Alternative Ethylene Oxide Production Process Technology – Stream Tables – Cont'd

Stream ID	H-300.->15-5	H-300.->15-6	H-300.->15-7	H-300.->15-8	H-300.->16	H-300.->16-0	H-300.->16-1	H-300.->16-3
Temperature F	232.50	232.50	477.84	232.50	203.07	167.66	167.66	168.32
Pressure psi	45.00	45.00	310.00	45.00	310.00	17.00	17.00	310.00
Vapor Frac	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
MoleFlow lbmol/hr	5675.	35284.	8208.	35284.	35492.	35489.	35489.	35489.
MassFlow lb/hr	136669.	747257.	210494.	747257.	735291.	735341.	735341.	735341.
ETHYLENE	94053.	0.	121373.	0.	0.	0.	0.	0.
OXYGEN	976.	0.	7196.	0.	0.	0.	0.	0.
CO2	0.	0.	9986.	0.	11376.	11546.	11546.	11546.
ARGON	1956.	489.	19504.	489.	27.	26.	26.	26.
METHANE	5913.	0.	15236.	0.	422.	426.	426.	426.
ETHANE	0.	5376.	3272.	5376.	3450.	3467.	3467.	3467.
EO	0.	3.	0.	3.	4.	2.	2.	2.
ACET	0.	0.	0.	0.	0.	0.	0.	0.
FORMAL	13.	5.	17.	5.	3.	4.	4.	4.
WATER	33758.	567063.	33910.	567063.	575795.	575656.	575656.	575656.
EG	0.	1.	0.	1.	1.	1.	1.	1.
EDC	0.	0.	0.	0.	0.	0.	0.	0.
K+	0.	81594.	0.	81594.	81594.	81594.	81594.	81594.
HCO3-	0.	59237.	0.	59237.	0.	0.	0.	0.
CO3--	0.	33489.	0.	33489.	62618.	62618.	62618.	62618.
VolFlow cuft/hr	926292.90	10766.97	260560.23	10766.97	10607.14	10491.22	10491.22	10484.59
Enthalpy MMBtu/hr	-122.38	-4454.67	-136.48	-4454.67	-4425.20	-4443.47	-4443.47	-4442.75

Stream ID	H-300.->16-5	H-300.->16-7	H-300.->17	H-300.->17-1	H-300.->17-2	H-300.->17-3	H-300.->17-4	H-300.->17-5
Temperature F	110.15	110.19	744.78	288.30	110.15	110.15	228.64	227.74
Pressure psi	310.00	312.00	310.00	310.00	310.00	310.00	45.00	45.00
Vapor Frac	0.00	0.00	1.00	1.00	0.77	1.00	1.00	0.00
MoleFlow lbmol/hr	663.	663.	8.	2919.	2919.	2256.	8.	35521.
MassFlow lb/hr	13631.	13631.	259.	75490.	75490.	61859.	259.	748233.
ETHYLENE	4016.	4016.	0.	31336.	31336.	27320.	0.	0.
OXYGEN	142.	142.	0.	6362.	6362.	6220.	0.	0.
CO2	0.	0.	61.	0.	0.	0.	61.	7355.
ARGON	352.	352.	108.	17439.	17439.	17087.	108.	381.
METHANE	860.	860.	0.	10605.	10605.	9745.	0.	1234.
ETHANE	244.	244.	29.	1589.	1589.	1346.	29.	5347.
EO	0.	0.	0.	1.	1.	1.	0.	3.
ACET	0.	0.	0.	0.	0.	0.	0.	0.
FORMAL	1.	1.	0.	4.	4.	2.	0.	5.
WATER	8015.	8015.	60.	8154.	8154.	139.	60.	570039.
EG	0.	0.	0.	0.	0.	0.	0.	1.
EDC	0.	0.	0.	0.	0.	0.	0.	0.
K+	0.	0.	0.	0.	0.	0.	0.	81594.
HCO3-	0.	0.	0.	0.	0.	0.	0.	38671.
CO3--	0.	0.	0.	0.	0.	0.	0.	43602.
VolFlow cuft/hr	550.43	550.43	347.49	73225.27	42739.55	42189.11	1368.60	11001.94
Enthalpy MMBtu/hr	-53.11	-53.11	-0.57	-39.68	-52.80	0.31	-0.61	-4456.52

Table 3B: Alternative Ethylene Oxide Production Process Technology – Stream Tables – Cont'd

Stream ID	H-300.->17-6	H-300.->17-T	H-300.->18	H-300.->19	H-300.->20	H-300.->20-1	H-300.->A-16	H-300.->A15
Temperature F	209.11	114.34	100.00	266.86	186.00	162.01	188.30	132.64
Pressure psi	45.00	310.00	310.00	39.70	17.00	17.00	310.00	310.00
Vapor Frac	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
MoleFlow lbmol/hr	35521.	2264.	77.	109.	458.	458.	35489.	2533.
MassFlow lb/hr	748233.	62118.	1234.	1967.	14859.	14859.	735341.	73825.
ETHYLENE	0.	27320.	0.	0.	0.	0.	0.	27320.
OXYGEN	0.	6220.	0.	0.	0.	0.	0.	6220.
CO2	7355.	61.	0.	0.	9756.	9756.	11546.	9986.
ARGON	381.	17195.	0.	0.	355.	355.	26.	17549.
METHANE	1234.	9745.	1234.	0.	808.	808.	426.	9323.
ETHANE	5347.	1375.	0.	0.	1880.	1880.	3467.	3272.
EO	3.	1.	0.	0.	1.	1.	2.	0.
ACET	0.	0.	0.	0.	0.	0.	0.	0.
FORMAL	5.	2.	0.	0.	1.	1.	4.	4.
WATER	570039.	199.	0.	1967.	2059.	2059.	575656.	151.
EG	1.	0.	0.	0.	0.	0.	1.	0.
EDC	0.	0.	0.	0.	0.	0.	0.	0.
K+	81594.	0.	0.	0.	0.	0.	81594.	0.
HCO3-	38671.	0.	0.	0.	0.	0.	0.	0.
CO3--	43602.	0.	0.	0.	0.	0.	62618.	0.
VolFlow cuft/hr	10921.05	42653.82	1441.51	21110.83	185763.74	178768.73	10555.38	51935.32
Enthalpy MMBtu/hr	-4466.72	-0.26	-2.46	-11.19	-52.79	-52.90	-4432.55	-38.57
Stream ID	H-400.->12-2	H-400.->12-4	H-400.->12-5	H-400.->21-0	H-400.->21-1	H-400.->22-1	H-400.->22-2	H-400.->22-3
Temperature F	62.60	62.88	83.51	146.75	122.12	122.78	122.79	122.79
Pressure psi	25.00	62.00	62.00	60.00	60.00	60.00	60.00	60.00
Vapor Frac	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
MoleFlow lbmol/hr	1853.	1853.	1853.	1571.	1571.	629.	629.	0.
MassFlow lb/hr	47411.	47411.	47411.	35204.	35204.	27511.	27511.	3.
ETHYLENE	125.	125.	125.	18.	18.	7.	7.	0.
OXYGEN	3.	3.	3.	0.	0.	0.	0.	0.
CO2	492.	492.	492.	69.	69.	27.	27.	0.
ARGON	11.	11.	11.	0.	0.	0.	0.	0.
METHANE	15.	15.	15.	1.	1.	0.	0.	0.
ETHANE	59.	59.	59.	13.	13.	5.	5.	0.
EO	22982.	22982.	22982.	11491.	11491.	27276.	27276.	3.
ACET	29.	29.	29.	17.	17.	30.	30.	0.
FORMAL	150.	150.	150.	97.	97.	49.	49.	0.
WATER	23546.	23546.	23546.	23498.	23498.	118.	118.	0.
EG	0.	0.	0.	0.	0.	0.	0.	0.
EDC	0.	0.	0.	0.	0.	0.	0.	0.
K+	0.	0.	0.	0.	0.	0.	0.	0.
HCO3-	0.	0.	0.	0.	0.	0.	0.	0.
CO3--	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	794.38	794.51	806.44	612.63	601.95	535.17	543.26	8.15
Enthalpy MMBtu/hr	-180.36	-180.35	-179.59	-167.10	-167.86	-20.96	-20.96	0.00

Table 3B: Alternative Ethylene Oxide Production Process Technology – Stream Tables – Cont'd

Stream ID	H-400.->22-4	H-400.->22-5	H-400.->401-OVHD	H-400.->S8
Temperature F	122.79	122.79	81.91	122.79
Pressure psi	60.00	60.00	60.00	60.00
Vapor Frac	0.00	0.00	1.00	0.00
MoleFlow lbmol/hr	252.	377.	30.	629.
MassFlow lb/hr	11003.	16505.	1200.	27508.
ETHYLENE	3.	4.	104.	7.
OXYGEN	0.	0.	3.	0.
CO2	11.	16.	412.	27.
ARGON	0.	0.	10.	0.
METHANE	0.	0.	14.	0.
ETHANE	2.	3.	44.	5.
EO	10909.	16363.	579.	27272.
ACET	12.	18.	0.	30.
FORMAL	20.	29.	33.	49.
WATER	47.	71.	0.	118.
EG	0.	0.	0.	0.
EDC	0.	0.	0.	0.
K+	0.	0.	0.	0.
HCO3-	0.	0.	0.	0.
CO3--	0.	0.	0.	0.
VolFlow cuft/hr	214.05	321.07	2908.79	535.11
Enthalpy MMBtu/hr	-8.38	-12.57	-1.93	-20.96

Figure 3A – Alternative Ethylene Oxide Process – Part 1

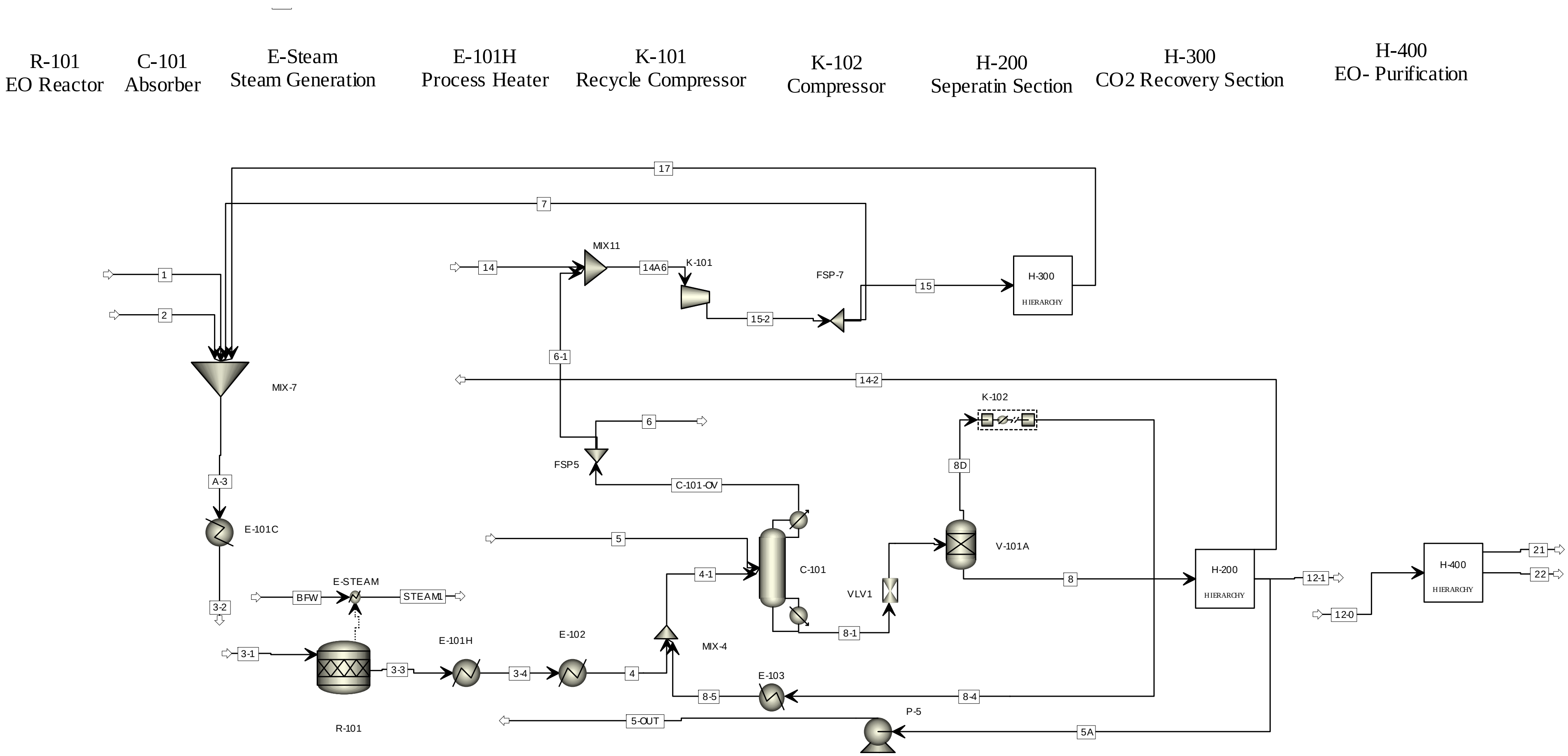


Figure 3B – Alternative Ethylene Oxide Process – Pt 2

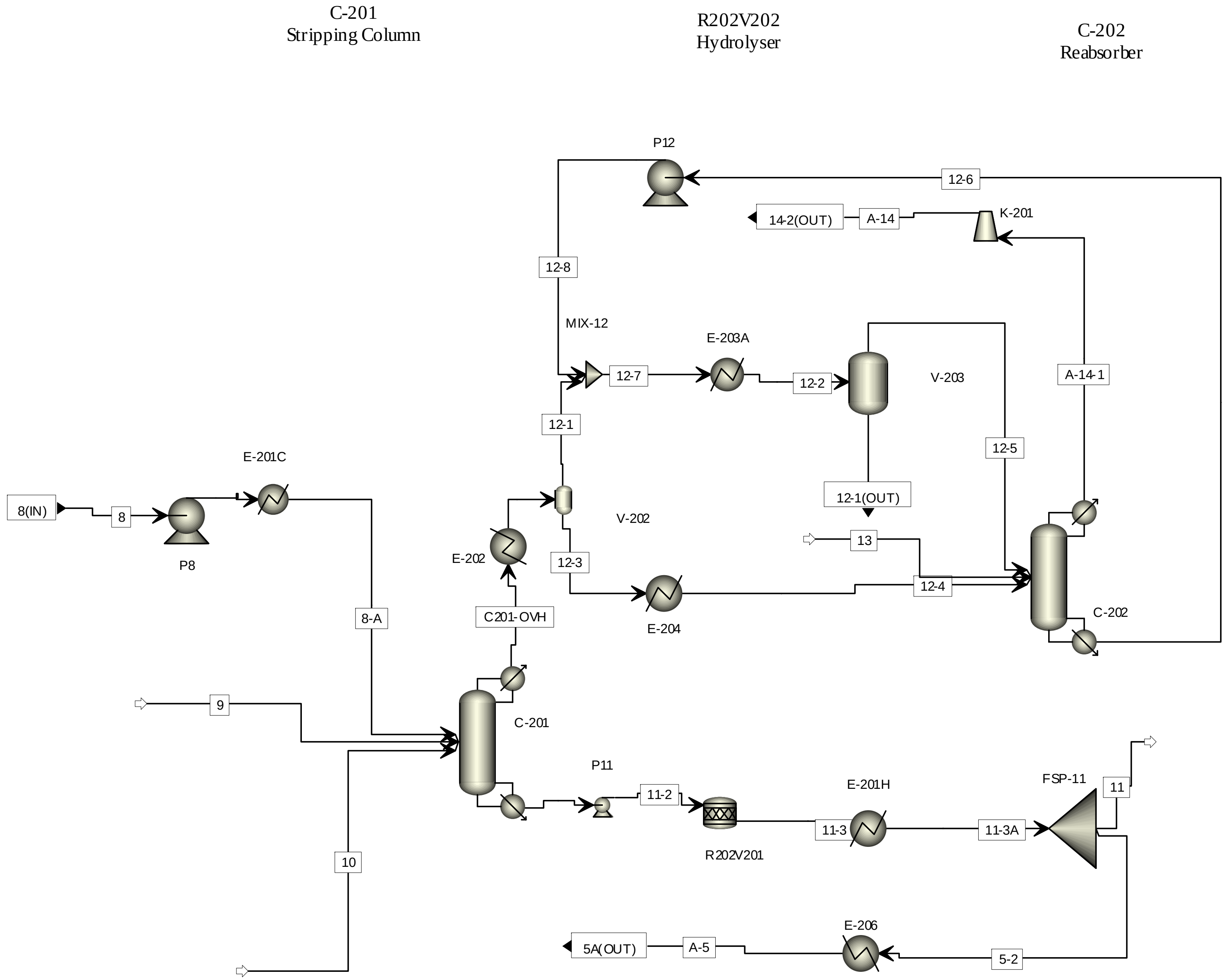


Table 3C: NEW Base Ethylene Oxide Production Process Technology – Energy and Exergy Loss Profile

Unit OP	Type	Energy Loss = Btu/lb		Exergy Loss = Btu/lb			
		Total = 8,345	%	Total External = 1,175	Total Internal = 5,772	Total = 6,947	%
FEED -PRETREAT							
..K-101	Compressor	0	0	0	75	75	1.09
..FSP-7	Flow Splitter	0	0	0	0	0	0
..MIX-7	Mixer	0	0	0	127	127	1.82
..MIX11	Mixer	0	0	0	1	1	0.01
EXOTHERMIC REACTOR							
..R-101	Reactor	0	0	0	2,380	2,380	34.25
..FSP5	Flow Splitter	0	0	0	0	0	0
..E-102	Cooler	1,186	14.21	252	41	293	4.22
..E-101C	Process Exchanger	0	0	0	313	313	4.5
EO ABSORBER							
..MIX-4	Mixer	0	0	0	103	103	1.48
..C-101	Absorber	1	0.01	0	478	478	6.88
..VLV1	Valve	0	0	0	421	421	6.07
..V-101A	Separator	611	7.32	42	0	42	0.6
..K-102	Compressor	742	8.9	162	348	510	7.34
..E-103	Cooler	583	6.99	121	3	124	1.79
..P-5	Pump	0	0	0	29	29	0.41
EO STRIPPER							
H-200..P8	Pump	0	0	0	1	1	0.02
H-200..E-202	Process Exchanger	1,032	12.37	172	23	195	2.8
H-200..C-201	Stripping Column	326	3.9	69	31	100	1.43
H-200..E-201C	Cooler	0	0	0	215	215	3.09
H-200..R202V201	EG Reactor	0	0	0	10	10	0.14
H-200..P11	Pump	0	0	0	4	4	0.06
H-200..E-206	Cooler	1,802	21.59	142	6	148	2.13
H-200..FSP-11	Flow Splitter	0	0	0	0	0	0
H-200..V-202	Flash Drum	0	0	0	0	0	0
H-200..V-203	Flash Drum	0	0	0	0	0	0
H-200..E-203A	Cooler	296	3.54	7	1	8	0.11
H-200..E-204	Cooler	87	1.04	4	1	5	0.07
H-200..C-202	Rectifying Column	7	0.08	0	2	2	0.03
H-200..K-201	Compressor	0	0	0	1	1	0.01
H-200..MIX-12	Mixer	0	0	0	3	3	0.05
H-200..P12	Pump	0	0	0	0	0	0

Table 3C: NEW Base Ethylene Oxide Production Process Technology – Energy and Exergy Loss Profile (Cont'd)

Unit OP	Type	Energy Loss = Btu/lb		Exergy Loss = Btu/lb			
		Total = 8,345	%	Total External = 1,175	Total Internal = 5,772	Total = 6,947	%
CO2 RECOVERY							
H-300..C-301	Absorber	0	0	0	369	369	5.31
H-300..VLV-301	Valve	0	0	0	419	419	6.03
H-300..MIX15	Mixer	0	0	0	141	141	2.03
H-300..K-201	Compressor	0	0	0	146	146	2.1
H-300..V-301	Flash Drum	0	0	0	0	0	0
H-300..E-301	Ovd Condenser	243	2.91	35	0	35	0.5
H-300..P-C301	Pump	0	0	0	0	0	0
H-300..C-302	Compressor	0	0	0	0	0	0
H-300..MIX-17	Mixer	0	0	0	2	2	0.03
H-300..K-302	Compressor	0	0	0	0	0	0
H-300..E-302C	Process Exchanger	0	0	0	18	18	0.26
H-300..C-303	Desorber	895	10.73	75	0	75	1.09
H-300..E-302B	Heater	0	0	0	0	0	0
H-300..MIX-16	Mixer	0	0	0	0	0	0
H-300..P16	Pump	0	0	0	6	6	0.09
H-300..P15-6	Pump	0	0	0	0	0	0
H-300..E-301A	Heater	0	0	0	40	40	0.58
H-300..V-302	Flash Drum	386	4.62	87	0	87	1.25
EO PURIFICATION							
H-400..C-401	EO Column	149	1.79	7	10	17	0.25
H-400..E-403	Cooler	0	0	0	0	0	0
H-400..V-401	Flash Drum	0	0	0	0	0	0
H-400..FSPT-22	Flow Splitter	0	0	0	0	0	0
H-400..E-401C	Process Exchanger	0	0	0	4	4	0.05

Table 3D: New Base Ethylene Oxide Production Process Technology – Stream Tables

Stream ID	.->1	.->2	.->3-1	.->3-2	.->3-3	.->3-4	.->4	.->4-1
Temperature F	230.00	230.00	320.49	328.11	480.00	308.11	200.00	182.94
Pressure psi	310.00	310.00	310.00	310.00	310.00	310.00	310.00	310.00
Vapor Frac	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
MoleFlow lbmol/hr	736.	652.	26553.	26559.	26281.	26281.	26281.	31113.
MassFlow lb/hr	20751.	21000.	665142.	665232.	665142.	665142.	665142.	805927.
ETHYLENE	19097.	0.	185697.	185695.	167105.	167105.	167105.	234286.
OXYGEN	0.	20354.	67779.	67779.	47549.	47549.	47549.	49076.
CO2	0.	0.	81568.	81580.	92056.	92056.	92056.	127339.
ARGON	0.	646.	106764.	106765.	106764.	106764.	106764.	110055.
METHANE	0.	0.	200369.	200479.	200321.	200321.	200321.	213741.
ETHANE	1654.	0.	21285.	21287.	21285.	21285.	21285.	41178.
EO	0.	0.	0.	2.	23911.	23911.	23911.	24007.
ACET	0.	0.	0.	0.	34.	34.	34.	34.
FORMAL	0.	0.	28.	28.	118.	118.	118.	118.
WATER	0.	0.	1627.	1618.	5974.	5974.	5974.	6068.
EG	0.	0.	21.	0.	21.	21.	21.	21.
EDC	0.	0.	3.	0.	3.	3.	3.	3.
K+	0.	0.	0.	0.	0.	0.	0.	0.
HCO3-	0.	0.	0.	0.	0.	0.	0.	0.
CO3--	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	17565.35	15572.33	717112.90	724284.47	854890.25	698504.79	600152.66	692118.16
Enthalpy MMBtu/hr	14.68	0.70	-537.94	-535.97	-584.24	-634.24	-662.59	-794.28

Stream ID	.->5	.->5-OUT	.->5A	.->6	.->6-1	.->7	.->8	.->8-1
Temperature F	100.79	100.79	100.00	101.09	101.09	132.68	120.14	134.87
Pressure psi	260.00	260.00	60.00	260.00	260.00	310.00	15.00	260.00
Vapor Frac	0.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00
MoleFlow lbmol/hr	52616.	52615.	52615.	64.	25388.	22698.	53445.	58277.
MassFlow lb/hr	974938.	974875.	974875.	1589.	633891.	566722.	1004606.	1145390.
ETHYLENE	0.	0.	0.	417.	166565.	148861.	126.	67306.
OXYGEN	0.	0.	0.	119.	47400.	42376.	30.	1557.
CO2	0.	0.	0.	228.	91121.	81507.	708.	35992.
ARGON	0.	0.	0.	267.	106414.	95133.	84.	3375.
METHANE	0.	0.	0.	500.	199628.	178494.	193.	13614.
ETHANE	0.	0.	0.	53.	21185.	18931.	48.	19942.
EO	0.	0.	0.	0.	0.	0.	23911.	24007.
ACET	0.	0.	0.	0.	0.	0.	34.	34.
FORMAL	151.	80.	80.	0.	30.	26.	239.	239.
WATER	936759.	936810.	936810.	4.	1548.	1393.	941179.	941273.
EG	38025.	37979.	37979.	0.	0.	0.	38045.	38045.
EDC	3.	5.	5.	0.	0.	0.	7.	7.
K+	0.	0.	0.	0.	0.	0.	0.	0.
HCO3-	0.	0.	0.	0.	0.	0.	0.	0.
CO3--	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	15856.83	15855.47	15848.49	1472.69	587604.12	465435.61	16556.68	20596.46
Enthalpy MMBtu/hr	-6486.66	-6486.73	-6487.45	-1.61	-643.96	-569.65	-6519.29	-6635.38

Table 3D: NEW Base Ethylene Oxide Production Process Technology – Stream Tables – Cont'd

Stream ID	.->8-4	.->8-5	.->8C	.->8D	.->12-0	.->12-1	.->14	.->14-2
Temperature F	350.00	100.00	120.14	120.14	59.69	59.65	586.58	665.83
Pressure psi	310.00	310.00	15.00	15.00	25.00	25.00	260.00	260.00
Vapor Frac	1.00	1.00	0.09	1.00	0.00	0.00	1.00	1.00
MoleFlow lbmol/hr	4832.	4832.	58277.	4832.	2141.	2141.	15.	16.
MassFlow lb/hr	140784.	140784.	1145390.	140784.	52637.	52637.	356.	402.
ETHYLENE	67181.	67181.	67306.	67181.	101.	101.	32.	25.
OXYGEN	1527.	1527.	1557.	1527.	3.	3.	26.	27.
CO2	35283.	35283.	35992.	35283.	597.	597.	98.	111.
ARGON	3291.	3291.	3375.	3291.	9.	9.	53.	75.
METHANE	13420.	13420.	13614.	13420.	44.	44.	134.	149.
ETHANE	19893.	19893.	19942.	19893.	46.	46.	1.	2.
EO	95.	95.	24007.	95.	22981.	22981.	0.	0.
ACET	0.	0.	34.	0.	34.	34.	0.	0.
FORMAL	0.	0.	239.	0.	156.	156.	0.	0.
WATER	94.	94.	941273.	94.	28664.	28664.	11.	13.
EG	0.	0.	38045.	0.	0.	0.	0.	0.
EDC	0.	0.	7.	0.	1.	1.	0.	0.
K+	0.	0.	0.	0.	0.	0.	0.	0.
HCO3-	0.	0.	0.	0.	0.	0.	0.	0.
CO3--	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	135434.76	93616.87	2284076.41	2004374.32	884.77	874.90	628.09	752.47
Enthalpy MMBtu/hr	-117.74	-131.69	-6635.38	-130.69	-215.93	-215.93	-0.61	-0.69
Stream ID	.->14A6	.->15	.->15-2	.->17	.->21	.->22	.->A-3	.->BFW
Temperature F	101.40	132.68	132.68	114.72	132.15	122.22	134.55	100.00
Pressure psi	260.00	310.00	310.00	310.00	60.00	60.00	310.00	214.70
Vapor Frac	1.00	1.00	1.00	1.00	0.00	0.00	1.00	0.00
MoleFlow lbmol/hr	25402.	2704.	25402.	2473.	1856.	260.	26559.	2203.
MassFlow lb/hr	634247.	67524.	634247.	56758.	40345.	11353.	665232.	39695.
ETHYLENE	166597.	17737.	166597.	17737.	17.	2.	185695.	0.
OXYGEN	47426.	5049.	47426.	5049.	0.	0.	67779.	0.
CO2	91219.	9711.	91219.	72.	94.	14.	81580.	0.
ARGON	106468.	11335.	106468.	10986.	0.	0.	106765.	0.
METHANE	199762.	21267.	199762.	21984.	2.	0.	200479.	0.
ETHANE	21186.	2256.	21186.	702.	11.	2.	21287.	0.
EO	0.	0.	0.	2.	11490.	11237.	2.	0.
ACET	0.	0.	0.	0.	19.	15.	0.	0.
FORMAL	30.	3.	30.	1.	104.	25.	28.	0.
WATER	1559.	166.	1559.	224.	28606.	57.	1618.	39695.
EG	0.	0.	0.	0.	0.	0.	0.	0.
EDC	0.	0.	0.	0.	1.	0.	0.	0.
K+	0.	0.	0.	0.	0.	0.	0.	0.
HCO3-	0.	0.	0.	0.	0.	0.	0.	0.
CO3--	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	588269.15	55456.04	520891.67	47072.57	691.08	220.67	546324.06	648.09
Enthalpy MMBtu/hr	-644.57	-67.87	-637.52	-31.70	-202.22	-8.72	-585.97	-269.77

Table 3D: NEW Base Ethylene Oxide Production Process Technology – Stream Tables – Cont'd

Stream ID	.->C-101-OV	.->STEAM1	H-200.->5-2	H-200.->8	H-200.->8-A	H-200.->8B	H-200.->9	H-200.->10
Temperature F	101.09	387.91	146.49	120.14	227.14	120.18	100.00	258.83
Pressure psi	260.00	214.70	60.00	15.00	25.00	25.00	25.00	34.70
Vapor Frac	1.00	1.00	0.00	0.00	0.03	0.00	0.00	1.00
MoleFlow lbmol/hr	25451.	2203.	52615.	53445.	53445.	53445.	1771.	1235.
MassFlow lb/hr	635479.	39695.	974875.	1004606.	1004606.	1004606.	31902.	22246.
ETHYLENE	166982.	0.	0.	126.	126.	126.	0.	0.
OXYGEN	47519.	0.	0.	30.	30.	30.	0.	0.
CO2	91349.	0.	0.	708.	708.	708.	0.	0.
ARGON	106681.	0.	0.	84.	84.	84.	0.	0.
METHANE	200128.	0.	0.	193.	193.	193.	0.	0.
ETHANE	21238.	0.	0.	48.	48.	48.	0.	0.
EO	0.	0.	0.	23911.	23911.	23911.	0.	0.
ACET	0.	0.	0.	34.	34.	34.	0.	0.
FORMAL	30.	0.	80.	239.	239.	239.	0.	0.
WATER	1552.	39695.	936810.	941179.	941179.	941179.	31902.	22246.
EG	0.	0.	37979.	38045.	38045.	38045.	0.	0.
EDC	0.	0.	5.	7.	7.	7.	0.	0.
K+	0.	0.	0.	0.	0.	0.	0.	0.
HCO3-	0.	0.	0.	0.	0.	0.	0.	0.
CO3--	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	589076.82	93348.71	16274.01	16556.68	488587.19	16557.06	520.86	274420.08
Enthalpy MMBtu/hr	-645.57	-223.48	-6444.37	-6519.29	-6387.85	-6519.26	-216.81	-126.56
Stream ID	H-200.->11	H-200.->11-1	H-200.->11-2	H-200.->11-3	H-200.->11-3A	H-200.->12	H-200.->12-1	H-200.->12-2
Temperature F	146.49	239.48	239.61	270.00	146.49	59.65	150.00	59.65
Pressure psi	60.00	25.00	60.00	60.00	60.00	25.00	25.00	25.00
Vapor Frac	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.03
MoleFlow lbmol/hr	1909.	54545.	54545.	54524.	54524.	2141.	590.	2207.
MassFlow lb/hr	35363.	1010238.	1010238.	1010238.	1010238.	52637.	23292.	55178.
ETHYLENE	0.	0.	0.	0.	0.	101.	122.	169.
OXYGEN	0.	0.	0.	0.	0.	3.	30.	32.
CO2	0.	0.	0.	0.	0.	597.	689.	955.
ARGON	0.	0.	0.	0.	0.	9.	83.	87.
METHANE	0.	0.	0.	0.	0.	44.	192.	211.
ETHANE	0.	0.	0.	0.	0.	46.	46.	64.
EO	0.	931.	931.	0.	0.	22981.	20458.	24787.
ACET	0.	0.	0.	0.	0.	34.	30.	35.
FORMAL	3.	83.	83.	83.	83.	156.	124.	163.
WATER	33982.	971173.	971173.	970792.	970792.	28664.	1517.	28674.
EG	1378.	38045.	38045.	39356.	39356.	0.	0.	0.
EDC	0.	6.	6.	6.	6.	1.	0.	1.
K+	0.	0.	0.	0.	0.	0.	0.	0.
HCO3-	0.	0.	0.	0.	0.	0.	0.	0.
CO3--	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	590.33	17878.68	17880.20	18251.35	16864.35	874.90	154396.53	15632.59
Enthalpy MMBtu/hr	-233.77	-6580.29	-6580.15	-6546.73	-6678.14	-215.93	-22.00	-218.62

Table 3D: NEW Base Ethylene Oxide Production Process Technology – Stream Tables – Cont'd

Stream ID	H-200.->12-3	H-200.->12-4	H-200.->12-5	H-200.->12-6	H-200.->12-7	H-200.->12-8	H-200.->13	H-200.->A-5
Temperature F	150.00	60.00	59.65	74.99	122.22	75.05	95.00	100.00
Pressure psi	25.00	25.00	25.00	17.00	25.00	25.00	25.00	60.00
Vapor Frac	0.00	0.00	1.00	0.00	0.24	0.00	0.00	0.00
MoleFlow lbmol/hr	1316.	1316.	66.	1617.	2207.	1617.	251.	52615.
MassFlow lb/hr	25224.	25224.	2541.	31886.	55178.	31886.	4522.	974875.
ETHYLENE	4.	4.	68.	47.	169.	47.	0.	0.
OXYGEN	0.	0.	28.	1.	32.	1.	0.	0.
CO2	20.	20.	358.	266.	955.	266.	0.	0.
ARGON	0.	0.	78.	4.	87.	4.	0.	0.
METHANE	1.	1.	167.	19.	211.	19.	0.	0.
ETHANE	2.	2.	18.	18.	64.	18.	0.	0.
EO	2523.	2523.	1806.	4328.	24787.	4328.	0.	0.
ACET	4.	4.	1.	5.	35.	5.	0.	0.
FORMAL	33.	33.	7.	39.	163.	39.	0.	80.
WATER	22637.	22637.	10.	27157.	28674.	27157.	4522.	936810.
EG	0.	0.	0.	0.	0.	0.	0.	37979.
EDC	1.	1.	0.	1.	1.	1.	0.	5.
K+	0.	0.	0.	0.	0.	0.	0.	0.
HCO3-	0.	0.	0.	0.	0.	0.	0.	0.
CO3--	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	428.11	405.84	14757.65	519.24	130612.64	519.25	73.63	15848.49
Enthalpy MMBtu/hr	-154.64	-156.72	-2.69	-189.55	-211.55	-189.54	-30.75	-6487.45
Stream ID	H-200.->A-14	H-200.->A-14-1	H-200.->C201-OVH	H-200.->C201OVH1	H-300.->15-2	H-300.->15-3	H-300.->15-4	H-300.->15-4-1
Temperature F	665.83	91.56	221.53	150.00	617.08	229.88	203.78	232.50
Pressure psi	260.00	17.00	25.00	25.00	310.00	310.00	45.00	45.00
Vapor Frac	1.00	1.00	1.00	0.31	1.00	0.00	0.10	0.14
MoleFlow lbmol/hr	16.	16.	1906.	1906.	5483.	40555.	40555.	40555.
MassFlow lb/hr	402.	402.	48517.	48517.	120876.	863219.	863219.	863219.
ETHYLENE	25.	25.	126.	126.	64006.	64006.	64006.	64006.
OXYGEN	27.	27.	30.	30.	1264.	1264.	1264.	1264.
CO2	111.	111.	708.	708.	0.	0.	0.	0.
ARGON	75.	75.	84.	84.	1990.	2487.	2487.	2487.
METHANE	149.	149.	193.	193.	19987.	19987.	19987.	19987.
ETHANE	2.	2.	48.	48.	0.	2909.	2909.	2909.
EO	0.	0.	22981.	22981.	0.	12.	12.	12.
ACET	0.	0.	34.	34.	0.	0.	0.	0.
FORMAL	0.	0.	156.	156.	8.	11.	11.	11.
WATER	13.	13.	24154.	24154.	33621.	598382.	598382.	598382.
EG	0.	0.	0.	0.	0.	1.	1.	1.
EDC	0.	0.	1.	1.	0.	0.	0.	0.
K+	0.	0.	0.	0.	0.	81594.	81594.	81594.
HCO3-	0.	0.	0.	0.	0.	58924.	58924.	58924.
CO3--	0.	0.	0.	0.	0.	33643.	33643.	33643.
VolFlow cuft/hr	752.47	5636.40	557249.27	154824.51	201192.50	17931.54	631638.77	931372.50
Enthalpy MMBtu/hr	-0.69	-0.78	-151.97	-176.65	-150.56	-4643.85	-4643.85	-4601.00

Table 3D: NEW Base Ethylene Oxide Production Process Technology – Stream Tables – Cont'd

Stream ID	H-300.->15-5	H-300.->15-6	H-300.->15-7	H-300.->15-8	H-300.->16	H-300.->16-0	H-300.->16-1	H-300.->16-3
Temperature F	232.50	232.50	480.48	232.50	118.77	172.44	172.44	173.10
Pressure psi	45.00	45.00	310.00	45.00	310.00	17.00	17.00	310.00
Vapor Frac	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
MoleFlow lbmol/hr	5483.	35072.	8188.	35072.	35313.	35564.	35564.	35564.
MassFlow lb/hr	120876.	742343.	188400.	742343.	731268.	736076.	736076.	736076.
ETHYLENE	64006.	0.	81743.	0.	0.	0.	0.	0.
OXYGEN	1264.	0.	6313.	0.	0.	0.	0.	0.
CO2	0.	0.	9711.	0.	11538.	11600.	11600.	11600.
ARGON	1990.	497.	13325.	497.	2.	3.	3.	3.
METHANE	19987.	0.	41254.	0.	717.	514.	514.	514.
ETHANE	0.	2909.	2256.	2909.	1337.	1907.	1907.	1907.
EO	0.	12.	0.	12.	14.	9.	9.	9.
ACET	0.	0.	0.	0.	0.	0.	0.	0.
FORMAL	8.	3.	11.	3.	1.	2.	2.	2.
WATER	33621.	564761.	33787.	564761.	573446.	577827.	577827.	577827.
EG	0.	1.	0.	1.	1.	1.	1.	1.
EDC	0.	0.	0.	0.	0.	0.	0.	0.
K+	0.	81594.	0.	81594.	81594.	81594.	81594.	81594.
HCO3-	0.	58924.	0.	58924.	0.	0.	0.	0.
CO3--	0.	33643.	0.	33643.	62618.	62618.	62618.	62618.
VolFlow cuft/hr	896155.00	10528.68	261693.85	10528.69	10165.14	10430.37	10430.37	10423.67
Enthalpy MMBtu/hr	-174.49	-4435.74	-218.44	-4435.74	-4450.65	-4454.27	-4454.27	-4453.56
Stream ID	H-300.->16-5	H-300.->16-7	H-300.->17	H-300.->17-1	H-300.->17-2	H-300.->17-3	H-300.->17-4	H-300.->17-5
Temperature F	110.15	110.21	796.28	230.54	110.15	110.15	228.72	227.69
Pressure psi	310.00	312.00	310.00	310.00	310.00	310.00	45.00	45.00
Vapor Frac	0.00	0.00	1.00	1.00	0.92	1.00	1.00	0.00
MoleFlow lbmol/hr	220.	220.	10.	2683.	2683.	2463.	10.	35325.
MassFlow lb/hr	4239.	4239.	309.	60689.	60689.	56450.	309.	743569.
ETHYLENE	795.	795.	0.	18532.	18532.	17737.	0.	0.
OXYGEN	35.	35.	0.	5084.	5084.	5049.	0.	0.
CO2	0.	0.	72.	0.	0.	0.	72.	7305.
ARGON	68.	68.	146.	10907.	10907.	10839.	146.	351.
METHANE	588.	588.	0.	22572.	22572.	21984.	0.	1534.
ETHANE	38.	38.	19.	721.	721.	684.	19.	2890.
EO	0.	0.	0.	2.	2.	2.	0.	12.
ACET	0.	0.	0.	0.	0.	0.	0.	0.
FORMAL	0.	0.	0.	2.	2.	1.	0.	3.
WATER	2715.	2715.	71.	2869.	2869.	153.	71.	567710.
EG	0.	0.	0.	0.	0.	0.	0.	1.
EDC	0.	0.	0.	0.	0.	0.	0.	0.
K+	0.	0.	0.	0.	0.	0.	0.	81594.
HCO3-	0.	0.	0.	0.	0.	0.	0.	38466.
CO3--	0.	0.	0.	0.	0.	0.	0.	43703.
VolFlow cuft/hr	168.08	168.08	426.94	62455.85	46692.86	46524.77	1610.17	10796.62
Enthalpy MMBtu/hr	-18.99	-18.99	-0.65	-44.23	-50.04	-31.05	-0.70	-4438.09

Table 3D: NEW Base Ethylene Oxide Production Process Technology – Stream Tables – Cont'd

Stream ID	H-300.->17-6	H-300.->17-T	H-300.->18	H-300.->19	H-300.->20	H-300.->20-1	H-300.->A-16	H-300.->A15
Temperature F	208.94	114.72	100.00	266.86	186.00	158.46	192.96	132.68
Pressure psi	45.00	310.00	310.00	39.70	17.00	17.00	310.00	310.00
Vapor Frac	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
MoleFlow lbmol/hr	35325.	2473.	96.	342.	419.	419.	35564.	2704.
MassFlow lb/hr	743569.	56758.	1534.	6167.	13660.	13660.	736076.	67524.
ETHYLENE	0.	17737.	0.	0.	0.	0.	0.	17737.
OXYGEN	0.	5049.	0.	0.	0.	0.	0.	5049.
CO2	7305.	72.	0.	0.	9577.	9577.	11600.	9711.
ARGON	351.	10986.	0.	0.	348.	348.	3.	11335.
METHANE	1534.	21984.	1534.	0.	1020.	1020.	514.	21267.
ETHANE	2890.	702.	0.	0.	983.	983.	1907.	2256.
EO	12.	2.	0.	0.	3.	3.	9.	0.
ACET	0.	0.	0.	0.	0.	0.	0.	0.
FORMAL	3.	1.	0.	0.	1.	1.	2.	3.
WATER	567710.	224.	0.	6167.	1729.	1729.	577827.	166.
EG	1.	0.	0.	0.	0.	0.	1.	0.
EDC	0.	0.	0.	0.	0.	0.	0.	0.
K+	81594.	0.	0.	0.	0.	0.	81594.	0.
HCO3-	38466.	0.	0.	0.	0.	0.	0.	0.
CO3--	43703.	0.	0.	0.	0.	0.	62618.	0.
VolFlow cuft/hr	10715.51	47072.57	1791.96	66179.26	169935.08	162596.75	10496.00	55456.04
Enthalpy MMBtu/hr	-4448.29	-31.70	-3.06	-35.08	-49.60	-49.71	-4443.36	-67.87
Stream ID	H-400.->12-2	H-400.->12-4	H-400.->12-5	H-400.->21-0	H-400.->21-1	H-400.->22-1	H-400.->22-2	H-400.->22-3
Temperature F	59.69	59.97	78.34	153.13	132.15	122.20	122.22	122.22
Pressure psi	25.00	62.00	62.00	60.00	60.00	60.00	60.00	60.00
Vapor Frac	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
MoleFlow lbmol/hr	2141.	2141.	2141.	1856.	1856.	650.	650.	0.
MassFlow lb/hr	52637.	52637.	52637.	40345.	40345.	28385.	28385.	4.
ETHYLENE	101.	101.	101.	17.	17.	6.	6.	0.
OXYGEN	3.	3.	3.	0.	0.	0.	0.	0.
CO2	597.	597.	597.	94.	94.	36.	36.	0.
ARGON	9.	9.	9.	0.	0.	0.	0.	0.
METHANE	44.	44.	44.	2.	2.	1.	1.	0.
ETHANE	46.	46.	46.	11.	11.	4.	4.	0.
EO	22981.	22981.	22981.	11490.	11490.	28095.	28095.	3.
ACET	34.	34.	34.	19.	19.	38.	38.	0.
FORMAL	156.	156.	156.	104.	104.	62.	62.	0.
WATER	28664.	28664.	28664.	28606.	28606.	143.	143.	0.
EG	0.	0.	0.	0.	0.	0.	0.	0.
EDC	1.	1.	1.	1.	1.	0.	0.	0.
K+	0.	0.	0.	0.	0.	0.	0.	0.
HCO3-	0.	0.	0.	0.	0.	0.	0.	0.
CO3--	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	884.77	875.10	886.39	701.37	691.08	551.73	560.09	8.41
Enthalpy MMBtu/hr	-215.93	-215.92	-215.16	-201.46	-202.22	-21.81	-21.81	0.00

Table 3D: NEW Base Ethylene Oxide Production Process Technology – Stream Tables – Cont'd

Stream ID	H-400.->22-4	H-400.->22-5	H-400.->401-OVHD	H-400.->S8
Temperature F	122.22	122.22	52.86	122.22
Pressure psi	60.00	60.00	60.00	60.00
Vapor Frac	0.00	0.00	1.00	0.00
MoleFlow lbmol/hr	260.	390.	25.	650.
MassFlow lb/hr	11353.	17029.	936.	28382.
ETHYLENE	2.	4.	82.	6.
OXYGEN	0.	0.	3.	0.
CO2	14.	21.	489.	36.
ARGON	0.	0.	9.	0.
METHANE	0.	0.	42.	1.
ETHANE	2.	2.	33.	4.
EO	11237.	16855.	250.	28092.
ACET	15.	23.	0.	38.
FORMAL	25.	37.	27.	62.
WATER	57.	86.	0.	143.
EG	0.	0.	0.	0.
EDC	0.	0.	0.	0.
K+	0.	0.	0.	0.
HCO3-	0.	0.	0.	0.
CO3--	0.	0.	0.	0.
VolFlow cuft/hr	220.67	331.00	2261.76	551.67
Enthalpy MMBtu/hr	-8.72	-13.08	-2.11	-21.81

Figure 3C – New Base EO Process – pt 1

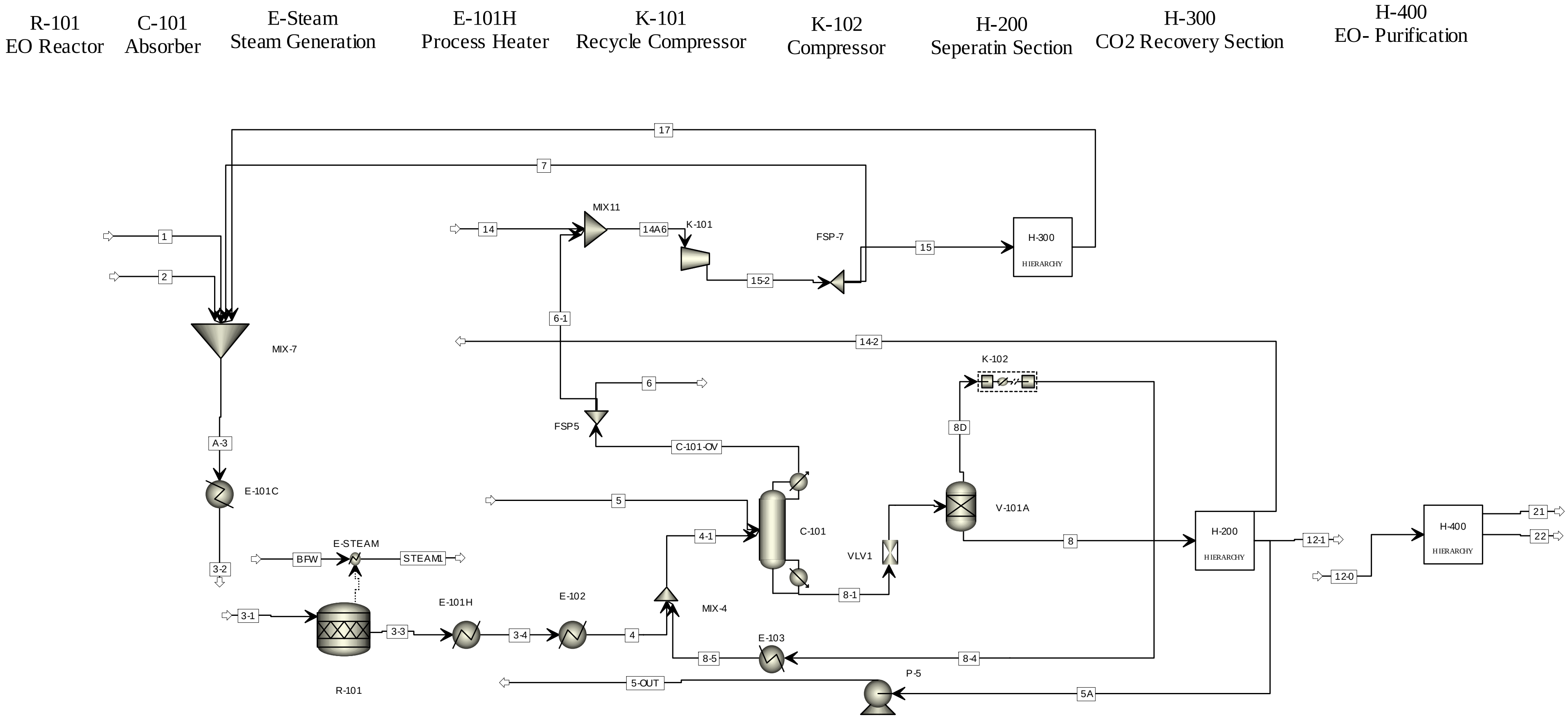
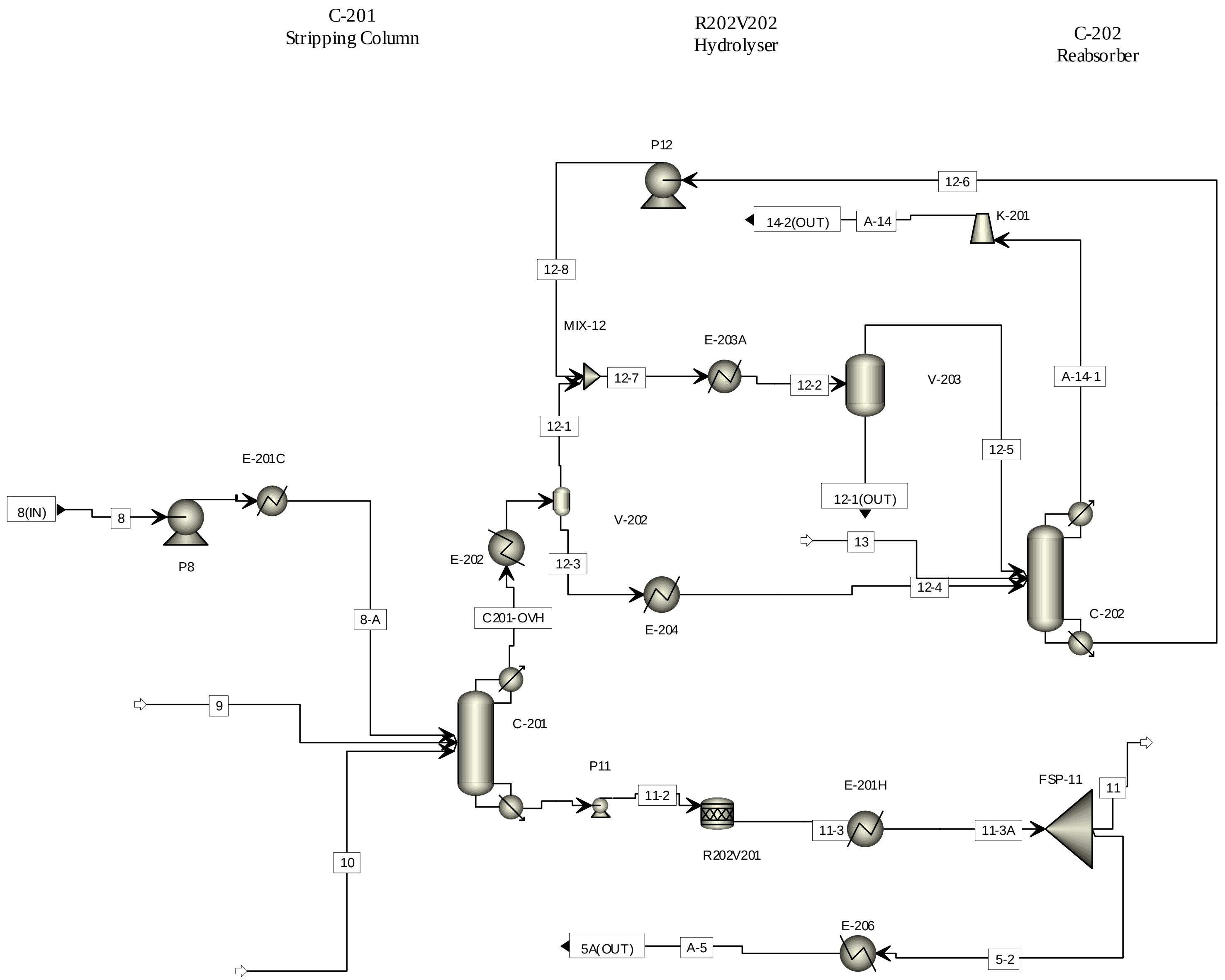


Figure 3D – New Base EO Process – pt 2



Appendix 4 – Ammonia

Table 4A: Alternative Ammonia Production Process Technology – Energy and Exergy Loss Profile

Unit OP	Type	Energy Loss = Btu/lb		Exergy Loss = Btu/lb			
		Total = 5,725	%	Total External = 1,353	Total Internal = 2,734	Total = 4,087	%
PREHEATING/REFORMING							
..COMP3	Methane Comp	151	2.63	25	65	90	2.21
..E-101	Process Preheater	0	0	0	1	1	0.02
..MIX1	Ref1 Feed Mixer	0	0	0	87	87	2.14
..COMP4	Process Air Comp	218	3.82	0	133	133	3.25
..E-103	Process Air Preheater	0	0	0	3	3	0.07
..REF1	Primary Reformer	0	0	0	36	36	0.87
..E-112	Process Air Preheater	0	0	0	0	0	0
..E201	Ref1 Effluent Heat Losses	74	1.3	53	0	53	1.31
..REF2	Secondary Reformer	118	2.06	91	469	560	13.69
..FLOW1	Flow Splitter	0	0	0	0	0	0
..WB	Waste Heat Boiler	0	0	0	517	517	12.66
SHIFT							
..CONV	Shift Converter	19	0.33	8	158	165	4.04
GAS UPGRADING							
..SEP1	Syn Gas Separator	2506	43.78	590	113	702	17.18
..MET	Methanator	1	0.01	0	24	25	0.6
..E104	Process Heat Exchanger	0	0	0	38	38	0.93
..FLOW2	Flow Splitter	0	0	0	0	0	0
AMMONIA SYN							
..E-105	Process Gas Cooler	93	1.63	8	1	9	0.22
..MIX3	Comp6 Feed Mixer	0	0	0	12	12	0.29
..MIX5	Mixer	0	0	0	0	0	0
..V-101	Knock Out Drum	0	0	0	0	0	0
..COMP5	Hp Syn Gas Comp	628	10.96	10	303	313	7.66
..COMP6	Recir Gas Comp	57	1	4	46	49	1.21
..SYN	Syn Gas Reactor	58	1.01	33	276	308	7.54
..SEP2	Ammonia Seprator#1	30	0.53	4	0	4	0.09
..SEP3	Ammonia Separator #2	36	0.63	18	0	18	0.43
..E106	Feed Water Pre-Heater	0	0	0	270	270	6.59
..E107	Process Heat Exchanger	0	0	0	127	127	3.1
..E-108	Process Gas Cooler	360	6.29	30	0	30	0.75
..E109	Process Heat Exchanger	0	0	0	14	14	0.34
..E-110	Process Gas Cooler	446	7.79	166	0	166	4.05
..MIX4	Product Mixer	0	0	0	0	0	0.01

Table 4A: Alternative Ammonia Production Process Technology – Energy and Exergy Loss Profile (Cont’d)

Unit OP	Type	Energy Loss = Btu/lb		Exergy Loss = Btu/lb			
		Total = 5,725	%	Total External = 1,353	Total Internal = 2,734	Total = 4,087	%
RESIDUAL NH3 REMOVAL							
ABS-STRP..FSPLT-75	Flow Splitter	0	0	0	0	0	0
ABS-STRP..E-73	Cooler	93	1.63	10	0	10	0.25
ABS-STRP..P71	Pump	0	0	0	3	3	0.08
ABS-STRP..C-402	Stripper	237	4.14	121	0	121	2.96
ABS-STRP..C-401	Absorber	0	0	0	15	15	0.36
ABS-STRP..MIX79	Mixer	0	0	0	0	0	0
ABS-STRP..E-51	Cooler	343	5.99	105	0	105	2.57
ABS-STRP..FLOW4	Flow Splitter	0	0	0	0	0	0
ABS-STRP..K84	Compressor	0	0	0	0	0	0
HEAT RECOVERY							
..E-601	Heat Recovery	257	4.49	79	25	104	2.54

Table 4B: Alternative Ammonia Production Process Technology – Stream Tables

Stream ID	ABS-STRP.->10	ABS-STRP.->47	ABS-STRP.->51	ABS-STRP.->70	ABS-STRP.->71	ABS-STRP.->72	ABS-STRP.->73	ABS-STRP.->74
Temperature F	22.79	22.79	76.73	30.00	42.73	33.00	266.53	266.53
Pressure psi	3335.87	3335.87	3335.87	3335.87	3335.87	60.00	60.00	60.00
Vapor Frac	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00
MoleFlow lbmol/hr	1082.	30956.	32586.	6.	1915.	1915.	1915.	10.
MassFlow lb/hr	11028.	315565.	335957.	100.	34400.	34400.	34400.	173.
N2	6737.	192785.	199522.	0.	0.	0.	0.	0.
O2	0.	0.	0.	0.	0.	0.	0.	0.
AR	1527.	43703.	45260.	0.	0.	0.	0.	0.
CH4	1305.	37348.	38676.	0.	0.	0.	0.	0.
CO	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
H2O	1.	24.	91.	100.	32680.	32680.	32680.	164.
H2	1454.	41618.	43072.	0.	0.	0.	0.	0.
NH3	3.	87.	9335.	0.	1720.	1720.	1720.	9.
VolFlow cuft/hr	1856.95	53134.60	61888.93	1.57	557.73	554.81	642.14	3.23
Enthalpy MMBtu/hr	-3.12	-89.39	-91.24	-0.69	-228.78	-229.47	-220.64	-1.11

Stream ID	ABS-STRP.->75	ABS-STRP.->76	ABS-STRP.->78	ABS-STRP.->79	ABS-STRP.->81	ABS-STRP.->82	ABS-STRP.->84	ABS-STRP.->G-RCYL-A
Temperature F	266.53	20.89	16.74	23.25	-4.00	20.89	1028.81	22.79
Pressure psi	60.00	60.00	3335.87	3335.87	3335.87	60.00	3335.87	3335.87
Vapor Frac	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00
MoleFlow lbmol/hr	1925.	543.	2468.	32039.	32586.	0.	0.	32037.
MassFlow lb/hr	34573.	9243.	43822.	326633.	335957.	6.	6.	326593.
N2	0.	0.	0.	199522.	199522.	0.	0.	199522.
O2	0.	0.	0.	0.	0.	0.	0.	0.
AR	0.	2.	2.	45258.	45260.	0.	0.	45231.
CH4	0.	0.	1.	38676.	38676.	0.	0.	38653.
CO	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
H2O	32845.	0.	32845.	24.	91.	0.	0.	25.
H2	0.	0.	0.	43072.	43072.	0.	0.	43073.
NH3	1729.	9240.	10974.	81.	9335.	5.	5.	90.
VolFlow cuft/hr	645.36	228.80	768.06	55047.31	52316.08	30.55	1.79	54991.54
Enthalpy MMBtu/hr	-221.75	-16.24	-249.06	-92.43	-112.04	-0.01	0.00	-92.52

Table 4B: Alternative Ammonia Production Process Technology – Stream Tables – Cont'd

Stream ID	ABS-STRP.->G-RCYL-B	.->3	.->4	.->5	.->7	.->8	.->9	.->9A
Temperature F	23.27	76.73	76.73	76.73	76.73	76.73	77.35	76.73
Pressure psi	3335.87	464.12	14.50	14.50	14.50	14.50	650.34	650.34
Vapor Frac	1.00	0.00	1.00	1.00	0.00	1.00	0.00	0.00
MoleFlow lbmol/hr	32039.	10778.	2761.	3954.	6049.	2807.	95.	90.
MassFlow lb/hr	326639.	194168.	44290.	112592.	108969.	119014.	1707.	1625.
N2	199522.	0.	0.	84801.	0.	0.	0.	0.
O2	0.	0.	0.	26087.	0.	0.	0.	0.
AR	45258.	0.	0.	1557.	0.	0.	0.	0.
CH4	38676.	0.	44290.	0.	0.	0.	0.	0.
CO	0.	0.	0.	0.	0.	183.	0.	0.
CO2	0.	0.	0.	0.	0.	117569.	0.	0.
H2O	24.	194168.	0.	0.	108969.	1128.	1707.	1625.
H2	43072.	0.	0.	147.	0.	134.	0.	0.
NH3	87.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	55049.62	3130.12	1093274.30	1568668.78	1756.66	1108158.51	27.53	26.19
Enthalpy MMBtu/hr	-92.43	-1333.10	-88.48	-0.02	-748.29	-458.82	-11.72	-11.15
Stream ID	.->9B	.->9C	.->9D	.->11	.->12	.->12A	.->12B	.->15
Temperature F	85.73	85.73	85.73	36.76	1138.02	1138.02	76.73	458.33
Pressure psi	1121.58	1934.28	3335.87	3335.87	464.12	464.12	14.70	464.12
Vapor Frac	0.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00
MoleFlow lbmol/hr	1.	2.	1.	5573.	849.	10778.	849.	10778.
MassFlow lb/hr	20.	41.	23.	94910.	15300.	194168.	15300.	194168.
N2	0.	0.	0.	0.	0.	0.	0.	0.
O2	0.	0.	0.	0.	0.	0.	0.	0.
AR	0.	0.	0.	2.	0.	0.	0.	0.
CH4	0.	0.	0.	0.	0.	0.	0.	0.
CO	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
H2O	20.	41.	23.	0.	15300.	194168.	15300.	194168.
H2	0.	0.	0.	0.	0.	0.	0.	0.
NH3	0.	0.	0.	94908.	0.	0.	0.	0.
VolFlow cuft/hr	0.32	0.66	0.37	2394.77	30841.24	391386.30	246.65	4132.37
Enthalpy MMBtu/hr	-0.13	-0.28	-0.15	-164.39	-80.66	-1023.65	-105.07	-1248.24

Table 4B: Alternative Ammonia Production Process Technology – Stream Tables – Cont'd

Stream ID	.->16	.->18	.->19	.->20	.->21	.->22	.->23	.->24
Temperature F	1138.02	301.73	580.73	391.73	710.33	1021.73	978.25	1471.73
Pressure psi	464.12	478.62	464.12	493.13	464.12	464.12	464.12	435.11
Vapor Frac	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
MoleFlow lbmol/hr	9929.	2761.	2761.	3954.	3954.	3954.	12689.	16933.
MassFlow lb/hr	178868.	44290.	44290.	112592.	112592.	112592.	223158.	223158.
N2	0.	0.	0.	84801.	84801.	84801.	0.	0.
O2	0.	0.	0.	26087.	26087.	26087.	0.	0.
AR	0.	0.	0.	1557.	1557.	1557.	0.	0.
CH4	0.	44290.	44290.	0.	0.	0.	44290.	10255.
CO	0.	0.	0.	0.	0.	0.	0.	25655.
CO2	0.	0.	0.	0.	0.	0.	0.	53061.
H2O	178868.	0.	0.	0.	0.	0.	178868.	118927.
H2	0.	0.	0.	147.	147.	147.	0.	15261.
NH3	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	360545.06	46381.23	66498.13	73913.05	108081.26	136751.82	414819.97	810064.26
Enthalpy MMBtu/hr	-942.99	-83.10	-74.34	8.59	17.79	27.07	-1017.33	-756.57
Stream ID	.->25	.->26	.->27	.->28	.->29	.->30	.->31	.->32
Temperature F	1426.73	1885.73	661.73	440.33	76.73	85.73	622.51	710.33
Pressure psi	435.11	420.61	414.81	406.11	14.50	394.50	388.70	382.90
Vapor Frac	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00
MoleFlow lbmol/hr	16933.	21350.	21350.	24092.	2742.	12494.	12494.	12329.
MassFlow lb/hr	223158.	335750.	335750.	385142.	49392.	107767.	107767.	107767.
N2	0.	84801.	84801.	84801.	0.	84801.	84801.	84801.
O2	0.	0.	0.	0.	0.	0.	0.	0.
AR	0.	1557.	1557.	1557.	0.	1557.	1557.	1557.
CH4	10255.	0.	0.	0.	0.	0.	0.	1329.
CO	25655.	44591.	44591.	2503.	0.	2320.	2320.	0.
CO2	53061.	51439.	51439.	117569.	0.	0.	0.	0.
H2O	118927.	137449.	137449.	159771.	49392.	282.	282.	1774.
H2	15261.	15913.	15913.	18942.	0.	18808.	18808.	18307.
NH3	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	791149.36	1283383.02	618464.09	565498.41	796.23	187547.32	376490.70	407457.43
Enthalpy MMBtu/hr	-763.62	-747.74	-972.33	-1313.27	-339.17	-4.86	42.25	42.20

Table 4B: Alternative Ammonia Production Process Technology – Stream Tables – Cont'd

Stream ID	.->33	.->34	.->35	.->35A	.->36	.->37	.->38	.->39
Temperature F	170.33	85.73	85.73	85.73	40.10	50.00	391.73	776.93
Pressure psi	380.00	377.10	3335.87	3335.87	3335.87	3625.94	3625.94	3625.94
Vapor Frac	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00
MoleFlow lbmol/hr	12329.	12329.	12234.	12235.	43189.	43189.	43189.	37616.
MassFlow lb/hr	107767.	107767.	106060.	106083.	421625.	421625.	421625.	421625.
N2	84801.	84801.	84801.	84801.	277586.	277586.	277586.	199522.
O2	0.	0.	0.	0.	0.	0.	0.	0.
AR	1557.	1557.	1557.	1557.	45260.	45260.	45260.	45260.
CH4	1329.	1329.	1329.	1329.	38676.	38676.	38676.	38676.
CO	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
H2O	1774.	1774.	67.	89.	91.	91.	91.	91.
H2	18307.	18307.	18307.	18307.	59925.	59925.	59925.	43072.
NH3	0.	0.	0.	0.	87.	87.	87.	95003.
VolFlow cuft/hr	221741.39	192230.62	23958.96	23959.33	77111.16	73118.32	119488.41	147435.47
Enthalpy MMBtu/hr	-4.91	-13.78	-2.22	-2.37	-91.61	-88.29	22.06	16.59
Stream ID	.->40	.->41	.->42	.->43	.->44	.->45	.->46	.->47
Temperature F	503.39	144.89	85.00	85.73	46.60	-4.27	-4.27	22.79
Pressure psi	3335.87	3335.87	3335.87	3335.87	3335.87	3335.87	3335.87	3335.87
Vapor Frac	1.00	1.00	0.94	1.00	0.96	0.93	1.00	1.00
MoleFlow lbmol/hr	37616.	37616.	37616.	35227.	35227.	35227.	32586.	30956.
MassFlow lb/hr	421625.	421625.	421625.	380933.	380933.	380933.	335957.	315565.
N2	199522.	199522.	199522.	199522.	199522.	199522.	199522.	192785.
O2	0.	0.	0.	0.	0.	0.	0.	0.
AR	45260.	45260.	45260.	45260.	45260.	45260.	45260.	43703.
CH4	38676.	38676.	38676.	38676.	38676.	38676.	38676.	37348.
CO	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
H2O	91.	91.	91.	91.	91.	91.	91.	24.
H2	43072.	43072.	43072.	43072.	43072.	43072.	43072.	41618.
NH3	95003.	95003.	95003.	54311.	54311.	54311.	9335.	87.
VolFlow cuft/hr	124902.16	77094.50	67261.90	66116.90	60245.84	53378.79	52283.37	53134.60
Enthalpy MMBtu/hr	-68.26	-178.61	-211.73	-145.84	-166.71	-190.58	-112.11	-89.39

Table 4B: Alternative Ammonia Production Process Technology – Stream Tables – Cont'd

Stream ID	.->48	.->49	.->203	.->H2OS	.->NH3-3
Temperature F	85.73	-4.27	76.73	76.73	20.89
Pressure psi	3335.87	3335.87	3335.87	14.50	60.00
Vapor Frac	0.00	0.00	1.00	0.00	0.00
MoleFlow lbmol/hr	2389.	2641.	32586.	8790.	543.
MassFlow lb/hr	40692.	44976.	335957.	158361.	9243.
N2	0.	0.	199522.	0.	0.
O2	0.	0.	0.	0.	0.
AR	0.	0.	45260.	0.	2.
CH4	0.	0.	38676.	0.	0.
CO	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.
H2O	0.	0.	91.	158361.	0.
H2	0.	0.	43072.	0.	0.
NH3	40692.	44976.	9335.	0.	9240.
VolFlow cuft/hr	1096.44	1081.83	61888.93	2552.89	228.80
Enthalpy MMBtu/hr	-68.30	-79.86	-91.24	-1087.46	-16.24

Figure 4A – Alternative Ammonia Process – pt 1

COMP3	COMP4	WB	COMP5	SYN	CONV	MET	SEP1	SEP2 &SEP3	REF1
Methane Comp	Process Air Comp	Waste Heat Boiler	HP Syn Gas Comp	Syn Gas Reactor	Shift Converter	Methanator	Syn Gas Separator	Ammonia Separator	Primary Reformer

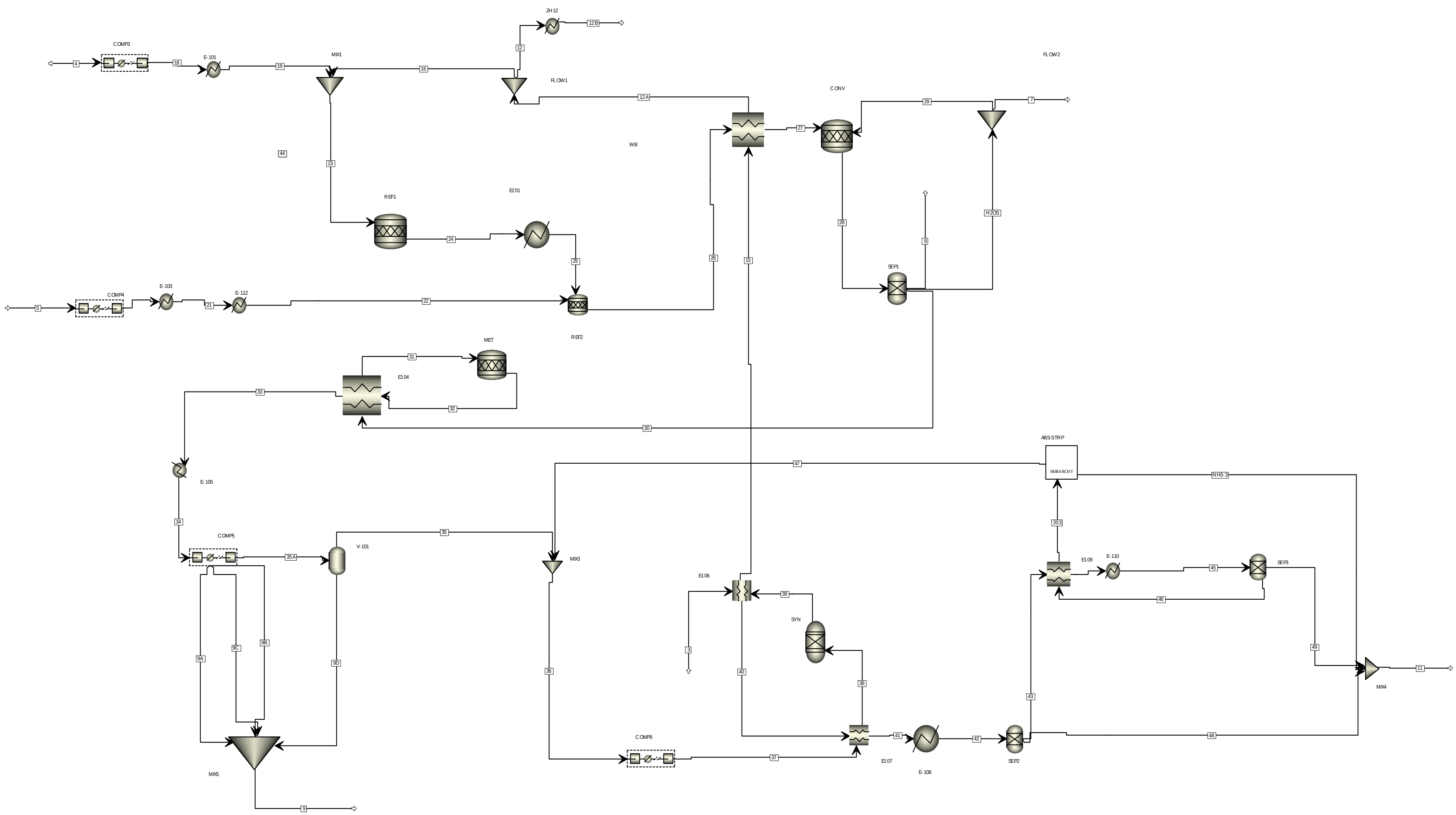


Figure 4B – Alternative Ammonia Process – Pt 2

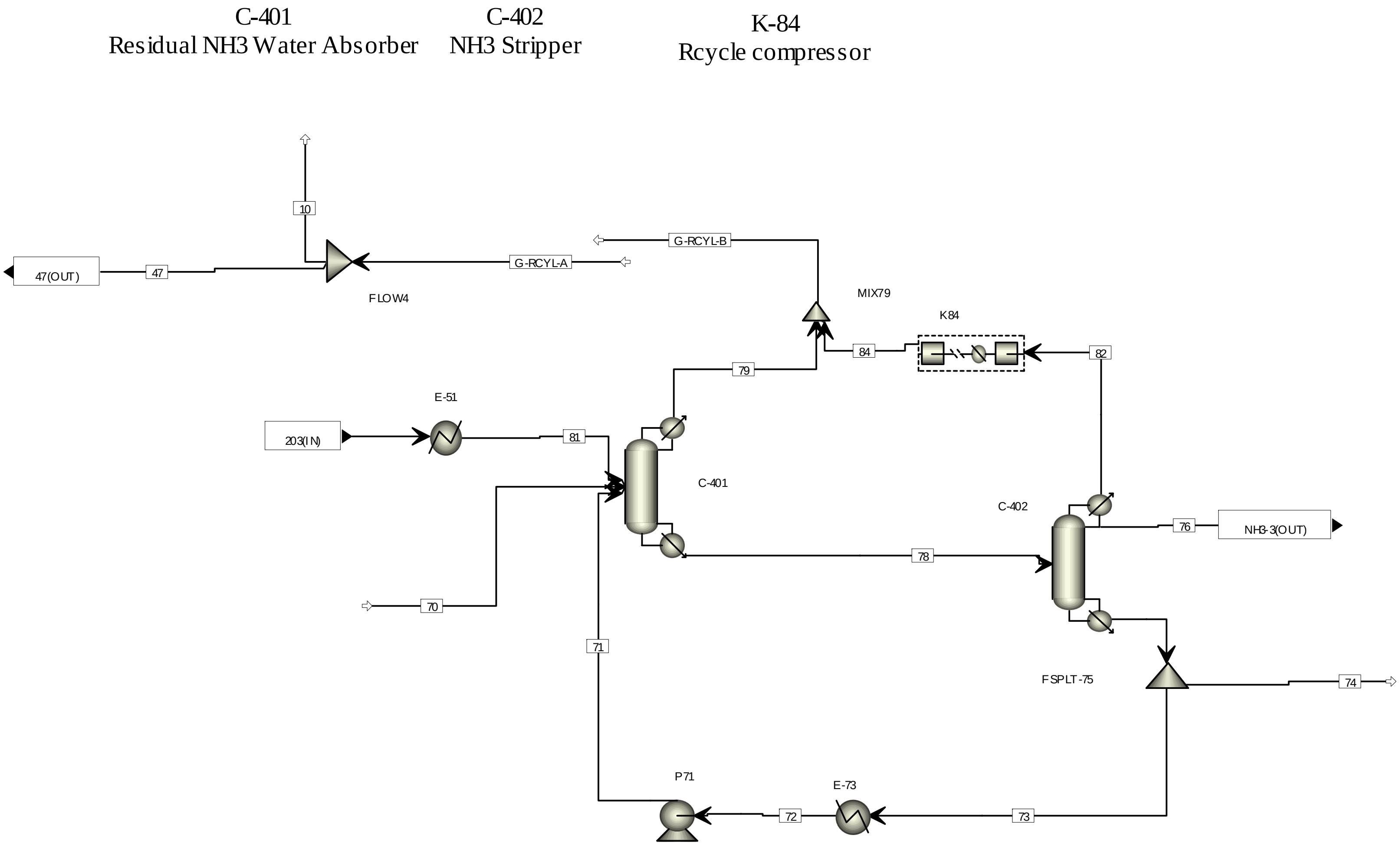


Figure 4C – Base Ammonia Case

COMP3
Methane Comp

COMP4
Process Air Comp

WB
Waste Heat Boiler

COMP5
HP Syn Gas Comp

COMP6
Recir Gas Comp

SYN
Syn Gas Reactor

CONV
Shift Converter

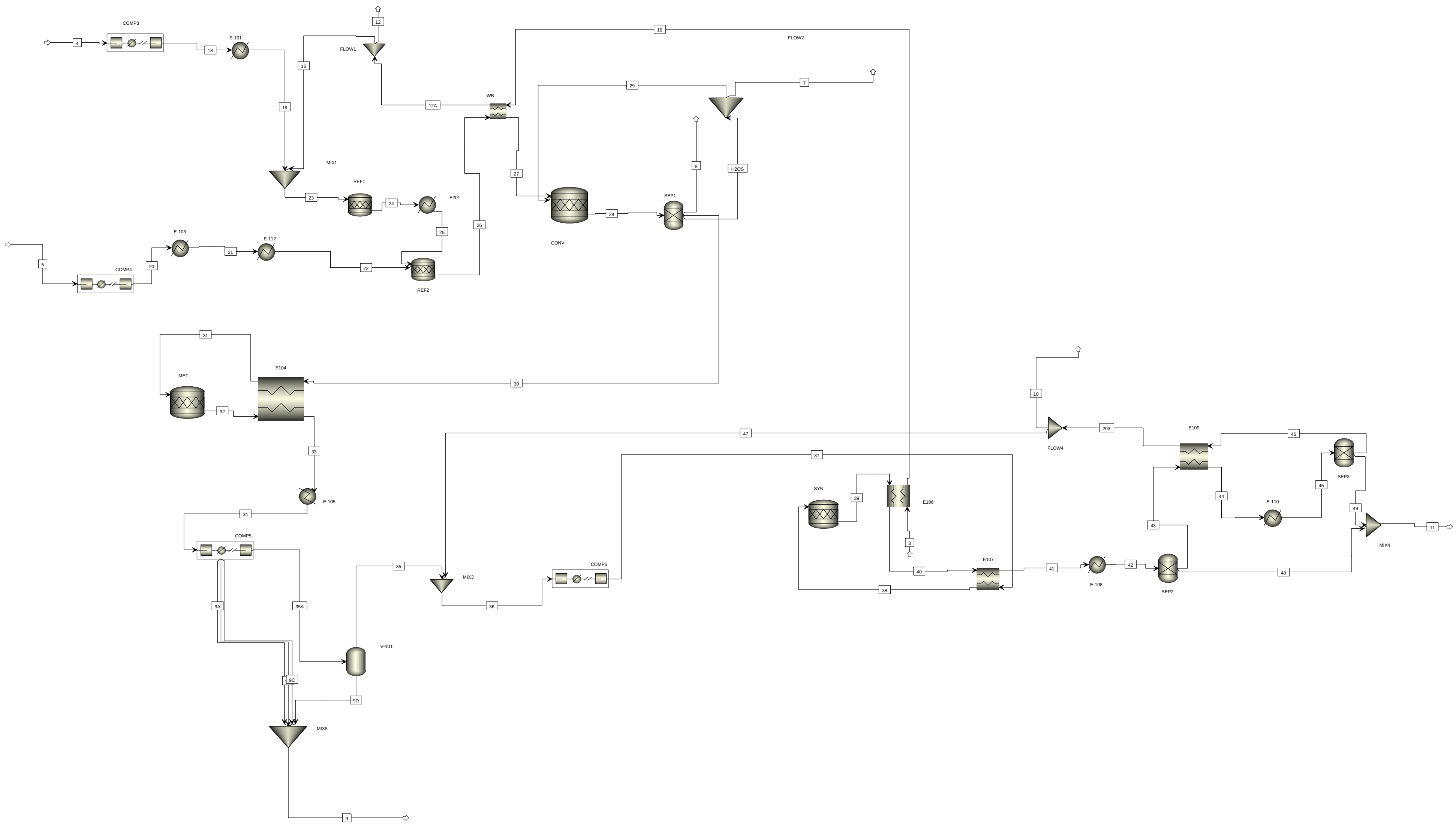
MET
Methanator

SEPA1
Syn Gas Separator

SEPA2 &SEPA3
Ammonia Separator

REF2
Secondary Reformer

REF1
Primary Reformer



Appendix 5 – Purified Terephthalic Acid (PTA)

Table 5A: Alternative PTA/IPA Combined Production Process Technology – Energy and Exergy Loss Profile

Unit OP	Type	Energy Loss = Btu/lb		Exergy Loss = Btu/lb			
		Total = 9,345	%	Total External = 2,222	Total Internal = 2,996	Total = 5,218	%
Feed Prep							
H-100..C-F1	Lights Separator	216	2.26	2	64	66	1.24
H-100..C-F2	O-xylene Separator	1554	16.27	430	18	448	8.4
H-100..C-F3	O-Xylene Rectifier	206	2.16	115	3	117	2.2
Oxidation							
H-200..MX-100	Acetic Acid Mixer	0	0	0	2	2	0.03
H-200..V-101	Catalyst Dissolver	0	0	0	0	0	0
H-200..MX-101	Feed/Recycle Mixer	0	0	0	2	2	0.05
H-200..V-102	Catalyst Solution Tank	0	0	0	13	13	0.24
H-200..K-101	Air Compressor	0	0	0	46	46	0.86
H-200..FS-101	Flow Splitter: Air	0	0	0	0	0	0
H-200..R-101	Oxidation Reactor	1399	14.65	508	1760	2268	42.5
H-200..E-101	Reactor Product Condenser	247	2.59	45	19	64	1.2
H-200..V-103	Condensate De-Gasser	0	0	0	2	2	0.04
H-200..R101VL	Knock Out Tank	67	0.7	24	4	28	0.52
H-200..R-102	MeAcetate Converter	8	0.09	1	13	14	0.26
H-200..C-101	Hp-Acetic Scrubber	0	0	0	1	1	0.01
H-200..R-103	MeAcetate Converter	0	0	0	0	0	0
H-200..S-105	N2-Expander	61	0.64	61	29	89	1.68
H-200..PSA-G104	N2-Separator	25	0.26	3	-7	-4	-0.08

Table 5A: Alternative PTA/IPA Combined Production Process Technology – Energy and Exergy Loss Profile (Cont'd)

Unit OP	Type	Energy Loss = Btu/lb		Exergy Loss = Btu/lb			
		Total = 9,345 0	%	Total External = 2,222 0	Total Internal = 2,996 0	Total = 5,218 0	%
CTA Crystallizer							
H-200..S-101	Crystallizer No. 1	0	0	0	2	2	0.03
H-200..E-102	S-101 Condenser	48	0.5	11	4	15	0.28
H-200..V-104	De-Gas Tank	0	0	0	0	0	0
H-200..S-102	Crystallizer No. 2	44	0.46	14	3	17	0.32
H-200..E-103	S-102 Condenser	1	0.01	0	0	0	0.01
H-200..V-105	De-Gas Tank	0	0	0	0	0	0
H-200..MIX11+13	Mixer	0	0	0	0	0	0
H-200..MIX10+12	Mixer	0	0	0	1	1	0.01
H-200..S-103	Crystallizer No. 3	102	1.07	23	13	36	0.67
H-200..E-104	S-103 Condenser	1	0.01	0	0	0	0
H-200..V-106	De-Gas Tank	0	0	0	0	0	0
H-200..MIX9+14	Mixer	0	0	0	0	0	0
H-200..MX-104	Mixer	0	0	0	0	0	0
H-200..V-107	Slurry Tank	0	0	0	0	0	0
H-200..S-104	Belt Filter	0	0	0	-14	-14	-0.26
H-200..V-108	De-Gas Tank	0	0	0	0	0	0
H-200..M:18A+32	Mixer	0	0	0	1	1	0.02
H-200..SP-V109L	Flow Splitter: V-109 LIQ.	0	0	0	0	0	0
H-200..V-109	Mother Liquor Tank	0	0	0	0	0	0

Table 5A: Alternative PTA/IPA Combined Production Process Technology – Energy and Exergy Loss Profile (Cont'd)

Unit OP	Type	Energy Loss = Btu/lb		Exergy Loss = Btu/lb			
		Total = 9,345	%	Total External = 2,222	Total Internal = 2,996	Total = 5,218	%
H-200..C-102	Acetic Acid Stripper	0	0	0	4	4	0.08
H-200..MIX24+26	Mixer	0	0	0	9	9	0.17
H-200..MIX17+23	Mixer	0	0	0	-3	-3	-0.06
H-200..E-105	C-210 Overhead Cooler	18	0.19	5	0	5	0.1
H-200..V-110	Condensate Hold Tank	79	0.83	15	7	22	0.41
H-200..C-103	C-103 Solvent Dehydrator	1776	18.59	238	298	535	10.04
H-200..SPLIT:31	Flow Splitter	0	0	0	0	0	0
H-200..PUMP21	R-103 Pump	0	0	0	0	0	0
Hydrogenation							
H-300..T-201	Inhibitor Tank	0	0	0	0	0	0
H-300..V-201	Slurry Tank	12	0.13	6	2	8	0.15
H-300..P-201	V-201 Pump	0	0	0	4	4	0.09
H-300..MX-201	Mixer	0	0	0	27	27	0.51
H-300..E-201	Dowtherm Heater	0	0	0	56	56	1.08
H-300..E-207	Cooler	47	0.51	11	1	12	0.22
H-300..S:E204HP	Flow Splitter	0	0	0	0	0	0
H-300..E-204HOT	Flow Splitter	0	0	0	270	270	5.17
H-300..SP-C201T	Flow Splitter	0	0	0	0	0	0
H-300..V-202	Slurry Dissolver	0	0	0	0	0	0
H-300..C-201	Solvent Evaporator	0	0	0	96	96	1.84
H-300..M:39B+40	Mixer	0	0	0	0	0	0

Table 5A: Alternative PTA/IPA Combined Production Process Technology – Energy and Exergy Loss Profile (Cont'd)

Unit OP	Type	Energy Loss = Btu/lb		Exergy Loss = Btu/lb			
		Total = 9,345	%	Total External = 2,222	Total Internal = 2,996	Total = 5,218	%
H-300..K-40	Compressor	0	0	0	0	0	0
H-300..R-201	Hydrogenation Reactor	0	0	0	0	0	0
PTA/ISO-PA Purification							
H-300..E-205	S-205 Condenser	0	0	0	0	0	0
H-300..E-206	Process Water Cooler	192	2.01	29	2	31	0.58
H-300..MIXFILTR	Mixer	0	0	0	10	10	0.18
H-300..S-202	Crystallizer	426	4.46	139	39	179	3.35
H-300..E-202	S-202 Condenser	2	0.02	1	0	1	0.01
H-300..V-203	Separator	0	0	0	0	0	0
H-300..S-203	Crystallizer	77	0.81	23	2	25	0.46
H-300..V-204	Condensate Separator	0	0	0	0	0	0
H-300..E-203	S-203 Condenser	0	0	0	0	0	0
H-300..V-205	Holding Tank	0	0	0	0	0	0
H-300..PUMP45	V-205 Pump	0	0	0	0	0	0.01
H-300..S-204	Centrifuge Separator	0	0	0	-25	-25	-0.47
H-300..S:FILTER	Flow Splitter	0	0	0	0	0	0
H-300..V-206	Re-Slurry Vessel	641	6.71	189	-37	153	2.86
H-300..MX-204	Mixer	0	0	0	4	4	0.08
H-300..S-205	Crystallizer	0	0	0	0	0	0
H-300..V-207	Condensate Separator	0	0	0	0	0	0

Table 5A: Alternative PTA/IPA Combined Production Process Technology – Energy and Exergy Loss Profile (Cont'd)

Unit OP	Type	Energy Loss = Btu/lb		Exergy Loss = Btu/lb			
		Total = 9,345	%	Total External = 2,222	Total Internal = 2,996	Total = 5,218	%
H-300..V-208	Knock Out Tank	156	1.63	32	7	39	0.74
H-300..S-206	Vacuum Filter	0	0	0	0	0	0
H-300..SPLIT:51	Flow Splitter	0	0	0	0	0	0
Product Refining							
H-400..MIX-100	Mixer	0	0	0	188	188	3.61
H-400..E-301	Cooler	457	4.9	127	12	138	2.65
H-400..SEP-301	Separator	0	0	0	0	0	0
H-400..E-302	Cooler	345	3.69	80	11	91	1.74
H-400..SEP-302	Separator	0	0	0	0	0	0
H-400..E-303	Cooler	1,343	14.37	205	17	221	4.24
H-400..SEP-303	Separator	0	0	0	0	0	0
H-400..P50	Pump	0	0	0	1	1	0.01
H-400..MIX-50	Mixer	0	0	0	19	19	0.37

Table 5B: Alternative PTA/IPA Combined Production Process Technology – Stream Tables

Stream ID	H-100.->81	H-100.->82	H-100.->83	H-100.->84	H-100.->85	H-100.->86	H-100.->87	H-100.->88
Temperature F	100.00	82.95	82.95	286.49	282.25	297.91	291.30	338.55
Pressure psi	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70
Vapor Frac	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
MoleFlow lbmol/hr	534.	8.	40.	485.	341.	144.	121.	23.
MassFlow lb/hr	55477.	282.	3248.	51946.	36275.	15671.	12856.	2815.
N2	0.	0.	0.	0.	0.	0.	0.	0.
H2	2.	2.	0.	0.	0.	0.	0.	0.
O2	0.	0.	0.	0.	0.	0.	0.	0.
CO	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
ACETICAC	0.	0.	0.	0.	0.	0.	0.	0.
P-XYLENE	10867.	0.	1.	10866.	10768.	98.	98.	0.
M-XYLENE	24358.	0.	2.	24356.	23815.	541.	541.	0.
O-XYLENE	12153.	0.	0.	12153.	97.	12056.	12034.	22.
TPA	0.	0.	0.	0.	0.	0.	0.	0.
CH3ACET	0.	0.	0.	0.	0.	0.	0.	0.
TOLUICAC	0.	0.	0.	0.	0.	0.	0.	0.
4-CBA	0.	0.	0.	0.	0.	0.	0.	0.
HBR	0.	0.	0.	0.	0.	0.	0.	0.
BZIOCAC	0.	0.	0.	0.	0.	0.	0.	0.
PHTHA-01	0.	0.	0.	0.	0.	0.	0.	0.
ISOPH-01	0.	0.	0.	0.	0.	0.	0.	0.
TRIMELAC	0.	0.	0.	0.	0.	0.	0.	0.
METHANOL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	0.	0.	0.
C1P	0.	0.	0.	0.	0.	0.	0.	0.
C2O	0.	0.	0.	0.	0.	0.	0.	0.
C2P	209.	192.	17.	0.	0.	0.	0.	0.
C3P	5.	4.	1.	0.	0.	0.	0.	0.
C4P	7.	4.	3.	0.	0.	0.	0.	0.
C5P	10.	3.	8.	0.	0.	0.	0.	0.
C6P	2.	0.	2.	0.	0.	0.	0.	0.
C7P	0.	0.	0.	0.	0.	0.	0.	0.
C8N	5.	0.	0.	5.	5.	0.	0.	0.
C8P	4.	0.	2.	2.	2.	0.	0.	0.
C9N	0.	0.	0.	0.	0.	0.	0.	0.
C9P	314.	0.	0.	314.	314.	0.	0.	0.
BEN	2314.	70.	2244.	0.	0.	0.	0.	0.
TOL	976.	9.	967.	1.	1.	0.	0.	0.
EB	1275.	0.	0.	1275.	1274.	1.	1.	0.
PB	42.	0.	0.	42.	0.	42.	40.	3.
MEB	226.	0.	0.	226.	0.	226.	49.	177.
TMB	2293.	0.	0.	2293.	0.	2293.	92.	2201.
DEB	280.	0.	0.	280.	0.	280.	2.	278.
DMEB	134.	0.	0.	134.	0.	134.	1.	133.
VolFlow cuft/hr	1778.01	3288.59	60.51	1098.17	770.77	327.78	267.34	60.57
Enthalpy MMBtu/hr	-4.99	-0.21	0.63	-0.89	-0.57	-0.31	0.01	-0.26

Table 5B: Alternative PTA/IPA Combined Production Process Technology – Stream Tables

Stream ID	H-200.->1	H-200.->1A	H-200.->2	H-200.->2A	H-200.->3	H-200.->4	H-200.->5	H-200.->5A
Temperature F	100.00	533.53	282.25	282.25	100.00	236.04	228.32	377.60
Pressure psi	14.70	71.01	14.70	14.70	15.00	14.70	14.70	215.00
Vapor Frac	1.00	1.00	0.00	0.00	0.00	0.01	0.00	1.00
MoleFlow lbmol/hr	5187.	5187.	341.	341.	47.	1384.	1645.	9622.
MassFlow lb/hr	149641.	149641.	36275.	36275.	2823.	77829.	110200.	312804.
N2	114787.	114787.	0.	0.	0.	0.	0.	115418.
H2	0.	0.	0.	0.	0.	0.	0.	0.
O2	34854.	34854.	0.	0.	0.	0.	0.	5258.
CO	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
ACETICAC	0.	0.	0.	0.	2823.	54938.	53249.	109827.
P-XYLENE	0.	0.	10768.	10768.	0.	24.	10386.	883.
M-XYLENE	0.	0.	23815.	23815.	0.	71.	23081.	1868.
O-XYLENE	0.	0.	97.	97.	0.	0.	94.	0.
TPA	0.	0.	0.	0.	0.	269.	269.	0.
CH3ACET	0.	0.	0.	0.	0.	0.	0.	0.
TOLUICAC	0.	0.	0.	0.	0.	158.	158.	8.
4-CBA	0.	0.	0.	0.	0.	14.	14.	0.
HBR	0.	0.	0.	0.	0.	0.	0.	0.
BZIOCAC	0.	0.	0.	0.	0.	221.	221.	0.
PHTHA-01	0.	0.	0.	0.	0.	3.	3.	1.
ISOPH-01	0.	0.	0.	0.	0.	596.	596.	0.
TRIMELAC	0.	0.	0.	0.	0.	8.	8.	0.
METHANOL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	0.	0.	0.	0.	0.	6124.	5440.	59914.
C1P	0.	0.	0.	0.	0.	0.	0.	0.
C2O	0.	0.	0.	0.	0.	0.	0.	0.
C2P	0.	0.	0.	0.	0.	0.	0.	0.
C3P	0.	0.	0.	0.	0.	0.	0.	0.
C4P	0.	0.	0.	0.	0.	0.	0.	0.
C5P	0.	0.	0.	0.	0.	0.	0.	0.
C6P	0.	0.	0.	0.	0.	0.	0.	0.
C7P	0.	0.	0.	0.	0.	0.	0.	0.
C8N	0.	0.	5.	5.	0.	175.	175.	234.
C8P	0.	0.	2.	2.	0.	0.	2.	0.
C9N	0.	0.	0.	0.	0.	0.	0.	0.
C9P	0.	0.	314.	314.	0.	15229.	15272.	17287.
BEN	0.	0.	0.	0.	0.	0.	0.	0.
TOL	0.	0.	1.	1.	0.	0.	1.	1.
EB	0.	0.	1274.	1274.	0.	1.	1233.	2105.
PB	0.	0.	0.	0.	0.	0.	0.	0.
MEB	0.	0.	0.	0.	0.	0.	0.	0.
TMB	0.	0.	0.	0.	0.	0.	0.	0.
DEB	0.	0.	0.	0.	0.	0.	0.	0.
DMEB	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	2118432.13	779492.08	770.77	770.77	42.78	7902.42	2014.86	387354.12
Enthalpy MMBtu/hr	0.82	16.72	-0.57	-0.57	-9.20	-233.13	-224.59	-670.95

Table 5B: Alternative PTA/IPA Combined Production Process Technology – Stream Tables

Stream ID	H-200.->5A1	H-200.->5A2	H-200.->5B	H-200.->6	H-200.->7	H-200.->8	H-200.->8A	H-200.->9
Temperature F	230.00	163.40	377.60	163.40	366.80	163.40	152.60	125.60
Pressure psi	215.00	215.00	215.00	210.00	139.00	210.00	180.00	139.00
Vapor Frac	0.48	0.45	0.00	0.00	0.00	1.00	1.00	0.00
MoleFlow lbmol/hr	9622.	9622.	2161.	5309.	2020.	4313.	4313.	141.
MassFlow lb/hr	312804.	312804.	136284.	190743.	131144.	122061.	122061.	5128.
N2	115418.	115418.	93.	1871.	31.	113546.	113546.	40.
H2	0.	0.	0.	0.	0.	0.	0.	0.
O2	5258.	5258.	8.	201.	17.	5057.	5057.	27.
CO	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
ACETICAC	109827.	109827.	51899.	108434.	48954.	1393.	1393.	2935.
P-XYLENE	883.	883.	138.	756.	118.	128.	128.	19.
M-XYLENE	1868.	1868.	396.	1630.	352.	239.	239.	42.
O-XYLENE	0.	0.	0.	0.	0.	0.	0.	0.
TPA	0.	0.	15943.	0.	15943.	0.	0.	0.
CH3ACET	0.	0.	0.	0.	0.	0.	0.	0.
TOLUICAC	8.	8.	240.	8.	240.	0.	0.	0.
4-CBA	0.	0.	118.	0.	118.	0.	0.	0.
HBR	0.	0.	0.	0.	0.	0.	0.	0.
BZIOCAC	0.	0.	431.	0.	431.	0.	0.	0.
PHTHA-01	1.	1.	150.	1.	150.	0.	0.	0.
ISOPH-01	0.	0.	35362.	0.	35362.	0.	0.	0.
TRIMELAC	0.	0.	32.	0.	32.	0.	0.	0.
METHANOL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	59914.	59914.	15203.	58630.	13657.	1283.	1283.	1537.
C1P	0.	0.	0.	0.	0.	0.	0.	0.
C2O	0.	0.	0.	0.	0.	0.	0.	0.
C2P	0.	0.	0.	0.	0.	0.	0.	0.
C3P	0.	0.	0.	0.	0.	0.	0.	0.
C4P	0.	0.	0.	0.	0.	0.	0.	0.
C5P	0.	0.	0.	0.	0.	0.	0.	0.
C6P	0.	0.	0.	0.	0.	0.	0.	0.
C7P	0.	0.	0.	0.	0.	0.	0.	0.
C8N	234.	234.	173.	231.	167.	2.	2.	6.
C8P	0.	0.	2.	0.	2.	0.	0.	0.
C9N	0.	0.	0.	0.	0.	0.	0.	0.
C9P	17287.	17287.	15134.	17146.	14666.	140.	140.	467.
BEN	0.	0.	0.	0.	0.	0.	0.	0.
TOL	1.	1.	1.	1.	1.	0.	0.	0.
EB	2105.	2105.	961.	1833.	904.	272.	272.	55.
PB	0.	0.	0.	0.	0.	0.	0.	0.
MEB	0.	0.	0.	0.	0.	0.	0.	0.
TMB	0.	0.	0.	0.	0.	0.	0.	0.
DEB	0.	0.	0.	0.	0.	0.	0.	0.
DMEB	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	162798.39	136984.24	2332.62	3350.10	2205.77	136942.38	156661.32	87.59
Enthalpy MMBtu/hr	-758.02	-771.79	-381.11	-762.46	-362.10	-9.28	-9.75	-20.40

Table 5B: Alternative PTA/IPA Combined Production Process Technology – Stream Tables

Stream ID	H-200.->10	H-200.->10+12	H-200.->11	H-200.->11+13	H-200.->12	H-200.->13	H-200.->14	H-200.->15
Temperature F	125.60	124.05	329.00	328.77	125.60	125.60	125.60	232.34
Pressure psi	139.00	77.00	77.00	77.00	77.00	77.00	17.00	17.00
Vapor Frac	1.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
MoleFlow lbmol/hr	52.	53.	2016.	2019.	1.	3.	2.	2016.
MassFlow lb/hr	1507.	1531.	131005.	131121.	23.	116.	72.	131032.
N2	1170.	1186.	14.	15.	17.	0.	0.	5.
H2	0.	0.	0.	0.	0.	0.	0.	0.
O2	313.	319.	11.	11.	6.	0.	0.	6.
CO	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
ACETICAC	10.	10.	48887.	48954.	0.	67.	42.	48911.
P-XYLENE	1.	1.	117.	118.	0.	0.	0.	118.
M-XYLENE	2.	2.	351.	352.	0.	1.	1.	351.
O-XYLENE	0.	0.	0.	0.	0.	0.	0.	0.
TPA	0.	0.	15943.	15943.	0.	0.	0.	15943.
CH3ACET	0.	0.	0.	0.	0.	0.	0.	0.
TOLUICAC	0.	0.	240.	240.	0.	0.	0.	240.
4-CBA	0.	0.	118.	118.	0.	0.	0.	118.
HBR	0.	0.	0.	0.	0.	0.	0.	0.
BZIOCAC	0.	0.	431.	431.	0.	0.	0.	431.
PHTHA-01	0.	0.	150.	150.	0.	0.	0.	150.
ISOPH-01	0.	0.	35362.	35362.	0.	0.	0.	35362.
TRIMELAC	0.	0.	32.	32.	0.	0.	0.	32.
METHANOL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	9.	9.	13622.	13657.	0.	35.	21.	13635.
C1P	0.	0.	0.	0.	0.	0.	0.	0.
C2O	0.	0.	0.	0.	0.	0.	0.	0.
C2P	0.	0.	0.	0.	0.	0.	0.	0.
C3P	0.	0.	0.	0.	0.	0.	0.	0.
C4P	0.	0.	0.	0.	0.	0.	0.	0.
C5P	0.	0.	0.	0.	0.	0.	0.	0.
C6P	0.	0.	0.	0.	0.	0.	0.	0.
C7P	0.	0.	0.	0.	0.	0.	0.	0.
C8N	0.	0.	166.	167.	0.	0.	0.	166.
C8P	0.	0.	2.	2.	0.	0.	0.	2.
C9N	0.	0.	0.	0.	0.	0.	0.	0.
C9P	1.	1.	14655.	14666.	0.	11.	7.	14659.
BEN	0.	0.	0.	0.	0.	0.	0.	0.
TOL	0.	0.	1.	1.	0.	0.	0.	1.
EB	2.	2.	902.	903.	0.	2.	1.	902.
PB	0.	0.	0.	0.	0.	0.	0.	0.
MEB	0.	0.	0.	0.	0.	0.	0.	0.
TMB	0.	0.	0.	0.	0.	0.	0.	0.
DEB	0.	0.	0.	0.	0.	0.	0.	0.
DMEB	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	2353.73	4307.56	2148.23	2159.36	64.66	1.98	1.23	2027.36
Enthalpy MMBtu/hr	-0.07	-0.07	-364.12	-364.58	0.00	-0.47	-0.29	-370.02

Table 5B: Alternative PTA/IPA Combined Production Process Technology – Stream Tables

Stream ID	H-200.->16	H-200.->17	H-200.->18	H-200.->18A	H-200.->19	H-200.->20	H-200.->21	H-200.->21A
Temperature F	357.80	231.68	231.68	231.80	231.68	231.80	126.95	152.60
Pressure psi	150.00	17.00	17.00	30.00	17.00	30.00	180.00	180.00
Vapor Frac	0.01	0.41	0.00	0.00	0.00	0.00	0.00	0.00
MoleFlow lbmol/hr	359.	622.	1126.	225.	627.	901.	223.	223.
MassFlow lb/hr	6501.	27446.	53107.	10609.	56979.	42499.	4031.	4031.
N2	1.	6.	0.	0.	0.	0.	5.	5.
H2	0.	0.	0.	0.	0.	0.	0.	0.
O2	1.	7.	0.	0.	0.	0.	4.	4.
CO	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
ACETICAC	37.	3667.	45097.	9008.	184.	36089.	18.	18.
P-XYLENE	0.	0.	118.	24.	0.	94.	0.	0.
M-XYLENE	0.	0.	352.	70.	0.	282.	1.	1.
O-XYLENE	0.	0.	0.	0.	0.	0.	0.	0.
TPA	0.	12.	147.	29.	15785.	118.	0.	0.
CH3ACET	0.	0.	0.	0.	0.	0.	0.	0.
TOLUICAC	0.	35.	174.	35.	32.	139.	0.	0.
4-CBA	0.	4.	47.	9.	68.	37.	0.	0.
HBR	0.	0.	0.	0.	0.	0.	0.	0.
BZIOCAC	0.	117.	259.	52.	55.	207.	0.	0.
PHTHA-01	0.	0.	1.	0.	148.	1.	0.	0.
ISOPH-01	0.	26.	326.	65.	35009.	261.	0.	0.
TRIMELAC	0.	2.	29.	6.	0.	23.	0.	0.
METHANOL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	6460.	7839.	6558.	1310.	5698.	5248.	3999.	3999.
C1P	0.	0.	0.	0.	0.	0.	0.	0.
C2O	0.	0.	0.	0.	0.	0.	0.	0.
C2P	0.	0.	0.	0.	0.	0.	0.	0.
C3P	0.	0.	0.	0.	0.	0.	0.	0.
C4P	0.	0.	0.	0.	0.	0.	0.	0.
C5P	0.	0.	0.	0.	0.	0.	0.	0.
C6P	0.	0.	0.	0.	0.	0.	0.	0.
C7P	0.	0.	0.	0.	0.	0.	0.	0.
C8N	0.	166.	0.	0.	0.	0.	0.	0.
C8P	0.	2.	0.	0.	0.	0.	0.	0.
C9N	0.	0.	0.	0.	0.	0.	0.	0.
C9P	0.	14659.	0.	0.	0.	0.	0.	0.
BEN	0.	0.	0.	0.	0.	0.	0.	0.
TOL	0.	1.	0.	0.	0.	0.	0.	0.
EB	2.	904.	0.	0.	0.	0.	4.	4.
PB	0.	0.	0.	0.	0.	0.	0.	0.
MEB	0.	0.	0.	0.	0.	0.	0.	0.
TMB	0.	0.	0.	0.	0.	0.	0.	0.
DEB	0.	0.	0.	0.	0.	0.	0.	0.
DMEB	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	344.59	111669.75	923.74	184.54	711.68	739.29	66.89	67.90
Enthalpy MMBtu/hr	-42.18	-72.57	-190.88	-38.13	-145.51	-152.75	-27.13	-27.03

Table 5B: Alternative PTA/IPA Combined Production Process Technology – Stream Tables

Stream ID	H-200.->21X	H-200.->22	H-200.->23	H-200.->24	H-200.->25	H-200.->26	H-200.->27	H-200.->28
Temperature F	125.60	147.26	148.36	266.74	297.74	124.17	288.97	261.62
Pressure psi	16.00	180.00	180.00	25.00	25.00	80.00	50.00	20.00
Vapor Frac	0.00	1.00	0.00	1.00	0.00	1.00	0.18	1.00
MoleFlow lbmol/hr	223.	4302.	233.	879.	23.	54.	856.	932.
MassFlow lb/hr	4031.	120742.	5350.	40635.	1863.	1547.	32796.	42183.
N2	5.	113473.	78.	0.	0.	1196.	84.	1196.
H2	0.	0.	0.	0.	0.	0.	0.	0.
O2	4.	5052.	9.	0.	0.	324.	15.	324.
CO	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
ACETICAC	18.	4.	1406.	35118.	971.	11.	5073.	35129.
P-XYLENE	0.	127.	1.	71.	24.	1.	1.	71.
M-XYLENE	1.	237.	3.	198.	84.	2.	3.	200.
O-XYLENE	0.	0.	0.	0.	0.	0.	0.	0.
TPA	0.	0.	0.	0.	118.	0.	12.	0.
CH3ACET	0.	0.	0.	0.	0.	0.	0.	0.
TOLUICAC	0.	0.	0.	0.	138.	0.	35.	0.
4-CBA	0.	0.	0.	0.	37.	0.	4.	0.
HBR	0.	0.	0.	0.	0.	0.	0.	0.
BZIOCAC	0.	0.	0.	0.	207.	0.	117.	0.
PHTHA-01	0.	0.	0.	0.	1.	0.	0.	0.
ISOPH-01	0.	0.	0.	0.	261.	0.	26.	0.
TRIMELAC	0.	0.	0.	0.	23.	0.	2.	0.
METHANOL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	3999.	1576.	3706.	5248.	0.	10.	11545.	5257.
C1P	0.	0.	0.	0.	0.	0.	0.	0.
C2O	0.	0.	0.	0.	0.	0.	0.	0.
C2P	0.	0.	0.	0.	0.	0.	0.	0.
C3P	0.	0.	0.	0.	0.	0.	0.	0.
C4P	0.	0.	0.	0.	0.	0.	0.	0.
C5P	0.	0.	0.	0.	0.	0.	0.	0.
C6P	0.	0.	0.	0.	0.	0.	0.	0.
C7P	0.	0.	0.	0.	0.	0.	0.	0.
C8N	0.	0.	2.	0.	0.	0.	169.	0.
C8P	0.	0.	0.	0.	0.	0.	2.	0.
C9N	0.	0.	0.	0.	0.	0.	0.	0.
C9P	0.	0.	140.	0.	0.	1.	14799.	1.
BEN	0.	0.	0.	0.	0.	0.	0.	0.
TOL	0.	0.	0.	0.	0.	0.	1.	0.
EB	4.	272.	4.	0.	0.	3.	907.	3.
PB	0.	0.	0.	0.	0.	0.	0.	0.
MEB	0.	0.	0.	0.	0.	0.	0.	0.
TMB	0.	0.	0.	0.	0.	0.	0.	0.
DEB	0.	0.	0.	0.	0.	0.	0.	0.
DMEB	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	66.84	155244.76	92.41	267934.83	28.69	4190.43	25124.23	354953.28
Enthalpy MMBtu/hr	-27.14	-7.06	-29.72	-136.78	-4.43	-0.07	-102.29	-136.85

Table 5B: Alternative PTA/IPA Combined Production Process Technology – Stream Tables

Stream ID	H-200.->29	H-200.->30	H-200.->31	H-200.->32	H-200.->33	H-200.->34	H-200.->35	H-200.->35A
Temperature F	124.35	125.60	125.60	245.69	125.60	238.88	12.08	147.26
Pressure psi	80.00	16.00	16.00	16.00	16.00	14.70	50.00	180.00
Vapor Frac	0.01	1.00	0.00	0.00	0.00	0.01	1.00	1.00
MoleFlow lbmol/hr	143.	74.	862.	984.	639.	1208.	3654.	3654.
MassFlow lb/hr	5201.	2886.	15600.	61285.	11569.	71893.	102387.	102387.
N2	40.	1220.	21.	0.	15.	0.	102126.	102126.
H2	0.	0.	0.	0.	0.	0.	0.	0.
O2	27.	338.	14.	0.	11.	0.	253.	253.
CO	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
ACETICAC	2977.	0.	70.	43082.	52.	52090.	0.	0.
P-XYLENE	19.	90.	1.	0.	1.	24.	0.	0.
M-XYLENE	43.	242.	3.	0.	2.	71.	0.	0.
O-XYLENE	0.	0.	0.	0.	0.	0.	0.	0.
TPA	0.	0.	0.	12.	0.	41.	0.	0.
CH3ACET	0.	0.	0.	0.	0.	0.	0.	0.
TOLUICAC	0.	0.	0.	36.	0.	70.	0.	0.
4-CBA	0.	0.	0.	4.	0.	13.	0.	0.
HBR	0.	0.	0.	0.	0.	0.	0.	0.
BZIOCAC	0.	0.	0.	118.	0.	169.	0.	0.
PHTHA-01	0.	0.	0.	0.	0.	0.	0.	0.
ISOPH-01	0.	0.	0.	26.	0.	91.	0.	0.
TRIMELAC	0.	0.	0.	2.	0.	8.	0.	0.
METHANOL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	1558.	166.	15475.	2600.	11477.	3910.	8.	8.
C1P	0.	0.	0.	0.	0.	0.	0.	0.
C2O	0.	0.	0.	0.	0.	0.	0.	0.
C2P	0.	0.	0.	0.	0.	0.	0.	0.
C3P	0.	0.	0.	0.	0.	0.	0.	0.
C4P	0.	0.	0.	0.	0.	0.	0.	0.
C5P	0.	0.	0.	0.	0.	0.	0.	0.
C6P	0.	0.	0.	0.	0.	0.	0.	0.
C7P	0.	0.	0.	0.	0.	0.	0.	0.
C8N	6.	0.	0.	175.	0.	175.	0.	0.
C8P	0.	2.	0.	0.	0.	0.	0.	0.
C9N	0.	0.	0.	0.	0.	0.	0.	0.
C9P	474.	0.	1.	15229.	1.	15229.	0.	0.
BEN	0.	0.	0.	0.	0.	0.	0.	0.
TOL	0.	0.	0.	0.	0.	0.	0.	0.
EB	56.	826.	15.	1.	11.	1.	0.	0.
PB	0.	0.	0.	0.	0.	0.	0.	0.
MEB	0.	0.	0.	0.	0.	0.	0.	0.
TMB	0.	0.	0.	0.	0.	0.	0.	0.
DEB	0.	0.	0.	0.	0.	0.	0.	0.
DMEB	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	155.43	29039.91	258.67	1117.32	191.83	6809.88	368959.38	132049.05
Enthalpy MMBtu/hr	-20.69	-0.80	-105.03	-169.33	-77.89	-207.46	-1.74	1.65

Table 5B: Alternative PTA/IPA Combined Production Process Technology – Stream Tables

Stream ID	H-200.->36	H-200.->38	H-200.->54	H-200.->57	H-200.->74	H-200.->100	H-200.->AIR2R101	H-200.->AIR2S101
Temperature F	147.26	100.00	12.08	362.24	125.60	100.00	533.53	533.53
Pressure psi	180.00	14.70	50.00	150.00	15.00	14.70	71.01	71.01
Vapor Frac	0.88	0.00	1.00	0.00	0.00	0.00	1.00	1.00
MoleFlow lbmol/hr	648.	327.	2779.	148.	7.	446.	5135.	52.
MassFlow lb/hr	18355.	34755.	77865.	3511.	269.	47378.	148145.	1496.
N2	11347.	0.	77667.	0.	0.	0.	113639.	1148.
H2	0.	0.	0.	0.	0.	0.	0.	0.
O2	4799.	0.	192.	0.	0.	0.	34505.	349.
CO	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
ACETICAC	4.	0.	0.	102.	201.	0.	0.	0.
P-XYLENE	127.	34583.	0.	0.	0.	47144.	0.	0.
M-XYLENE	237.	86.	0.	0.	0.	117.	0.	0.
O-XYLENE	0.	86.	0.	0.	0.	117.	0.	0.
TPA	0.	0.	0.	227.	0.	0.	0.	0.
CH3ACET	0.	0.	0.	0.	0.	0.	0.	0.
TOLUICAC	0.	0.	0.	87.	0.	0.	0.	0.
4-CBA	0.	0.	0.	0.	0.	0.	0.	0.
HBR	0.	0.	0.	0.	0.	0.	0.	0.
BZIOCAC	0.	0.	0.	52.	0.	0.	0.	0.
PHTHA-01	0.	0.	0.	2.	0.	0.	0.	0.
ISOPH-01	0.	0.	0.	504.	0.	0.	0.	0.
TRIMELAC	0.	0.	0.	0.	0.	0.	0.	0.
METHANOL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	1569.	0.	6.	2535.	68.	0.	0.	0.
C1P	0.	0.	0.	0.	0.	0.	0.	0.
C2O	0.	0.	0.	0.	0.	0.	0.	0.
C2P	0.	0.	0.	0.	0.	0.	0.	0.
C3P	0.	0.	0.	0.	0.	0.	0.	0.
C4P	0.	0.	0.	0.	0.	0.	0.	0.
C5P	0.	0.	0.	0.	0.	0.	0.	0.
C6P	0.	0.	0.	0.	0.	0.	0.	0.
C7P	0.	0.	0.	0.	0.	0.	0.	0.
C8N	0.	0.	0.	0.	0.	0.	0.	0.
C8P	0.	0.	0.	0.	0.	0.	0.	0.
C9N	0.	0.	0.	0.	0.	0.	0.	0.
C9P	0.	0.	0.	0.	0.	0.	0.	0.
BEN	0.	0.	0.	0.	0.	0.	0.	0.
TOL	0.	0.	0.	0.	0.	0.	0.	0.
EB	272.	0.	0.	0.	0.	0.	0.	0.
PB	0.	0.	0.	0.	0.	0.	0.	0.
MEB	0.	0.	0.	0.	0.	0.	0.	0.
TMB	0.	0.	0.	0.	0.	0.	0.	0.
DEB	0.	0.	0.	0.	0.	0.	0.	0.
DMEB	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	20597.38	656.61	280593.61	65.29	4.45	895.10	771697.22	7794.92
Enthalpy MMBtu/hr	-10.07	-3.09	-1.32	-18.43	-1.12	-4.21	16.55	0.17

Table 5B: Alternative PTA/IPA Combined Production Process Technology – Stream Tables

Stream ID	H-200.->C103TOPF	H-200.->N2TOUTIL	H-200.->R101PROD	H-200.->S101-V	H-200.->S102-V	H-200.->S103-V	H-200.->V101-L	H-200.->V101-V
Temperature F	203.00	12.08	383.00	366.80	329.00	232.34	221.47	221.47
Pressure psi	17.00	50.00	219.00	139.00	77.00	17.00	15.00	15.00
Vapor Frac	0.00	1.00	0.84	1.00	1.00	1.00	0.00	1.00
MoleFlow lbmol/hr	844.	875.	11783.	193.	4.	3.	176.	26.
MassFlow lb/hr	32387.	24522.	449087.	6636.	140.	89.	5936.	667.
N2	5.	24459.	115511.	1210.	17.	10.	0.	0.
H2	0.	0.	0.	0.	0.	0.	0.	0.
O2	2.	61.	5266.	340.	6.	5.	0.	0.
CO	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
ACETICAC	5046.	0.	161726.	2945.	67.	43.	2848.	277.
P-XYLENE	1.	0.	1021.	20.	0.	0.	0.	0.
M-XYLENE	2.	0.	2265.	44.	1.	1.	0.	0.
O-XYLENE	0.	0.	0.	0.	0.	0.	0.	0.
TPA	12.	0.	15943.	0.	0.	0.	227.	0.
CH3ACET	0.	0.	0.	0.	0.	0.	0.	0.
TOLUICAC	35.	0.	248.	0.	0.	0.	87.	0.
4-CBA	4.	0.	118.	0.	0.	0.	0.	0.
HBR	0.	0.	0.	0.	0.	0.	0.	0.
BZIOCAC	117.	0.	431.	0.	0.	0.	52.	0.
PHTHA-01	0.	0.	150.	0.	0.	0.	2.	0.
ISOPH-01	26.	0.	35362.	0.	0.	0.	504.	0.
TRIMELAC	2.	0.	32.	0.	0.	0.	0.	0.
METHANOL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	11426.	2.	75117.	1546.	35.	22.	2214.	389.
C1P	0.	0.	0.	0.	0.	0.	0.	0.
C2O	0.	0.	0.	0.	0.	0.	0.	0.
C2P	0.	0.	0.	0.	0.	0.	0.	0.
C3P	0.	0.	0.	0.	0.	0.	0.	0.
C4P	0.	0.	0.	0.	0.	0.	0.	0.
C5P	0.	0.	0.	0.	0.	0.	0.	0.
C6P	0.	0.	0.	0.	0.	0.	0.	0.
C7P	0.	0.	0.	0.	0.	0.	0.	0.
C8N	168.	0.	406.	6.	0.	0.	0.	0.
C8P	2.	0.	2.	0.	0.	0.	0.	0.
C9N	0.	0.	0.	0.	0.	0.	0.	0.
C9P	14754.	0.	32421.	468.	11.	7.	0.	0.
BEN	0.	0.	0.	0.	0.	0.	0.	0.
TOL	0.	0.	2.	0.	0.	0.	0.	0.
EB	783.	0.	3066.	57.	2.	2.	0.	0.
PB	0.	0.	0.	0.	0.	0.	0.	0.
MEB	0.	0.	0.	0.	0.	0.	0.	0.
TMB	0.	0.	0.	0.	0.	0.	0.	0.
DEB	0.	0.	0.	0.	0.	0.	0.	0.
DMEB	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	623.59	88365.77	393087.25	11867.01	426.82	1090.31	102.10	12669.35
Enthalpy MMBtu/hr	-105.91	-0.42	-1048.34	-17.79	-0.41	-0.26	-25.68	-3.07

Table 5B: Alternative PTA/IPA Combined Production Process Technology – Stream Tables

Stream ID	H-200.->V101FEED	H-200.->V102-V	H-200.->V104FEED	H-200.->V105FEED	H-200.->V106-V	H-200.->V106FEED	H-200.->V107-L	H-200.->V107-V
Temperature F	221.47	228.32	125.60	125.60	125.60	125.60	232.34	-459.67
Pressure psi	15.00	14.70	139.00	77.00	17.00	17.00	17.00	17.00
Vapor Frac	0.13	1.00	0.27	0.20	1.00	0.22	0.00	0.00
MoleFlow lbmol/hr	202.	80.	193.	4.	1.	3.	2016.	0.
MassFlow lb/hr	6602.	3904.	6636.	140.	17.	89.	131032.	0.
N2	0.	0.	1210.	17.	10.	10.	5.	0.
H2	0.	0.	0.	0.	0.	0.	0.	0.
O2	0.	0.	340.	6.	5.	5.	6.	0.
CO	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
ACETICAC	3125.	1689.	2945.	67.	1.	43.	48911.	0.
P-XYLENE	0.	406.	20.	0.	0.	0.	118.	0.
M-XYLENE	0.	804.	44.	1.	0.	1.	351.	0.
O-XYLENE	0.	3.	0.	0.	0.	0.	0.	0.
TPA	227.	0.	0.	0.	0.	0.	15943.	0.
CH3ACET	0.	0.	0.	0.	0.	0.	0.	0.
TOLUICAC	87.	0.	0.	0.	0.	0.	240.	0.
4-CBA	0.	0.	0.	0.	0.	0.	118.	0.
HBR	0.	0.	0.	0.	0.	0.	0.	0.
BZIOCAC	52.	0.	0.	0.	0.	0.	431.	0.
PHTHA-01	2.	0.	0.	0.	0.	0.	150.	0.
ISOPH-01	504.	0.	0.	0.	0.	0.	35362.	0.
TRIMELAC	0.	0.	0.	0.	0.	0.	32.	0.
METHANOL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	2603.	684.	1546.	35.	1.	22.	13635.	0.
C1P	0.	0.	0.	0.	0.	0.	0.	0.
C2O	0.	0.	0.	0.	0.	0.	0.	0.
C2P	0.	0.	0.	0.	0.	0.	0.	0.
C3P	0.	0.	0.	0.	0.	0.	0.	0.
C4P	0.	0.	0.	0.	0.	0.	0.	0.
C5P	0.	0.	0.	0.	0.	0.	0.	0.
C6P	0.	0.	0.	0.	0.	0.	0.	0.
C7P	0.	0.	0.	0.	0.	0.	0.	0.
C8N	0.	4.	6.	0.	0.	0.	166.	0.
C8P	0.	0.	0.	0.	0.	0.	2.	0.
C9N	0.	0.	0.	0.	0.	0.	0.	0.
C9P	0.	271.	468.	11.	0.	7.	14659.	0.
BEN	0.	0.	0.	0.	0.	0.	0.	0.
TOL	0.	0.	0.	0.	0.	0.	1.	0.
EB	0.	42.	57.	2.	0.	2.	902.	0.
PB	0.	0.	0.	0.	0.	0.	0.	0.
MEB	0.	0.	0.	0.	0.	0.	0.	0.
TMB	0.	0.	0.	0.	0.	0.	0.	0.
DEB	0.	0.	0.	0.	0.	0.	0.	0.
DMEB	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	12771.44	39617.26	2441.31	66.65	207.45	208.68	2027.36	0.00
Enthalpy MMBtu/hr	-28.75	-9.11	-20.47	-0.47	-0.01	-0.29	-370.02	0.00

Table 5B: Alternative PTA/IPA Combined Production Process Technology – Stream Tables

Stream ID	H-200.->V108-L	H-200.->V108-V	H-200.->V108FEED	H-200.->V109-L	H-200.->V109-V	H-200.->V110-V	H-300.->16	H-300.->19
Temperature F	231.80	231.80	231.80	231.80	-459.67	203.00	357.80	231.68
Pressure psi	30.00	30.00	150.00	30.00	30.00	17.00	150.00	17.00
Vapor Frac	0.00	1.00	0.00	0.00	0.00	1.00	0.01	0.00
MoleFlow lbmol/hr	359.	0.	359.	1126.	0.	12.	359.	627.
MassFlow lb/hr	6501.	0.	6501.	53107.	0.	409.	6501.	56979.
N2	1.	0.	1.	0.	0.	79.	1.	0.
H2	0.	0.	0.	0.	0.	0.	0.	0.
O2	1.	0.	1.	0.	0.	13.	1.	0.
CO	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
ACETICAC	37.	0.	37.	45097.	0.	27.	37.	184.
P-XYLENE	0.	0.	0.	118.	0.	0.	0.	0.
M-XYLENE	0.	0.	0.	352.	0.	0.	0.	0.
O-XYLENE	0.	0.	0.	0.	0.	0.	0.	0.
TPA	0.	0.	0.	147.	0.	0.	0.	15785.
CH3ACET	0.	0.	0.	0.	0.	0.	0.	0.
TOLUICAC	0.	0.	0.	174.	0.	0.	0.	32.
4-CBA	0.	0.	0.	47.	0.	0.	0.	68.
HBR	0.	0.	0.	0.	0.	0.	0.	0.
BZIOCAC	0.	0.	0.	259.	0.	0.	0.	55.
PHTHA-01	0.	0.	0.	1.	0.	0.	0.	148.
ISOPH-01	0.	0.	0.	326.	0.	0.	0.	35009.
TRIMELAC	0.	0.	0.	29.	0.	0.	0.	0.
METHANOL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	6460.	0.	6460.	6558.	0.	118.	6460.	5698.
C1P	0.	0.	0.	0.	0.	0.	0.	0.
C2O	0.	0.	0.	0.	0.	0.	0.	0.
C2P	0.	0.	0.	0.	0.	0.	0.	0.
C3P	0.	0.	0.	0.	0.	0.	0.	0.
C4P	0.	0.	0.	0.	0.	0.	0.	0.
C5P	0.	0.	0.	0.	0.	0.	0.	0.
C6P	0.	0.	0.	0.	0.	0.	0.	0.
C7P	0.	0.	0.	0.	0.	0.	0.	0.
C8N	0.	0.	0.	0.	0.	1.	0.	0.
C8P	0.	0.	0.	0.	0.	0.	0.	0.
C9N	0.	0.	0.	0.	0.	0.	0.	0.
C9P	0.	0.	0.	0.	0.	45.	0.	0.
BEN	0.	0.	0.	0.	0.	0.	0.	0.
TOL	0.	0.	0.	0.	0.	0.	0.	0.
EB	2.	0.	2.	0.	0.	125.	2.	0.
PB	0.	0.	0.	0.	0.	0.	0.	0.
MEB	0.	0.	0.	0.	0.	0.	0.	0.
TMB	0.	0.	0.	0.	0.	0.	0.	0.
DEB	0.	0.	0.	0.	0.	0.	0.	0.
DMEB	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	114.99	0.02	114.99	923.83	0.00	4897.11	344.59	711.68
Enthalpy MMBtu/hr	-43.17	0.00	-43.17	-190.88	0.00	-0.77	-42.18	-145.51

Table 5B: Alternative PTA/IPA Combined Production Process Technology – Stream Tables

Stream ID	H-300.->19A	H-300.->19B	H-300.->33	H-300.->33A	H-300.->37	H-300.->37A	H-300.->37X	H-300.->38
Temperature F	143.60	147.23	125.60	185.99	125.60	125.60	220.95	125.60
Pressure psi	15.00	915.00	16.00	16.00	15.00	14.70	16.00	14.70
Vapor Frac	0.00	0.00	0.00	0.00	0.00	0.00	0.06	1.00
MoleFlow lbmol/hr	4123.	4123.	639.	2352.	3496.	3496.	3496.	0.
MassFlow lb/hr	162449.	162449.	11569.	64146.	105470.	105470.	105472.	0.
N2	8.	8.	15.	18.	8.	8.	8.	0.
H2	0.	0.	0.	0.	0.	0.	0.	0.
O2	9.	9.	11.	13.	9.	9.	9.	0.
CO	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
ACETICAC	594.	594.	52.	71.	410.	410.	410.	0.
P-XYLENE	1.	1.	1.	1.	1.	1.	1.	0.
M-XYLENE	3.	3.	2.	3.	3.	3.	3.	0.
O-XYLENE	0.	0.	0.	0.	0.	0.	0.	0.
TPA	30376.	30376.	0.	7541.	14592.	14592.	14592.	0.
CH3ACET	0.	0.	0.	0.	0.	0.	0.	0.
TOLUICAC	174.	174.	0.	3.	142.	142.	142.	0.
4-CBA	68.	68.	0.	0.	0.	0.	0.	0.
HBR	0.	0.	0.	0.	0.	0.	0.	0.
BZIOCAC	139.	139.	0.	1.	84.	84.	84.	0.
PHTHA-01	285.	285.	0.	71.	137.	137.	137.	0.
ISOPH-01	67374.	67374.	0.	16726.	32364.	32364.	32364.	0.
TRIMELAC	0.	0.	0.	0.	0.	0.	0.	0.
METHANOL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	63401.	63401.	11477.	39684.	57703.	57703.	57705.	0.
C1P	0.	0.	0.	0.	0.	0.	0.	0.
C2O	0.	0.	0.	0.	0.	0.	0.	0.
C2P	0.	0.	0.	0.	0.	0.	0.	0.
C3P	0.	0.	0.	0.	0.	0.	0.	0.
C4P	0.	0.	0.	0.	0.	0.	0.	0.
C5P	0.	0.	0.	0.	0.	0.	0.	0.
C6P	0.	0.	0.	0.	0.	0.	0.	0.
C7P	0.	0.	0.	0.	0.	0.	0.	0.
C8N	0.	0.	0.	0.	0.	0.	0.	0.
C8P	0.	0.	0.	0.	0.	0.	0.	0.
C9N	0.	0.	0.	0.	0.	0.	0.	0.
C9P	1.	1.	1.	1.	1.	1.	1.	0.
BEN	0.	0.	0.	0.	0.	0.	0.	0.
TOL	0.	0.	0.	0.	0.	0.	0.	0.
EB	16.	16.	11.	14.	16.	16.	16.	0.
PB	0.	0.	0.	0.	0.	0.	0.	0.
MEB	0.	0.	0.	0.	0.	0.	0.	0.
TMB	0.	0.	0.	0.	0.	0.	0.	0.
DEB	0.	0.	0.	0.	0.	0.	0.	0.
DMEB	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	2383.56	2387.28	191.83	1028.89	1612.42	1612.37	97858.90	0.05
Enthalpy MMBtu/hr	-638.80	-638.20	-77.89	-317.96	-492.62	-492.62	-481.96	0.00

Table 5B: Alternative PTA/IPA Combined Production Process Technology – Stream Tables

Stream ID	H-300.->39	H-300.->39A	H-300.->39B	H-300.->39C	H-300.->40	H-300.->40B	H-300.->41	H-300.->41A
Temperature F	225.08	512.60	512.60	512.31	194.00	2157.35	512.60	512.60
Pressure psi	915.00	915.00	915.00	915.00	14.70	915.00	975.00	975.00
Vapor Frac	0.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00
MoleFlow lbmol/hr	4532.	4532.	4532.	4534.	2.	2.	4533.	4533.
MassFlow lb/hr	169853.	169853.	169853.	169856.	4.	4.	169856.	169856.
N2	9.	9.	9.	9.	0.	0.	9.	9.
H2	0.	0.	0.	4.	4.	4.	2.	2.
O2	10.	10.	10.	10.	0.	0.	10.	10.
CO	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
ACETICAC	636.	636.	636.	636.	0.	0.	636.	636.
P-XYLENE	1.	1.	1.	1.	0.	0.	1.	1.
M-XYLENE	4.	4.	4.	4.	0.	0.	4.	4.
O-XYLENE	0.	0.	0.	0.	0.	0.	0.	0.
TPA	30376.	30376.	30376.	30376.	0.	0.	30376.	30376.
CH3ACET	0.	0.	0.	0.	0.	0.	0.	0.
TOLUICAC	174.	174.	174.	174.	0.	0.	235.	235.
4-CBA	68.	68.	68.	68.	0.	0.	1.	1.
HBR	0.	0.	0.	0.	0.	0.	0.	0.
BZIOCAC	139.	139.	139.	139.	0.	0.	139.	139.
PHTHA-01	285.	285.	285.	285.	0.	0.	285.	285.
ISOPH-01	67374.	67374.	67374.	67374.	0.	0.	67374.	67374.
TRIMELAC	0.	0.	0.	0.	0.	0.	0.	0.
METHANOL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	70759.	70759.	70759.	70759.	0.	0.	70767.	70767.
C1P	0.	0.	0.	0.	0.	0.	0.	0.
C2O	0.	0.	0.	0.	0.	0.	0.	0.
C2P	0.	0.	0.	0.	0.	0.	0.	0.
C3P	0.	0.	0.	0.	0.	0.	0.	0.
C4P	0.	0.	0.	0.	0.	0.	0.	0.
C5P	0.	0.	0.	0.	0.	0.	0.	0.
C6P	0.	0.	0.	0.	0.	0.	0.	0.
C7P	0.	0.	0.	0.	0.	0.	0.	0.
C8N	0.	0.	0.	0.	0.	0.	0.	0.
C8P	0.	0.	0.	0.	0.	0.	0.	0.
C9N	0.	0.	0.	0.	0.	0.	0.	0.
C9P	1.	1.	1.	1.	0.	0.	1.	1.
BEN	0.	0.	0.	0.	0.	0.	0.	0.
TOL	0.	0.	0.	0.	0.	0.	0.	0.
EB	18.	18.	18.	18.	0.	0.	18.	18.
PB	0.	0.	0.	0.	0.	0.	0.	0.
MEB	0.	0.	0.	0.	0.	0.	0.	0.
TMB	0.	0.	0.	0.	0.	0.	0.	0.
DEB	0.	0.	0.	0.	0.	0.	0.	0.
DMEB	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	2610.94	3068.46	3068.46	3139.10	868.70	56.37	3097.92	3097.92

Table 5B: Alternative PTA/IPA Combined Production Process Technology – Stream Tables

Stream ID	H-300.->42	H-300.->43	H-300.->44	H-300.->45	H-300.->45A	H-300.->46	H-300.->46A	H-300.->46B
Temperature F	125.60	125.60	125.60	302.00	302.31	512.60	302.31	302.31
Pressure psi	114.00	114.00	70.00	73.00	150.00	975.00	150.00	150.00
Vapor Frac	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MoleFlow lbmol/hr	1.	6.	0.	4526.	4526.	4533.	1479.	2313.
MassFlow lb/hr	8.	116.	0.	169732.	169732.	169856.	27596.	43165.
N2	3.	0.	0.	5.	5.	9.	2.	3.
H2	2.	0.	0.	0.	0.	2.	0.	0.
O2	2.	0.	0.	7.	7.	10.	3.	4.
CO	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
ACETICAC	0.	1.	0.	636.	636.	636.	238.	373.
P-XYLENE	0.	0.	0.	1.	1.	1.	0.	1.
M-XYLENE	0.	0.	0.	3.	3.	4.	1.	2.
O-XYLENE	0.	0.	0.	0.	0.	0.	0.	0.
TPA	0.	0.	0.	30376.	30376.	30376.	227.	356.
CH3ACET	0.	0.	0.	0.	0.	0.	0.	0.
TOLUICAC	0.	0.	0.	235.	235.	235.	88.	137.
4-CBA	0.	0.	0.	1.	1.	1.	0.	0.
HBR	0.	0.	0.	0.	0.	0.	0.	0.
BZIOCAC	0.	0.	0.	139.	139.	139.	52.	81.
PHTHA-01	0.	0.	0.	285.	285.	285.	2.	3.
ISOPH-01	0.	0.	0.	67374.	67374.	67374.	504.	789.
TRIMELAC	0.	0.	0.	0.	0.	0.	0.	0.
METHANOL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	0.	115.	0.	70651.	70651.	70767.	26470.	41403.
C1P	0.	0.	0.	0.	0.	0.	0.	0.
C2O	0.	0.	0.	0.	0.	0.	0.	0.
C2P	0.	0.	0.	0.	0.	0.	0.	0.
C3P	0.	0.	0.	0.	0.	0.	0.	0.
C4P	0.	0.	0.	0.	0.	0.	0.	0.
C5P	0.	0.	0.	0.	0.	0.	0.	0.
C6P	0.	0.	0.	0.	0.	0.	0.	0.
C7P	0.	0.	0.	0.	0.	0.	0.	0.
C8N	0.	0.	0.	0.	0.	0.	0.	0.
C8P	0.	0.	0.	0.	0.	0.	0.	0.
C9N	0.	0.	0.	0.	0.	0.	0.	0.
C9P	0.	0.	0.	1.	1.	1.	0.	1.
BEN	0.	0.	0.	0.	0.	0.	0.	0.
TOL	0.	0.	0.	0.	0.	0.	0.	0.
EB	0.	0.	0.	18.	18.	18.	7.	11.
PB	0.	0.	0.	0.	0.	0.	0.	0.
MEB	0.	0.	0.	0.	0.	0.	0.	0.
TMB	0.	0.	0.	0.	0.	0.	0.	0.
DEB	0.	0.	0.	0.	0.	0.	0.	0.
DMEB	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	62.66	1.93	0.00	2709.27	2709.70	3097.92	510.93	799.19
Enthalpy MMBtu/hr	0.00	-0.78	0.00	-670.79	-670.73	-643.47	-176.73	-276.44

Table 5B: Alternative PTA/IPA Combined Production Process Technology – Stream Tables

Stream ID	H-300.->47	H-300.->48	H-300.->49	H-300.->50	H-300.->51	H-300.->52A	H-300.->52B	H-300.->53
Temperature F	302.31	302.00	125.60	217.40	217.40	217.40	217.40	194.00
Pressure psi	150.00	16.00	16.00	17.00	17.00	17.00	17.00	80.00
Vapor Frac	0.00	0.92	0.00	0.00	0.00	0.00	0.00	0.00
MoleFlow lbmol/hr	733.	2352.	0.	1285.	1799.	623.	1176.	1090.
MassFlow lb/hr	98970.	64146.	0.	67962.	95133.	32943.	62190.	19634.
N2	0.	18.	0.	5.	7.	2.	5.	0.
H2	0.	0.	0.	0.	0.	0.	0.	0.
O2	0.	13.	0.	4.	6.	2.	4.	0.
CO	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
ACETICAC	25.	71.	0.	40.	56.	19.	37.	0.
P-XYLENE	0.	1.	0.	0.	1.	0.	0.	0.
M-XYLENE	0.	3.	0.	1.	2.	1.	1.	0.
O-XYLENE	0.	0.	0.	0.	0.	0.	0.	0.
TPA	29793.	7541.	0.	15557.	21777.	7541.	14236.	0.
CH3ACET	0.	0.	0.	0.	0.	0.	0.	0.
TOLUICAC	10.	3.	0.	5.	7.	3.	5.	0.
4-CBA	0.	0.	0.	0.	0.	0.	0.	0.
HBR	0.	0.	0.	0.	0.	0.	0.	0.
BZIOCAC	6.	1.	0.	3.	4.	1.	3.	0.
PHTHA-01	280.	71.	0.	146.	204.	71.	134.	0.
ISOPH-01	66080.	16726.	0.	34505.	48301.	16726.	31575.	0.
TRIMELAC	0.	0.	0.	0.	0.	0.	0.	0.
METHANOL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	2777.	39684.	0.	17688.	24760.	8574.	16186.	19634.
C1P	0.	0.	0.	0.	0.	0.	0.	0.
C2O	0.	0.	0.	0.	0.	0.	0.	0.
C2P	0.	0.	0.	0.	0.	0.	0.	0.
C3P	0.	0.	0.	0.	0.	0.	0.	0.
C4P	0.	0.	0.	0.	0.	0.	0.	0.
C5P	0.	0.	0.	0.	0.	0.	0.	0.
C6P	0.	0.	0.	0.	0.	0.	0.	0.
C7P	0.	0.	0.	0.	0.	0.	0.	0.
C8N	0.	0.	0.	0.	0.	0.	0.	0.
C8P	0.	0.	0.	0.	0.	0.	0.	0.
C9N	0.	0.	0.	0.	0.	0.	0.	0.
C9P	0.	1.	0.	0.	0.	0.	0.	0.
BEN	0.	0.	0.	0.	0.	0.	0.	0.
TOL	0.	0.	0.	0.	0.	0.	0.	0.
EB	0.	14.	0.	6.	8.	3.	5.	0.
PB	0.	0.	0.	0.	0.	0.	0.	0.
MEB	0.	0.	0.	0.	0.	0.	0.	0.
TMB	0.	0.	0.	0.	0.	0.	0.	0.
DEB	0.	0.	0.	0.	0.	0.	0.	0.
DMEB	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	1096.65	1097452.18	0.01	967.99	1355.00	469.21	885.79	338.76
Enthalpy MMBtu/hr	-217.53	-276.42	0.00	-223.73	-313.18	-108.45	-204.73	-131.62

Table 5B: Alternative PTA/IPA Combined Production Process Technology – Stream Tables

Stream ID	H-300.->57	H-300.->58	H-300.->59	H-300.->60	H-300.->C201TOP	H-300.->E-207F	H-300.->E204HF	H-300.->E204HP
Temperature F	362.24	358.99	125.60	224.04	358.99	357.80	358.99	357.80
Pressure psi	150.00	150.00	150.00	975.00	150.00	150.00	150.00	150.00
Vapor Frac	0.00	1.00	0.00	0.00	1.00	0.01	1.00	0.01
MoleFlow lbmol/hr	148.	409.	563.	4533.	1331.	563.	922.	922.
MassFlow lb/hr	3511.	7404.	10181.	169856.	24085.	10181.	16681.	16681.
N2	0.	1.	1.	9.	2.	1.	1.	1.
H2	0.	0.	0.	2.	0.	0.	0.	0.
O2	0.	1.	1.	10.	3.	1.	2.	2.
CO	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
ACETICAC	102.	42.	58.	636.	137.	58.	95.	95.
P-XYLENE	0.	0.	0.	1.	0.	0.	0.	0.
M-XYLENE	0.	0.	1.	4.	1.	1.	1.	1.
O-XYLENE	0.	0.	0.	0.	0.	0.	0.	0.
TPA	227.	0.	0.	30376.	0.	0.	0.	0.
CH3ACET	0.	0.	0.	0.	0.	0.	0.	0.
TOLUICAC	87.	0.	0.	235.	1.	0.	0.	0.
4-CBA	0.	0.	0.	1.	0.	0.	0.	0.
HBR	0.	0.	0.	0.	0.	0.	0.	0.
BZIOCAC	52.	0.	0.	139.	0.	0.	0.	0.
PHTHA-01	2.	0.	0.	285.	0.	0.	0.	0.
ISOPH-01	504.	0.	0.	67374.	0.	0.	0.	0.
TRIMELAC	0.	0.	0.	0.	0.	0.	0.	0.
METHANOL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	2535.	7358.	10117.	70767.	23935.	10117.	16577.	16577.
C1P	0.	0.	0.	0.	0.	0.	0.	0.
C2O	0.	0.	0.	0.	0.	0.	0.	0.
C2P	0.	0.	0.	0.	0.	0.	0.	0.
C3P	0.	0.	0.	0.	0.	0.	0.	0.
C4P	0.	0.	0.	0.	0.	0.	0.	0.
C5P	0.	0.	0.	0.	0.	0.	0.	0.
C6P	0.	0.	0.	0.	0.	0.	0.	0.
C7P	0.	0.	0.	0.	0.	0.	0.	0.
C8N	0.	0.	0.	0.	0.	0.	0.	0.
C8P	0.	0.	0.	0.	0.	0.	0.	0.
C9N	0.	0.	0.	0.	0.	0.	0.	0.
C9P	0.	0.	0.	1.	0.	0.	0.	0.
BEN	0.	0.	0.	0.	0.	0.	0.	0.
TOL	0.	0.	0.	0.	0.	0.	0.	0.
EB	0.	2.	3.	18.	7.	3.	5.	5.
PB	0.	0.	0.	0.	0.	0.	0.	0.
MEB	0.	0.	0.	0.	0.	0.	0.	0.
TMB	0.	0.	0.	0.	0.	0.	0.	0.
DEB	0.	0.	0.	0.	0.	0.	0.	0.
DMEB	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	65.29	22902.43	168.70	2617.00	74502.58	539.65	51600.15	884.24
Enthalpy MMBtu/hr	-18.43	-41.73	-68.70	-680.05	-135.74	-66.06	-94.01	-108.24

Table 5B: Alternative PTA/IPA Combined Production Process Technology – Stream Tables

Stream ID	H-300.->FILTRATE	H-300.->S202-TPA	H-300.->S202-V	H-300.->S203-TPA	H-300.->S203-V	H-300.->S205-TPA	H-300.->S205-V	H-300.->S206FEED
Temperature F	302.31	338.00	338.00	302.00	302.00	315.96	315.96	217.40
Pressure psi	150.00	117.00	117.00	73.00	73.00	76.00	76.00	17.00
Vapor Frac	0.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
MoleFlow lbmol/hr	3792.	4526.	8.	4526.	0.	3085.	0.	3084.
MassFlow lb/hr	70762.	169732.	125.	169732.	0.	163115.	1.	163095.
N2	5.	5.	4.	5.	0.	18.	0.	12.
H2	0.	0.	2.	0.	0.	0.	0.	0.
O2	7.	7.	2.	7.	0.	13.	0.	11.
CO	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
ACETICAC	611.	636.	1.	636.	0.	96.	0.	96.
P-XYLENE	1.	1.	0.	1.	0.	1.	0.	1.
M-XYLENE	3.	3.	0.	3.	0.	3.	0.	3.
O-XYLENE	0.	0.	0.	0.	0.	0.	0.	0.
TPA	583.	30376.	0.	30376.	0.	37334.	0.	37334.
CH3ACET	0.	0.	0.	0.	0.	0.	0.	0.
TOLUICAC	225.	235.	0.	235.	0.	12.	0.	12.
4-CBA	1.	1.	0.	1.	0.	0.	0.	0.
HBR	0.	0.	0.	0.	0.	0.	0.	0.
BZIOCAC	133.	139.	0.	139.	0.	7.	0.	7.
PHTHA-01	5.	285.	0.	285.	0.	350.	0.	350.
ISOPH-01	1294.	67374.	0.	67374.	0.	82806.	0.	82806.
TRIMELAC	0.	0.	0.	0.	0.	0.	0.	0.
METHANOL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	67875.	70651.	116.	70651.	0.	42460.	0.	42448.
C1P	0.	0.	0.	0.	0.	0.	0.	0.
C2O	0.	0.	0.	0.	0.	0.	0.	0.
C2P	0.	0.	0.	0.	0.	0.	0.	0.
C3P	0.	0.	0.	0.	0.	0.	0.	0.
C4P	0.	0.	0.	0.	0.	0.	0.	0.
C5P	0.	0.	0.	0.	0.	0.	0.	0.
C6P	0.	0.	0.	0.	0.	0.	0.	0.
C7P	0.	0.	0.	0.	0.	0.	0.	0.
C8N	0.	0.	0.	0.	0.	0.	0.	0.
C8P	0.	0.	0.	0.	0.	0.	0.	0.
C9N	0.	0.	0.	0.	0.	0.	0.	0.
C9P	1.	1.	0.	1.	0.	1.	0.	1.
BEN	0.	0.	0.	0.	0.	0.	0.	0.
TOL	0.	0.	0.	0.	0.	0.	0.	0.
EB	18.	18.	0.	18.	0.	14.	0.	13.
PB	0.	0.	0.	0.	0.	0.	0.	0.
MEB	0.	0.	0.	0.	0.	0.	0.	0.
TMB	0.	0.	0.	0.	0.	0.	0.	0.
DEB	0.	0.	0.	0.	0.	0.	0.	0.
DMEB	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	1310.14	2760.76	537.73	2709.27	0.12	2423.19	3.31	2322.99

Table 5B: Alternative PTA/IPA Combined Production Process Technology – Stream Tables

Stream ID	H-300.->V201-V	H-300.->V202-V	H-300.->V203FEED	H-300.->V204-V	H-300.->V204FEED	H-300.->V205-V	H-300.->V206-L	H-300.->V206-V
Temperature F	-459.67	-459.67	125.60	125.60	125.60	-459.67	302.00	-459.67
Pressure psi	15.00	915.00	117.00	70.00	73.00	73.00	76.00	76.00
Vapor Frac	0.00	0.00	0.15	1.00	0.18	0.00	0.00	0.00
MoleFlow lbmol/hr	0.	0.	8.	0.	0.	0.	3085.	0.
MassFlow lb/hr	0.	0.	125.	0.	0.	0.	163115.	0.
N2	0.	0.	4.	0.	0.	0.	18.	0.
H2	0.	0.	2.	0.	0.	0.	0.	0.
O2	0.	0.	2.	0.	0.	0.	13.	0.
CO	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
ACETICAC	0.	0.	1.	0.	0.	0.	96.	0.
P-XYLENE	0.	0.	0.	0.	0.	0.	1.	0.
M-XYLENE	0.	0.	0.	0.	0.	0.	3.	0.
O-XYLENE	0.	0.	0.	0.	0.	0.	0.	0.
TPA	0.	0.	0.	0.	0.	0.	37334.	0.
CH3ACET	0.	0.	0.	0.	0.	0.	0.	0.
TOLUICAC	0.	0.	0.	0.	0.	0.	12.	0.
4-CBA	0.	0.	0.	0.	0.	0.	0.	0.
HBR	0.	0.	0.	0.	0.	0.	0.	0.
BZIOCAC	0.	0.	0.	0.	0.	0.	7.	0.
PHTHA-01	0.	0.	0.	0.	0.	0.	350.	0.
ISOPH-01	0.	0.	0.	0.	0.	0.	82806.	0.
TRIMELAC	0.	0.	0.	0.	0.	0.	0.	0.
METHANOL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	0.	0.	116.	0.	0.	0.	42461.	0.
C1P	0.	0.	0.	0.	0.	0.	0.	0.
C2O	0.	0.	0.	0.	0.	0.	0.	0.
C2P	0.	0.	0.	0.	0.	0.	0.	0.
C3P	0.	0.	0.	0.	0.	0.	0.	0.
C4P	0.	0.	0.	0.	0.	0.	0.	0.
C5P	0.	0.	0.	0.	0.	0.	0.	0.
C6P	0.	0.	0.	0.	0.	0.	0.	0.
C7P	0.	0.	0.	0.	0.	0.	0.	0.
C8N	0.	0.	0.	0.	0.	0.	0.	0.
C8P	0.	0.	0.	0.	0.	0.	0.	0.
C9N	0.	0.	0.	0.	0.	0.	0.	0.
C9P	0.	0.	0.	0.	0.	0.	1.	0.
BEN	0.	0.	0.	0.	0.	0.	0.	0.
TOL	0.	0.	0.	0.	0.	0.	0.	0.
EB	0.	0.	0.	0.	0.	0.	14.	0.
PB	0.	0.	0.	0.	0.	0.	0.	0.
MEB	0.	0.	0.	0.	0.	0.	0.	0.
TMB	0.	0.	0.	0.	0.	0.	0.	0.
DEB	0.	0.	0.	0.	0.	0.	0.	0.
DMEB	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	0.00	0.00	62.94	0.02	0.02	0.00	2408.28	0.00
Enthalpy MMBtu/hr	0.00	0.00	-0.78	0.00	0.00	0.00	-529.58	0.00

Table 5B: Alternative PTA/IPA Combined Production Process Technology – Stream Tables

Stream ID	H-300.->V207-V	H-300.->V207FEED	H-300.->V208-V	H-400.->50G	H-400.->50H	H-400.->50I	H-400.->100	H-400.->101
Temperature F	125.60	125.60	217.40	217.40	127.29	127.42	120.00	320.18
Pressure psi	16.00	76.00	17.00	17.00	14.70	89.70	14.70	89.70
Vapor Frac	1.00	0.15	1.00	0.00	0.00	0.00	0.00	1.00
MoleFlow lbmol/hr	0.	0.	1.	1285.	25154.	25154.	23869.	5849.
MassFlow lb/hr	0.	1.	20.	67962.	497962.	497962.	430000.	105363.
N2	0.	0.	5.	5.	5.	5.	0.	0.
H2	0.	0.	0.	0.	0.	0.	0.	0.
O2	0.	0.	2.	4.	4.	4.	0.	0.
CO	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
ACETICAC	0.	0.	0.	40.	40.	40.	0.	0.
P-XYLENE	0.	0.	0.	0.	0.	0.	0.	0.
M-XYLENE	0.	0.	0.	1.	1.	1.	0.	0.
O-XYLENE	0.	0.	0.	0.	0.	0.	0.	0.
TPA	0.	0.	0.	15557.	15557.	15557.	0.	0.
CH3ACET	0.	0.	0.	0.	0.	0.	0.	0.
TOLUICAC	0.	0.	0.	5.	5.	5.	0.	0.
4-CBA	0.	0.	0.	0.	0.	0.	0.	0.
HBR	0.	0.	0.	0.	0.	0.	0.	0.
BZIOCAC	0.	0.	0.	3.	3.	3.	0.	0.
PHTHA-01	0.	0.	0.	146.	146.	146.	0.	0.
ISOPH-01	0.	0.	0.	34505.	34505.	34505.	0.	0.
TRIMELAC	0.	0.	0.	0.	0.	0.	0.	0.
METHANOL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	0.	0.	12.	17688.	447688.	447688.	430000.	105363.
C1P	0.	0.	0.	0.	0.	0.	0.	0.
C2O	0.	0.	0.	0.	0.	0.	0.	0.
C2P	0.	0.	0.	0.	0.	0.	0.	0.
C3P	0.	0.	0.	0.	0.	0.	0.	0.
C4P	0.	0.	0.	0.	0.	0.	0.	0.
C5P	0.	0.	0.	0.	0.	0.	0.	0.
C6P	0.	0.	0.	0.	0.	0.	0.	0.
C7P	0.	0.	0.	0.	0.	0.	0.	0.
C8N	0.	0.	0.	0.	0.	0.	0.	0.
C8P	0.	0.	0.	0.	0.	0.	0.	0.
C9N	0.	0.	0.	0.	0.	0.	0.	0.
C9P	0.	0.	0.	0.	0.	0.	0.	0.
BEN	0.	0.	0.	0.	0.	0.	0.	0.
TOL	0.	0.	0.	0.	0.	0.	0.	0.
EB	0.	0.	0.	6.	6.	6.	0.	0.
PB	0.	0.	0.	0.	0.	0.	0.	0.
MEB	0.	0.	0.	0.	0.	0.	0.	0.
TMB	0.	0.	0.	0.	0.	0.	0.	0.
DEB	0.	0.	0.	0.	0.	0.	0.	0.
DMEB	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	2.10	0.39	401.86	967.99	8155.65	8156.25	7099.68	529424.16
Enthalpy MMBtu/hr	0.00	0.00	-0.07	-223.73	-3137.99	-3137.85	-2914.26	-597.20

Table 5B: Alternative PTA/IPA Combined Production Process Technology – Stream Tables

Stream ID	H-400.->102	H-400.->103	H-400.->104	H-400.->105	H-400.->105B	H-400.->107	H-400.->107B	H-400.->108
Temperature F	318.13	280.00	280.00	280.00	250.00	250.00	250.00	250.00
Pressure psi	89.70	89.70	89.70	89.70	89.70	89.70	89.70	89.70
Vapor Frac	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MoleFlow lbmol/hr	31304.	31304.	190.	31114.	31114.	301.	301.	30813.
MassFlow lb/hr	653387.	653387.	17286.	636102.	636102.	50062.	50062.	586039.
N2	5.	5.	0.	5.	5.	0.	0.	5.
H2	0.	0.	0.	0.	0.	0.	0.	0.
O2	4.	4.	0.	4.	4.	0.	0.	4.
CO	0.	0.	0.	0.	0.	0.	0.	0.
CO2	0.	0.	0.	0.	0.	0.	0.	0.
ACETICAC	40.	40.	0.	40.	40.	0.	0.	40.
P-XYLENE	0.	0.	0.	0.	0.	0.	0.	0.
M-XYLENE	1.	1.	0.	1.	1.	0.	0.	1.
O-XYLENE	0.	0.	0.	0.	0.	0.	0.	0.
TPA	31114.	31114.	15557.	15557.	15557.	15557.	15557.	0.
CH3ACET	0.	0.	0.	0.	0.	0.	0.	0.
TOLUICAC	5.	5.	0.	5.	5.	0.	0.	5.
4-CBA	0.	0.	0.	0.	0.	0.	0.	0.
HBR	0.	0.	0.	0.	0.	0.	0.	0.
BZIOCAC	3.	3.	0.	3.	3.	0.	0.	3.
PHTHA-01	146.	146.	0.	146.	146.	0.	0.	146.
ISOPH-01	69010.	69010.	0.	69010.	69010.	34505.	34505.	34505.
TRIMELAC	0.	0.	0.	0.	0.	0.	0.	0.
METHANOL	0.	0.	0.	0.	0.	0.	0.	0.
WATER	553051.	553051.	1729.	551323.	551323.	0.	0.	551323.
C1P	0.	0.	0.	0.	0.	0.	0.	0.
C2O	0.	0.	0.	0.	0.	0.	0.	0.
C2P	0.	0.	0.	0.	0.	0.	0.	0.
C3P	0.	0.	0.	0.	0.	0.	0.	0.
C4P	0.	0.	0.	0.	0.	0.	0.	0.
C5P	0.	0.	0.	0.	0.	0.	0.	0.
C6P	0.	0.	0.	0.	0.	0.	0.	0.
C7P	0.	0.	0.	0.	0.	0.	0.	0.
C8N	0.	0.	0.	0.	0.	0.	0.	0.
C8P	0.	0.	0.	0.	0.	0.	0.	0.
C9N	0.	0.	0.	0.	0.	0.	0.	0.
C9P	0.	0.	0.	0.	0.	0.	0.	0.
BEN	0.	0.	0.	0.	0.	0.	0.	0.
TOL	0.	0.	0.	0.	0.	0.	0.	0.
EB	6.	6.	0.	6.	6.	0.	0.	6.
PB	0.	0.	0.	0.	0.	0.	0.	0.
MEB	0.	0.	0.	0.	0.	0.	0.	0.
TMB	0.	0.	0.	0.	0.	0.	0.	0.
DEB	0.	0.	0.	0.	0.	0.	0.	0.
DMEB	0.	0.	0.	0.	0.	0.	0.	0.
VolFlow cuft/hr	11964.54	11651.22	216.87	11379.11	11153.51	490.51	490.51	10396.56
Enthalpy MMBtu/hr	-3839.66	-3865.11	-43.21	-3821.90	-3841.07	-104.61	-104.61	-3736.45

Table 5B: Alternative PTA/IPA Combined Production Process Technology – Stream Tables

Stream ID	H-400.->109	H-400.->110	H-400.->111
Temperature F	120.00	120.00	120.00
Pressure psi	89.70	89.70	89.70
Vapor Frac	0.00	0.00	0.00
MoleFlow lbmol/hr	30813.	421.	30392.
MassFlow lb/hr	586039.	38339.	547700.
N2	5.	0.	5.
H2	0.	0.	0.
O2	4.	0.	4.
CO	0.	0.	0.
CO2	0.	0.	0.
ACETICAC	40.	0.	40.
P-XYLENE	0.	0.	0.
M-XYLENE	1.	0.	1.
O-XYLENE	0.	0.	0.
TPA	0.	0.	0.
CH3ACET	0.	0.	0.
TOLUICAC	5.	0.	5.
4-CBA	0.	0.	0.
HBR	0.	0.	0.
BZIOCAC	3.	0.	3.
PHTHA-01	146.	0.	146.
ISOPH-01	34505.	34505.	0.
TRIMELAC	0.	0.	0.
METHANOL	0.	0.	0.
WATER	551323.	3834.	547489.
C1P	0.	0.	0.
C2O	0.	0.	0.
C2P	0.	0.	0.
C3P	0.	0.	0.
C4P	0.	0.	0.
C5P	0.	0.	0.
C6P	0.	0.	0.
C7P	0.	0.	0.
C8N	0.	0.	0.
C8P	0.	0.	0.
C9N	0.	0.	0.
C9P	0.	0.	0.
BEN	0.	0.	0.
TOL	0.	0.	0.
EB	6.	0.	6.
PB	0.	0.	0.
MEB	0.	0.	0.
TMB	0.	0.	0.
DEB	0.	0.	0.
DMEB	0.	0.	0.
VolFlow cuft/hr	9601.48	460.54	9042.60
Enthalpy MMBtu/hr	-3811.17	-100.31	-3710.86

Figure 5A – Alt. Terephthalic Acid/IPA – pt 1

V-101	S-105	PSA-G104	R-101	C-101	S-101, S102, S-103	S-104	C-102	C-103
Catalyst Dissolver	N2-Expander	N2-Separator	Oxidation Reactor	HP-Acetic Acid Scrubber	Nos 1,2,3 Crystallizers	Belt-Filter	Acetic Acid Stripper	Sovent Dehydrator

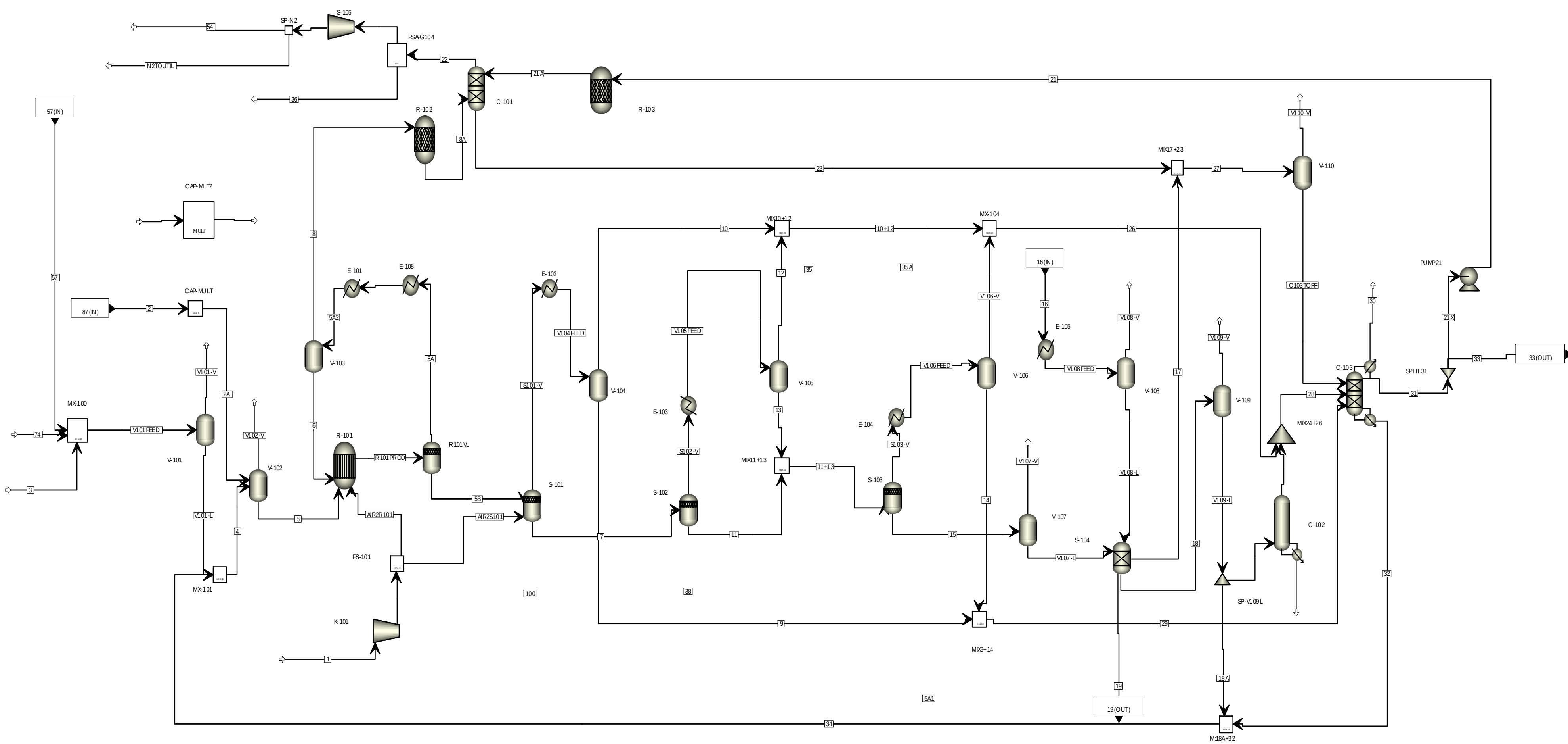


Figure 5B – Alt. Terephthalic Acid/IPA – pt 2

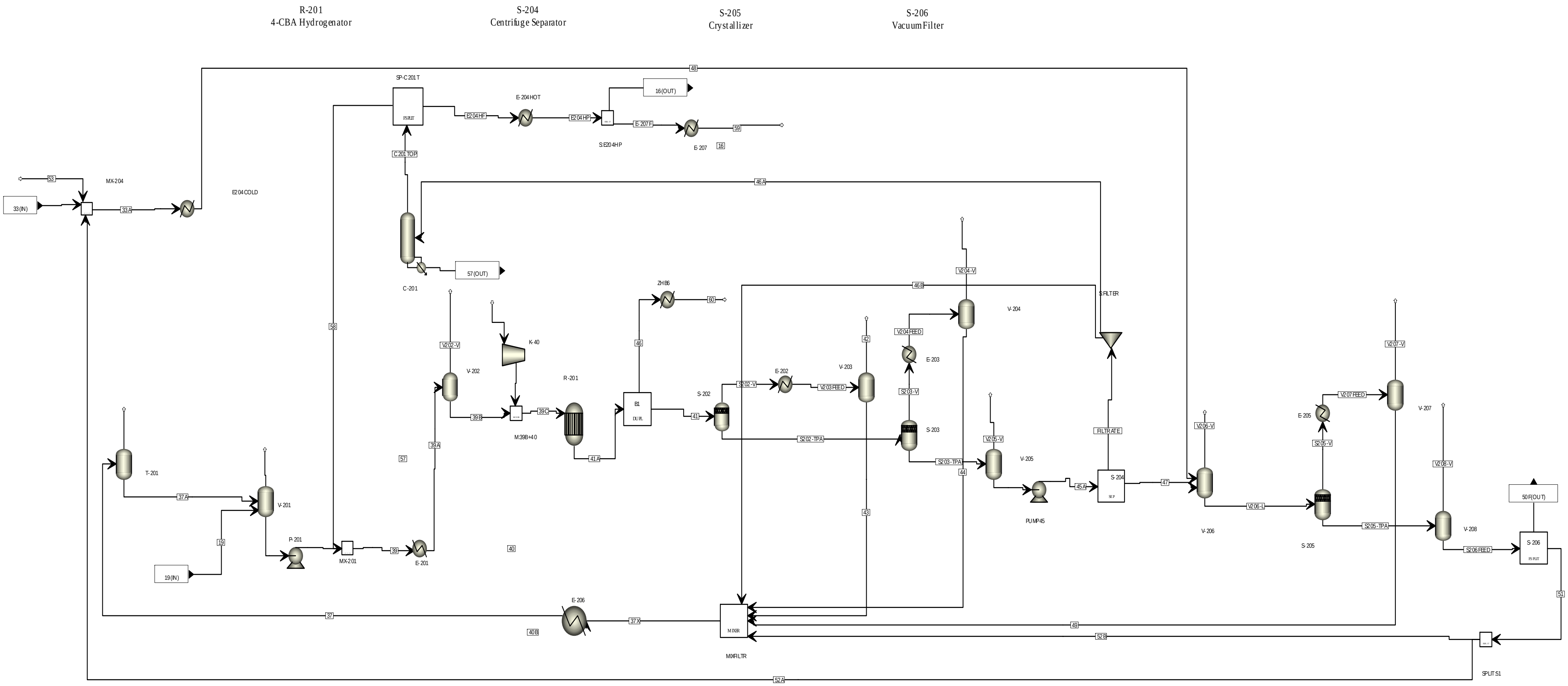


Figure 5C – Alt. Terephthalic Acid/IPA – pt 3

E-301/SEP-301
1st _Crystalizer

E-302/SEP-302
2nd _Crystalizer

E-303/SEP-303
3rd _Crystalizer

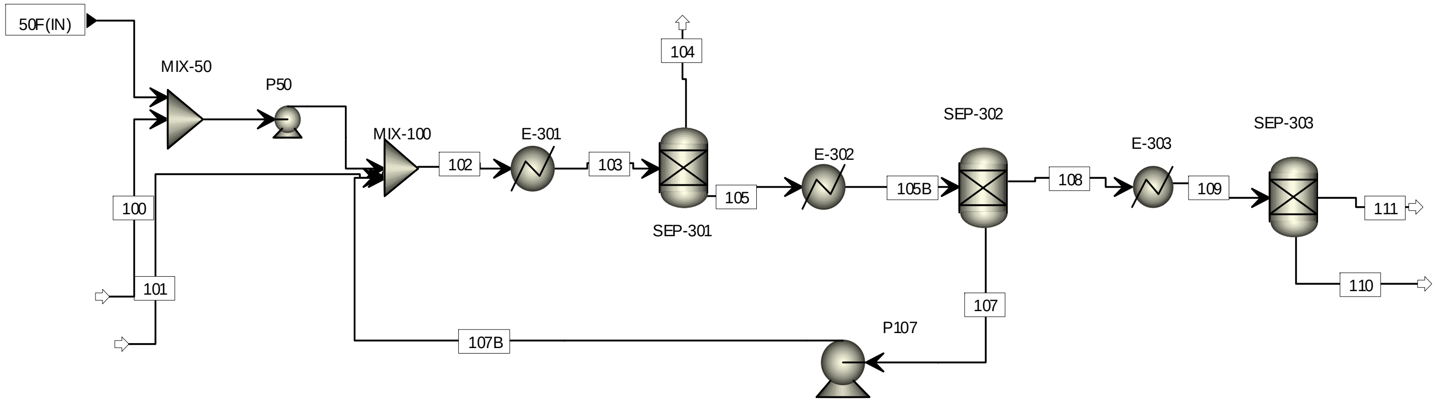


Figure 5D – Base Terephthalic Acid Case – pt 1

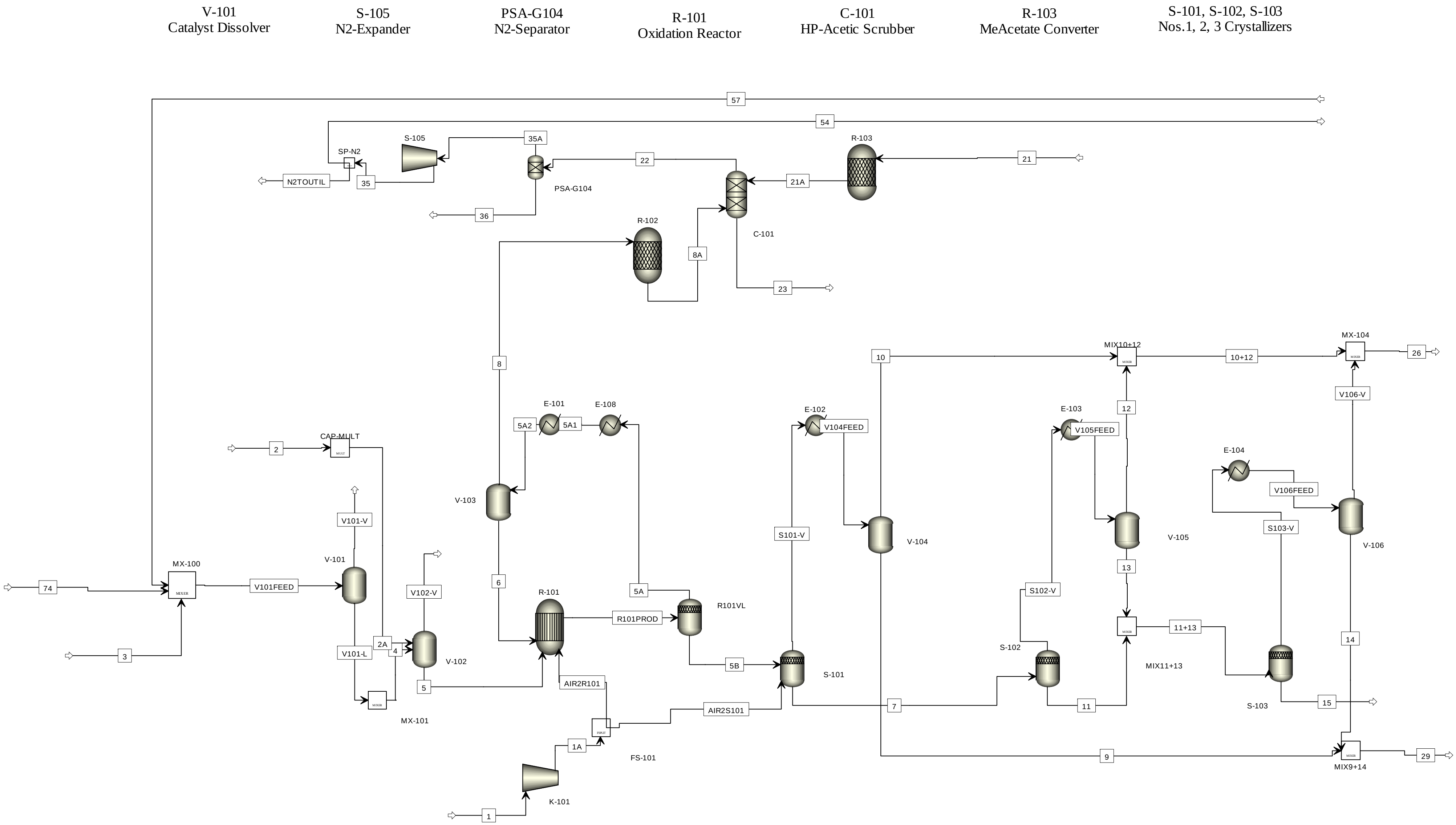


Figure 5E – Base Terephthalic Acid Case – pt 2

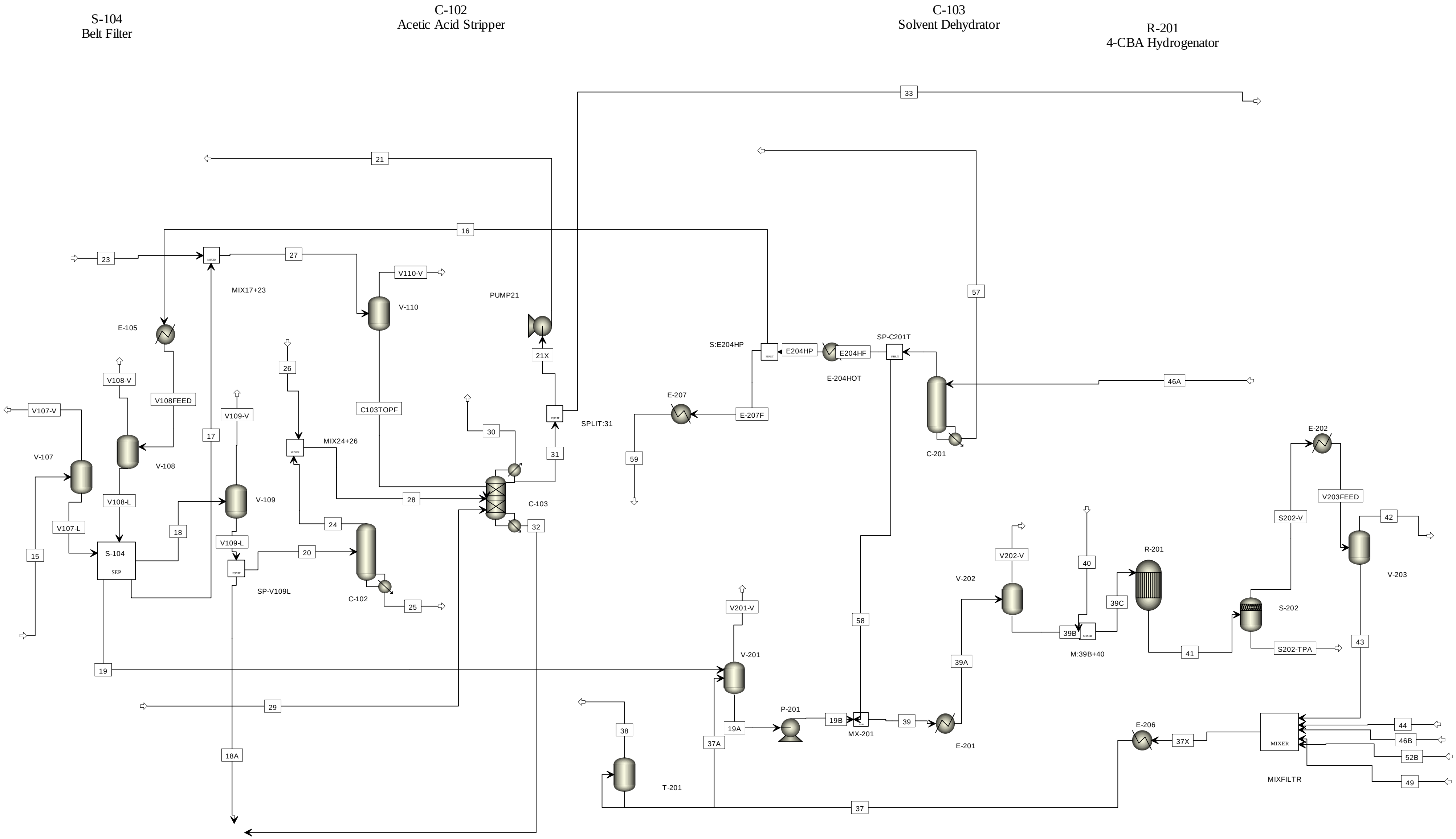
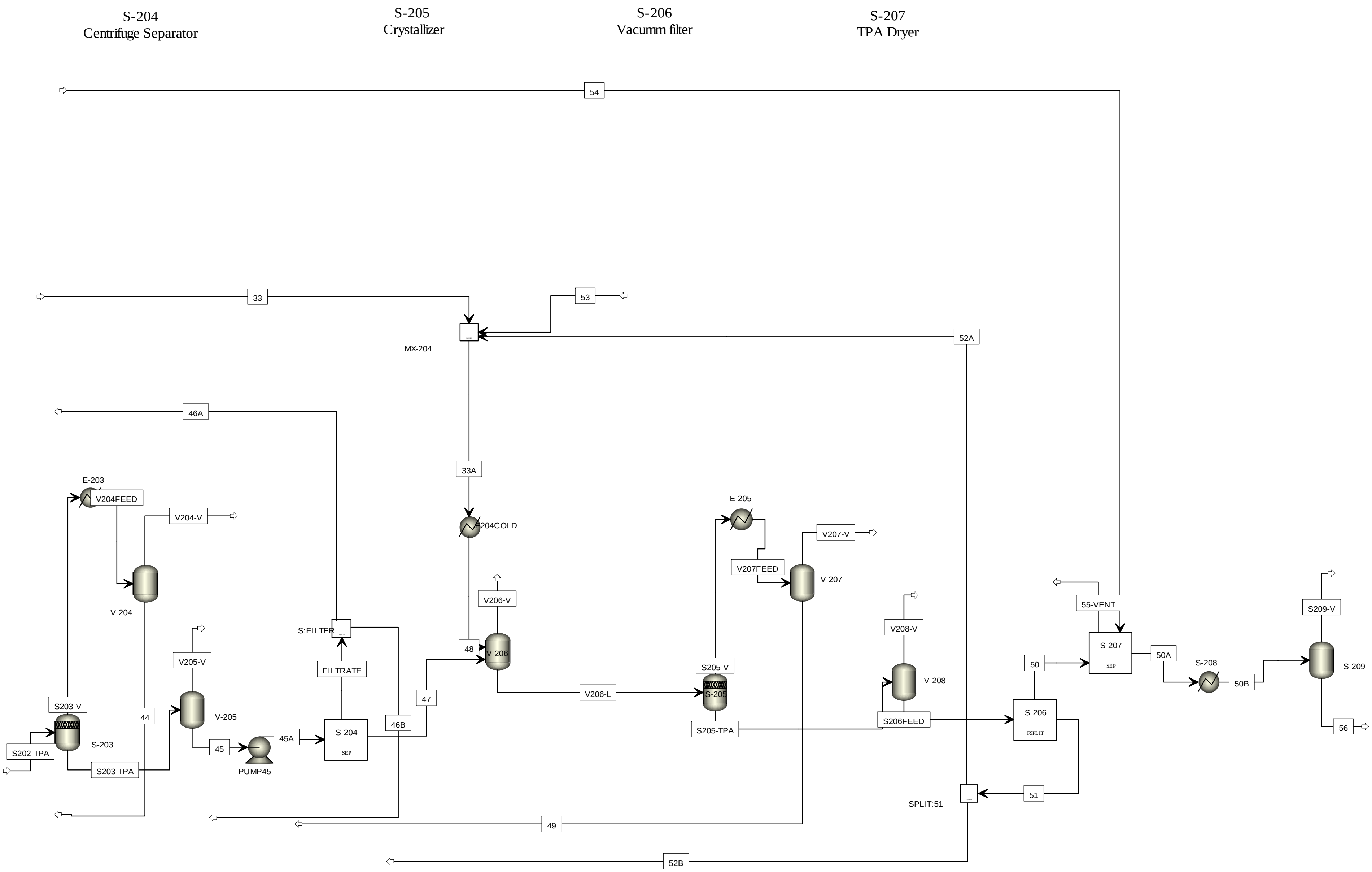


Figure 5F – Base Terephthalic Acid – Part 3



Appendix 6—Fuel and Feedstock Prices used for CPAT

Table 6A: Raw Material, Product, and Utility Prices used for CPAT Cases (based on 2006 prices)

Fuel/Feedstock	Notes	Cost	Unit
Utilities			
Electricity, KWH		$0.0557	per KWH
Fuel/Steam		$8.22	per MM Btu
Chemicals			
Ethylene		$0.55	per lb
Ethane		$0.18	per lb
Propylene	Co-product	$0.45	per lb
Chlorine		$0.17	per lb
Sodium Chloride		$0.02	per lb
Causttic Soda	Co-product	$0.15	per lb
Hydrogen	By-product	$1.27	per lb
Ethylene Oxide		$0.80	per lb
Ethylene		$0.55	per lb
Oxygen		$0.05	per lb
Dilute MEG	By-product	$0.38	per lb
Ammonia		$0.16	per lb
Methane		$0.15	per lb
Terephthalic Acid		$0.42	per lb
PTA/IPA		$0.42	per lb
p-Xylene		$0.52	per lb
Acetic Acid		$0.47	per lb
Mixed Xylenes		$0.31	per lb
o-Xylene	By-product	$0.37	per lb