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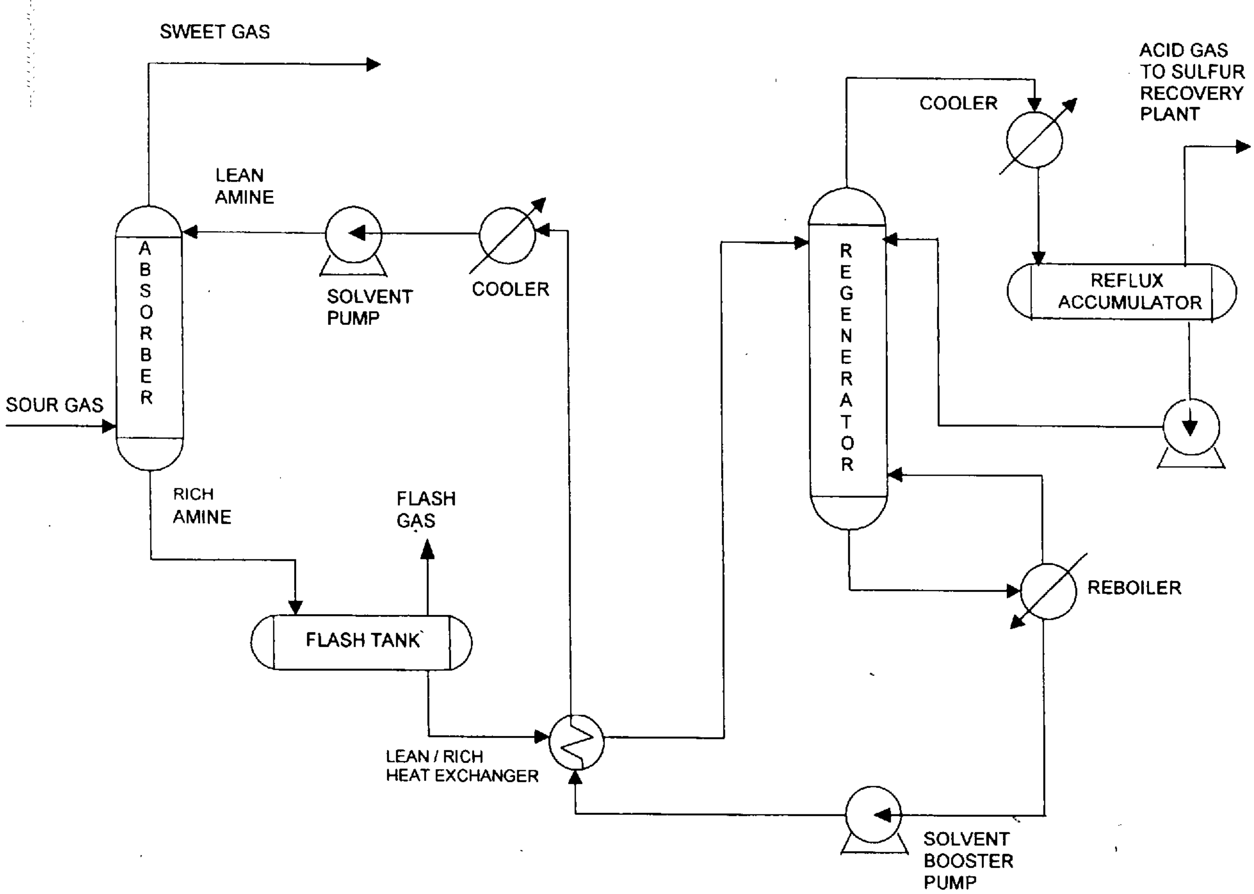
AMINE UNIT AIR EMISSIONS MODEL EVALUATION

HEALTH AND ENVIRONMENTAL SCIENCES DEPARTMENT
PUBLICATION NUMBER 4680
DECEMBER 1998



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Amine Unit Air Emissions Model Evaluation

Health and Environmental Sciences Department

API PUBLICATION NUMBER 4680

PREPARED UNDER CONTRACT BY:

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EXECUTIVE SUMMARY

The implementation of the 1990 Clean Air Act Amendments (CAAA) in the United States has created the need for a reliable method to estimate and report hydrocarbon emissions from amine based sour gas and natural gas liquid (NGL) sweetening units. To address this need, a software simulation package, called Amine Unit Air Emission Model (AMINECalc Version 1.0) was developed for the American Petroleum Institute (API) by DB Robinson Research Ltd. (DBRR).

The output simulated by the AMINECalc Model is designed to suit the needs of regulatory reporting requirements. Thus, the major objective of this project is to develop a reliable and user-friendly software package that will gain acceptance by the US Environmental Protection Agency (EPA) and amine unit operators. With the intention of validating the model, API requested DBRR to evaluate the model prediction by comparing the simulation results with field data collected from operating plants. This report evaluates the model prediction as well as recommends improvements and modifications to the model to refine the predictions.

SECTION 1
INTRODUCTION

The implementation of the 1990 Clean Air Act Amendments (CAAA) in the United States has caused the need for a reliable method to estimate and report hydrocarbon emissions from amine based sour gas and natural gas liquid (NGL) sweetening units. To address this need, a software simulation package, called Amine Unit Air Emission Model (AMINECalc Version 1.0) was developed for the American Petroleum Institute (API) by DB Robinson Research Ltd. (DBRR).

Many of the amine units in the field are fitted with sulfur recovery units (SRUs) to control hydrogen sulfide (H_2S) and/or carbon dioxide (CO_2) and do not release volatile organic compounds (VOCs) and hazardous air pollutants (HAPs) to the atmosphere. However, some amine units do not have SRUs because they are used primarily to remove only CO_2 from natural gas without H_2S; consequently some amine regenerators have the potential to release HAPs and VOCs to the atmosphere. The AMINECalc model was developed primarily for those units having the potential to emit VOCs and HAPs to the atmosphere.

The calculation algorithm of this package is based on AMSIM, a commercial software package developed by DBRR. Equipped with a rigorous non-equilibrium stage model and the Peng-Robinson equation of state, AMSIM was designed to provide accurate and reliable solutions for sour gas and liquefied petroleum gas processes. The emphasis of this commercial software package was on acid gas (H_2S and CO_2) removal, and its predictions have been constantly verified by actual plant data.

The objective of the current project is to develop a PC-based emission model to predict HAPs and VOCs from flash tanks and solvent regenerators of a natural gas sweetening unit. The AMINECalc model was re-engineered from AMSIM and enhanced to accommodate three types of calculations: mass balance calculation, gas process simulation, and NGL process simulation. The emphasis is on HAPs which include benzene, toluene, ethylbenzene and xylenes (BTEX), as well as VOCs emitted from amine units.

Amine unit operators may be required to report the emissions to the appropriate regulatory agencies. In order to gain wide acceptance by end users, special attention has been paid to the program interface design. Extensive computer literacy or simulation experience is not a requirement to operate the AMINECalc simulator. Users with a basic knowledge of Windows™ should be at ease when using the program.

SECTION 2
THE AMINECalc MODEL

Among many treatment processes for sour gas, the absorption technology using aqueous solutions of alkanolamines is popular for economic reasons. The use of simulation software for sweetening processes has steadily increased over the years. This section will provide a general background of the amine process.

2.1 THE AMINE PROCESS

Figure 2-1 presents a process flow diagram of a typical amine-sweetening unit. The system consists of two major unit operations: absorption and regeneration. A feed stream, which is either natural gas or natural gas liquid (NGL) containing acid gases (H_2S and/or CO_2), is introduced into an absorption column where it is counter-currently contacted with an amine solution. The acid gas contents are removed through chemical reactions with the amine. After the absorbing treatment, the natural gas or the NGL is ready for consumer use or for further chemical processing.

This process is often referred to as a gas sweetening process. The treated gas or liquid is called sweetened gas or liquid while the amine solution entering and leaving the column is commonly known as the lean and rich amine solution respectively. After selectively absorbing the acid gases from the stream, the rich amine solution requires regeneration before it can be reused. The function of the regeneration column is to strip absorbed acid gases from the rich amine solution. A flash tank is commonly installed downstream from the absorber to recover dissolved and entrained hydrocarbons and to reduce the hydrocarbon contents of the acid gas product.

Together with other gaseous hydrocarbon species, hazardous air pollutants (HAPs) are potentially emitted from flash tanks and regenerators. Using the comprehensive AMINECalc model, one can estimate hydrocarbon emissions from amine sweetening units.

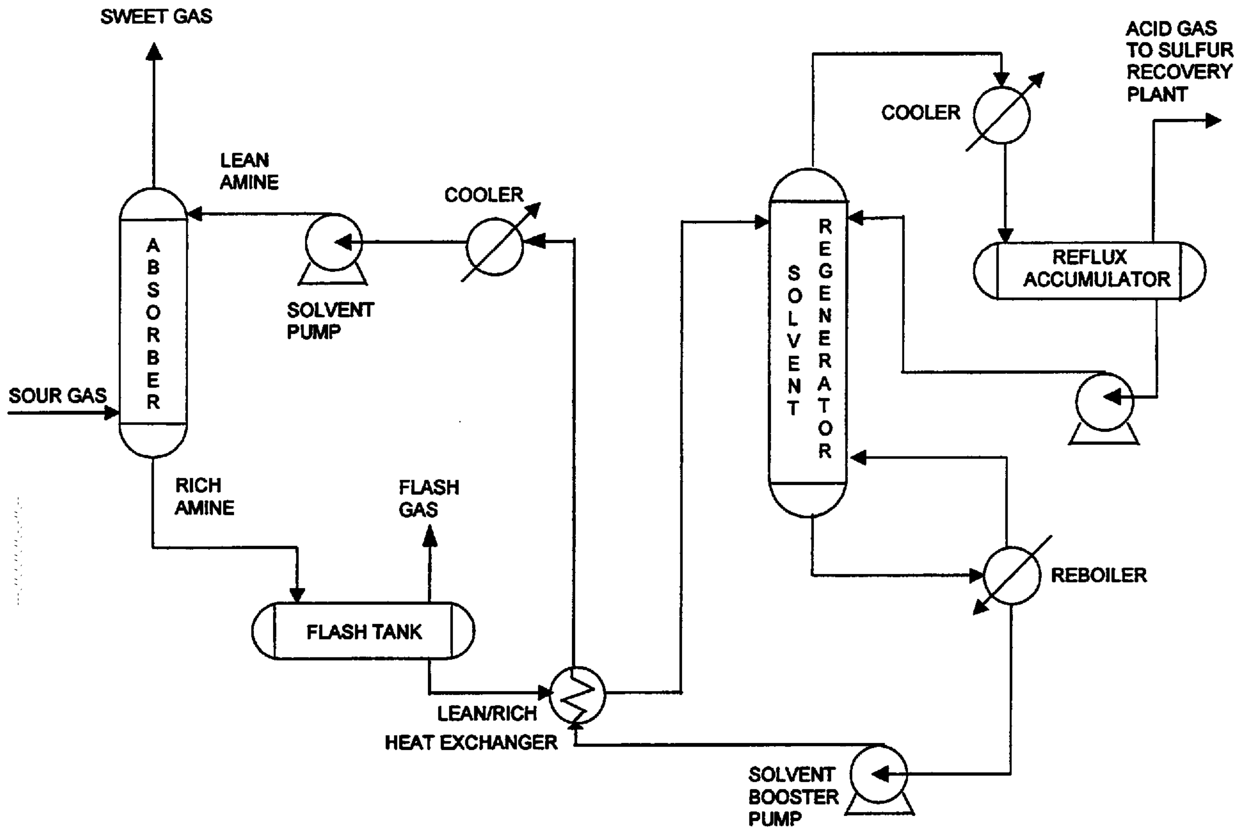

Figure 2-1: Typical Amine Sweetening Unit

2.2 MODEL DESCRIPTIONS

The AMINECalc package offers three options:

- mass balance calculation
- gas process (gas feed) simulation
- NGL (liquid feed) simulation.

The mass balance calculation option is a descriptive calculation that has the flexibility to allow users to specify their cases according to the availability of their plant data. The two simulation options allow users to perform rigorous process modeling that predicts hydrocarbon emissions from amine units based on operating conditions.

Option 1: Mass Balance Calculation

The mass balance calculation option requires input of the flow rates of lean amine stream exiting a regenerator and flow rates and compositions of the rich amine stream exiting an absorption column. As shown in Figure 2-2, a rich amine stream enters a flash tank at a pressure lower than the absorber pressure. By executing a flash calculation on the flash tank, the program calculates the flow rate and compositions of the vent gas. Simulated information of the flashed liquid and the input data of the lean amine stream are used in a mass balance calculation to give an estimate of the contents of the stripped acid gas at the top of the regenerator.

Option 2: Gas Process Simulation

The gas process simulation requires the input of sour gas feed data and lean amine circulation rate as well as the number of trays of the absorber. Figure 2-3 is the flow diagram for the sour gas treating process. The program will rigorously simulate the operation of the absorber column and calculate the hydrocarbon contents in the rich amine stream. The calculated information of the rich amine stream will then be used to predict the flows of the flash gas and the stripped acid gas of the solvent regenerator.

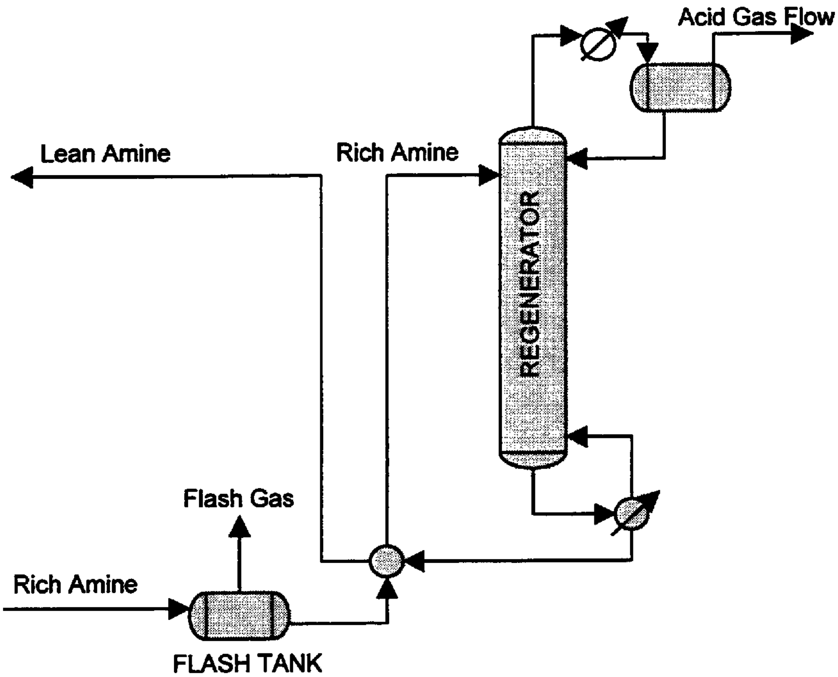

Figure 2-2 Flow Diagram for Mass Balance Calculation

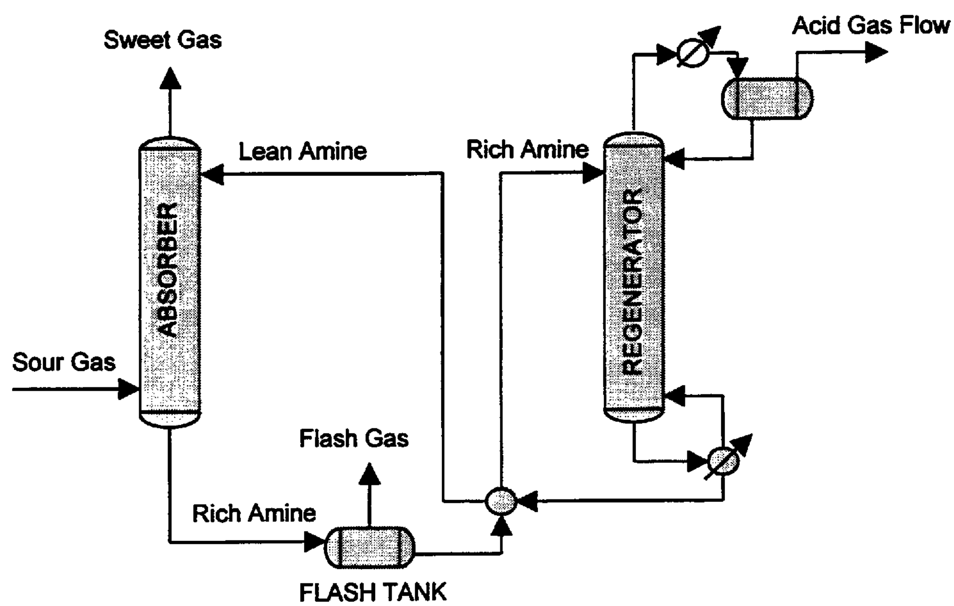

Figure 2-3 Flow Diagram for Sour Gas/NGL Process Simulation

Option 3: NGL Process Simulation

The NGL process simulation has the same flow diagram as shown in Figure 2-3 and requires the same input information. The difference between the NGL Process Simulation and the Gas Process Simulation is that the feed in the NGL Process Simulation is in liquid form and the absorber is a liquid-liquid contactor instead of a vapor-liquid absorption column. Through a liquid-liquid extraction simulation, the contents of the sweetened NGL from the top of the absorber, along with the flash vent and the regenerator vent emissions, are predicted.

2.3 MODEL INPUT REQUIREMENTS

Input requirements for each option are summarized in Table 2-1.

Table 2-1: Program Options and Input Requirements

Input Variables	Option 1 Mass Balance Calculation	Option 2 Gas Process Simulation	Option 3 NGL Process Simulation
Sour Gas Feed			
Flow rate (MMscfd)		X	
Composition (mole%)		X	
Temperature/Pressure (°F/psia)		X	
NGL Feed			
Flow rate (gpm)			X
Composition (mole%)			X
Temperature/Pressure (°F/psia)			X
Lean Amine			
Temperature/Pressure (°F/psia)	X	X	X
Flow rate (gpm)	X	X	X
Amine concentration (wt%)	X	X	X
Acid gas loading (mol acid gas/mol amine)	X	X	X
Rich Amine			
Temperature/Pressure (°F/psia)	X		
Flow rate (gpm)	X		
Composition (mole%)	X		
Absorber			
Tray numbers		X	X
Flash Tank			
Pressure (psia)	X	X	X

SECTION 3
MODEL RESULTS

This section will detail the model results and compare the predictions with actual emissions. A brief description of the model inputs and assumptions used in the model will also be presented.

3.1 MODEL INPUTS

Six sets of real process input data and emissions were used in the model simulation. First three sets of data were provided by Radian Corporation (1-3) and the other three were taken from a SPE paper (4). These data for Cases 1 and 2 were monitored and measured at sites located in Louisiana and Texas respectively. The locations of the amine unit for Cases 3 to 6 are not known.

User-defined stream characteristics and operating parameters are required to run the simulation. Summarized in Table 3-1 is the input data for the six test cases. Most of the lean solvent characteristics were taken from the actual values monitored on-site except for solvent pressure and temperature for some cases. These values were estimated using the pressure and temperature of absorber exit gas. Actual sour gas loadings for all lean solvent feeds were not available and hence were assumed.

Sour gas properties such as flow rate, pressure, and temperature that were used as model inputs were actual site-monitored values except for inlet feed gas temperature for Case 4 to 6. Detailed feed compositions for each test case can be viewed in Table 3-2.

For those unavailable operating parameters, assumptions were made or default values in the program were used. For example, a total of 20 trays were assumed for the absorber in all six test cases.

Table 3-1: Input Data for Case Simulations

Stream Characteristics	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Lean Solvent						
Type of Solvent	DEA	DEA	MEA	DEA	DEA	DEA
Solvent Weight Percent	23.0	32.0	27.2	31.8	32.4	28.5
Lean Solvent Flow Rate (gpm)	122.0	115.28	610.5	99.0	104.0	611.0
Lean Solvent Pressure (psia)	1015.0	1015.0	742.9	1025.0*	1018.0*	1008.0*
Lean Solvent Temperature (°F)	118.0	94.0	101.4	105.0*	110.0*	80.0*
H_2S Loading (mol/mol)	0.000	0.000	0.001	0.000	0.000	0.001
CO_2 Loading (mol/mol)	0.001	0.010	0.010	0.010	0.0010	0.010
Feed Gas						
Feed Gas Flow Rate (MMscfd)	11.07	14.66	107.1	9.52	25.0	54.8
Feed Gas Pressure (psia)	1055.0	1020.0	698.7	1025.0	1023.0	1012.0
Feed Gas Temperature (°F)	84.0	94.0	86.6	105.0*	105.0*	80.0*
Flash Tank						
Operating Pressure (psia)	120	114	53.4	123	122	100.0

* Values were assigned due to the lack of measured data.

Table 3-2: Feed Gas Compositions in Mole Percent

Component	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
H2S	0	0	0.2*	0	0	1.0*
CO2	6.889	7.1495	5.5*	6.98	7.13	10.0*
N2	1.640	0.6824	0*	0	0.37	1.45
O2	0.260	0	0*	0	0	0
C1	81.1	83.7731	87.5*	84	84.51	82.17
C2	6.41	4.3549	5.3*	3.95	4.62	2.68
C3	1.82	1.7814	1.5*	1.75	1.74	0.55
i-C4	0.449	0.4614	0*	0.53*	0.412	0.16
n-C4	0.53	0.5536	0*	0.53*	0.459	0
i-C5	0.274	0.2948	0*	0.235*	0.211	0
n-C5	0.182	0.2030	0*	0.235*	0.137	0.058
Hexanes	0.0641	0.1400	0*	0.19*	0.153	1.0*
n-Heptane	0.0274	0.1094	0*	1.3657*	0.0055*	0.814*
Benzene	0.0350	0.0389	0.0048	0.02	0.0234	0.0275
Toluene	0.0211	0.0272	0.0012	0.0108	0.0168	0.0262
Ethylbenzene	0.0007	0.0011	0.0001	0.0006	0.0013	0.0009
Xylenes	0.0050	0.0154	0.0001	0.0029	0.0090	0.0104
C10+	0.2382	0.2667	0*	0	0	0
n-Hexane	0.0697	0.0828	0.0289	0.2*	0.202	0.053

* Values were assigned due to the lack of measured data or reported data.

The composition of the feed gas for Case 1 and Case 2 was analyzed whereas only BTEX and n-hexane were analyzed for the feed gas in Case 3. In Case 4, feed gas compositions for C4s to C6s were not reported in the paper. As a result, based on typical sour gas compositions and known total feed gas flow rates, values were assumed for those non-measured and non-reported values such as the acid gases, C1, C2, and C3 in Case 3 as well as some other values for other cases.

Isomers of C6 alkanes (except n-C6) were grouped as "hexanes" while p, m, and o-xylenes were put together into "xylenes". The rest of the cyclic components and non-identified HC were considered as C10+ pseudo-component.

Due to a lack of literature data of BTEX solubility in amine solutions, Henry's constant for BTEX and n-hexane in water were employed and adjusted as temperature-independent constants in such a way that simulated emissions match with actual emissions.

3.2 RESULT COMPARISONS

The focus of this evaluation is on HAP predictions. Consequently, only BTEX and n-hexane emissions will be used as comparisons. Gas stream samplings were performed at the flash gas vent and the regenerator vent. Laboratory measurements of these samples will be summarized and compared with the model predictions. Emissions for total HAPs were computed as the sum of BTEX and n-hexane emissions. All predictions were of uncontrolled conditions. Only Cases 1, 3, and 6 reported flash emissions. These results will be compared and presented in both tabular and graphical forms for all six cases. A complete listing of the model runs can be viewed in Appendix A.

Case 1

Simulation results for Case 1 as well as the result comparison with actual emissions from solvent regenerator and flash tank can be viewed from Table 3-3 and Table 3-4 respectively.

Table 3-3: Result Comparisons for Case 1 Regenerator Vent

Species	Lab Measurement, tons/year	Simulation, tons/year
n-Hexane	0.06	0.07
Benzene	7.50	10.71
Toluene	3.50	3.35
Ethylbenzene	0.06	0.21
Xylenes	0.50	0.67
Total BTEX	11.56	14.95
Total HAPs	11.62	15.02

Table 3-4: Result Comparisons for Case 1 Flash Vent

Species	Lab Measurement, tons/year	Simulation, tons/year
n-Hexane	0.17	0.72
Benzene	0.94	2.94
Toluene	0.58	1.79
Ethylbenzene	0.02	0.08
Xylenes	0.14	0.45
Total BTEX	1.68	5.25
Total HAPs	1.85	5.98

As observed from Table 3-3, simulated emissions from the regenerator vent agree extremely well with the measured emissions except for that of ethylbenzene. Predictions within a factor of two for total BTEX and HAPs measurements are considered acceptable. On the other hand, the flash vent predictions are about three times the measured emissions as seen from Table 3-4.

Case 2

Stream samplings were not carried out at the flash gas vent for Case 2. Therefore, only regenerator vent emissions will be compared with predicted values. Measured emissions for Case 2 are controlled emissions as a BTEX stripper was used as the control measure for the amine unit. Shown in Table 3-5 are the controlled emissions that were measured on-site.

Table 3-5: Regenerator Vent Emissions for Case 2

Species	Measurement of Controlled Emissions, tons/year
n-Hexane	Neg.
Benzene	1.97
Toluene	0.85
Ethylbenzene	0.01
Xylenes	0.24

The control factor for each component is determined by the stripping efficiency of the BTEX stripper on the corresponding component. They are reported to differ for the four BTEX components (2). These values are tabulated in Table 3-6.

Table 3-6: BTEX Stripper Efficiency

Species	Stripper Efficiency, %
Benzene	70.1
Toluene	73.9
Ethylbenzene	95.6
xylenes	71.7

Because the program does not allow users to specify an individual control factor for each component to compute its controlled emission, it is necessary to calculate the potential emissions that would occur if no control measures were being employed. The uncontrolled emissions can be computed using the efficiencies of the BTEX stripper and the controlled emissions. As shown in Table 3-7, these uncontrolled emissions were summarized and compared with the program predictions.

Table 3-7: Result Comparisons for Case 2 Regenerator Vent

Species	Uncontrolled Emission, tons/year	Simulation, tons/year
n-Hexane	neg.	0.05
Benzene	6.59	9.37
Toluene	3.26	3.32
Ethylbenzene	0.23	0.26
Xylenes	0.85	1.57
Total BTEX	10.93	14.52
Total HAPs	10.93	14.57

The model predictions for Case 2 are within a factor of two of actual emissions. Predictions for total BTEX and total HAPs were a little higher than the measured emissions because benzene and xylenes were slightly over-predicted.

<u>**Case 3**</u>

The following two tables display the model predictions for Case 3 and also compare the prediction results with plant data. Predictions for n-hexane and benzene are comparable with the measured values especially for the flash vent emissions. However, others were under-predicted. For the regenerator, total BTEX and total HAPs predictions were only half the amount of actual emissions. Flash tank predictions were more agreeable with measured values if compared with the regenerator predictions.

As mentioned in section 3.1, process information especially on feed gas for Case 3 was inadequate. The majority of the simulation input was assumed instead. Thus, it is conceivable that the prediction would not meet the performance expectation.

Table 3-8: Result Comparisons for Case 3 Regenerator Vent

Species	Lab Measurement, tons/year	Simulation, tons/year
n-Hexane	0.13	0.08
Benzene	7.41	3.10
Toluene	3.41	0.66
Ethylbenzene	0.25	0.06
Xylenes	0.55	0.05
Total BTEX	11.62	3.87
Total HAPs	11.75	3.95

Table 3-9: Result Comparisons for Case 3 Flash Vent

Species	Lab Measurement, tons/year	Simulation, tons/year
n-Hexane	1.03	1.20
Benzene	1.70	1.77
Toluene	0.95	0.49
Ethylbenzene	0.13	0.04
Xylenes	0.15	0.04
Total BTEX	2.93	2.34
Total HAPs	3.96	3.54

Case 4

Only regenerator vent emissions were reported for this case. Predictions were generated for Case 4 and these results are presented in the following table. Measured flash vent emissions for this case were not available for comparisons. As observed from the following table, the simulated emissions match the field data very well. Predictions were slightly under-predicted. Predictions for both total BTEX and total HAPs are well within a factor of two of site-measured data.

Table 3-10: Result Comparisons for Case 4 Regenerator Vent

Species	Lab Measurement, tons/year	Simulation, tons/year
n-Hexane	0.16	0.18
Benzene	5.8	4.6
Toluene	2.5	1.4
Ethylbenzene	0.06	0.14
Xylenes	0.51	0.31
Total BTEX	8.87	6.41
Total HAPs	9.0	6.59

Case 5

Only regenerator vent emissions were measured for this case. As a result, there will be only one set of data for comparison. As observed from Table 3-11, most of the predicted emissions match the field data very well except for toluene. Predictions for benzene and toluene were under-predicted. Prediction for total BTEX and total HAPs is considered acceptable as these predictions are within a factor of two of measured emissions.

Table 3-11: Result Comparisons for Case 5 Regenerator Vent

Species	Lab Measurement, tons/year	Simulation, tons/year
n-Hexane	0.10	0.11
Benzene	8.2	6.1
Toluene	5.3	1.7
Ethylbenzene	0.2	0.3
Xylenes	1.5	0.8
Total BTEX	15.2	8.9
Total HAPs	15.3	9.0

Case 6

The following two tables display the result comparisons for Case 6. Predictions for the regenerator vent were reasonable except for toluene. Predictions for toluene are observed to diverge significantly from measured values in regenerator vent. As a result, total BTEX and total HAPs predictions for regenerator vent were lower than the actual emissions.

Table 3-12: Result Comparisons for Case 6 Regenerator Vent

Species	Lab Measurement, tons/year	Simulation, tons/year
n-Hexane	0.12	0.10
Benzene	42.2	41.1
Toluene	34.8	12.2
Ethylbenzene	0.94	1.38
Xylenes	10.3	3.9
Total BTEX	88.24	58.56
Total HAPs	88.36	58.66

Table 3-13: Result Comparisons for Case 6 Flash Vent

Species	Lab Measurement, tons/year	Simulation, tons/year
n-Hexane	0.47	2.35
Benzene	8.1	17.6
Toluene	7.7	13.8
Ethylbenzene	0.18	0.73
Xylenes	2.4	5.6
Total BTEX	18.38	37.71
Total HAPs	18.85	40.06

All of the species were over-predicted for the flash vent emissions. Consequently, total BTEX and total HAPs predictions were more than twice the measured emissions.

Result Comparisons on Individual Component

In order to observe the performance of the prediction for each species separately, results were compared using bar charts. Presented in the following figures are the comparisons for each HAP species, total BTEX, and total HAPs. Shown in Table 3-10 is the nine data sets from the six test cases represented by the x-coordinate of the following bar charts.

Table 3-14: Legend for Bar Chart Abscissa

Data Set	Case
1	Case 1 regenerator vent
2	Case 1 flash vent
3	Case 2 regenerator vent
4	Case 3 regenerator vent
5	Case 3 flash vent
6	Case 4 regenerator vent
7	Case 5 regenerator vent
8	Case 6 regenerator vent
9	Case 6 flash vent

Predictions for the five species, as observed from the following figures, are acceptable when compared with the plant data, except for the last two sets of data (Case 6). Predictions for total BTEX and total HAPs are generally satisfactory.

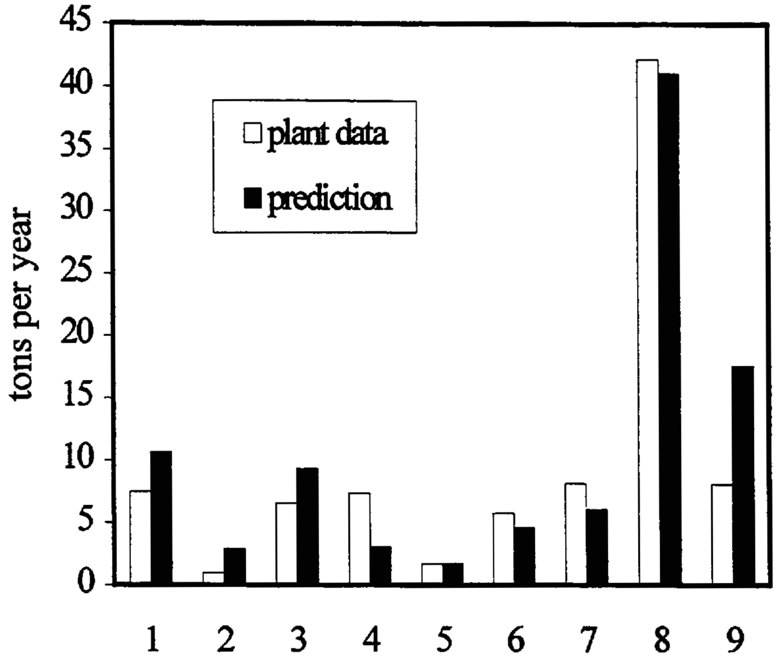

Figure 3-1: Result Comparisons for Benzene

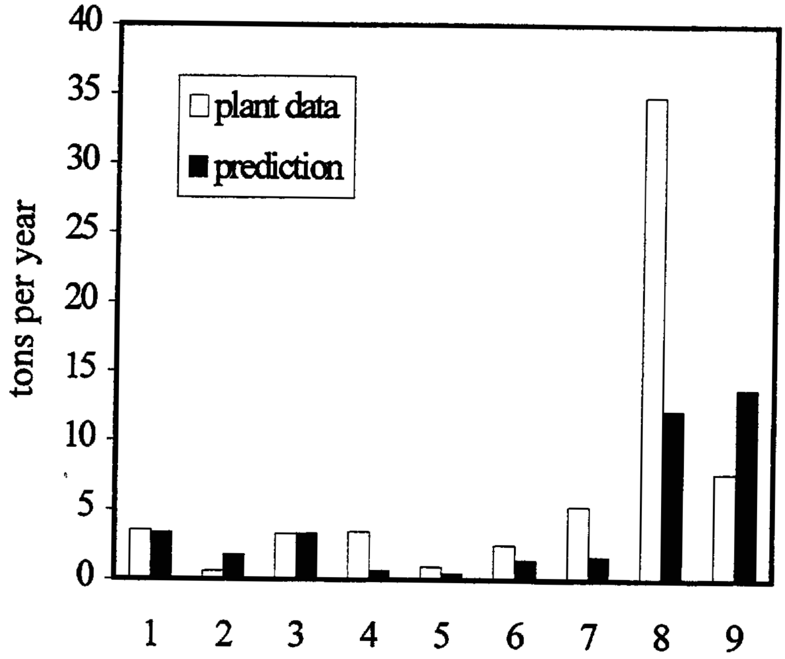

Figure 3-2: Result Comparisons for Toluene

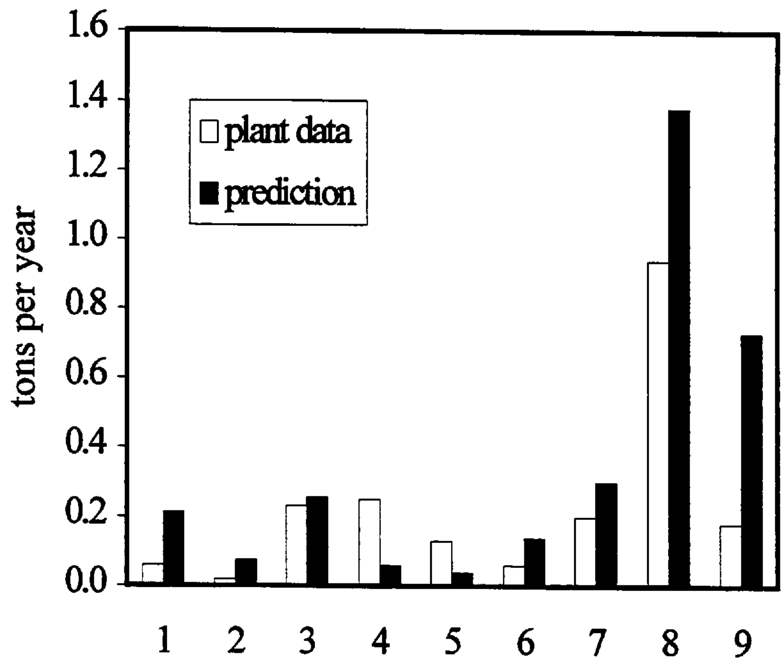

Figure 3-3: Result Comparisons for Ethylbenzene

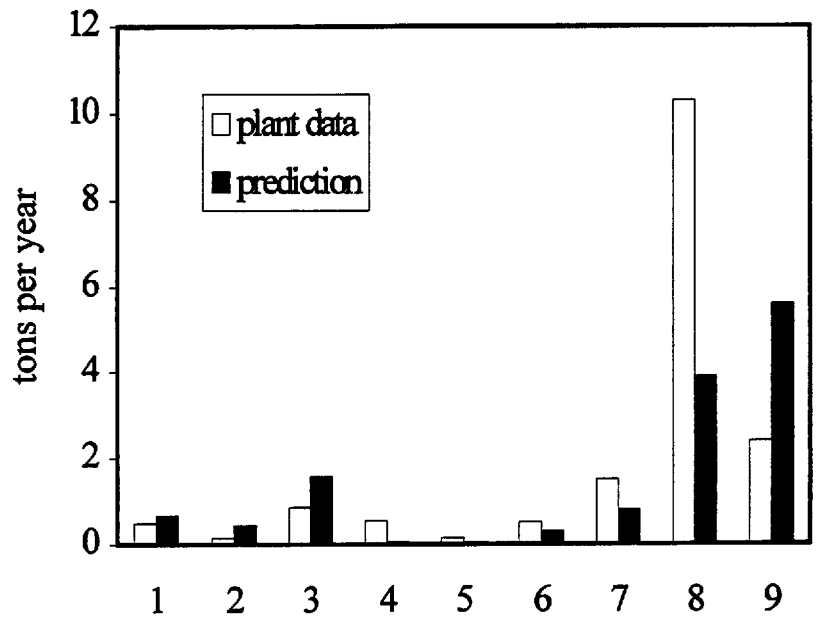

Figure 3-4: Result Comparisons for Xylenes

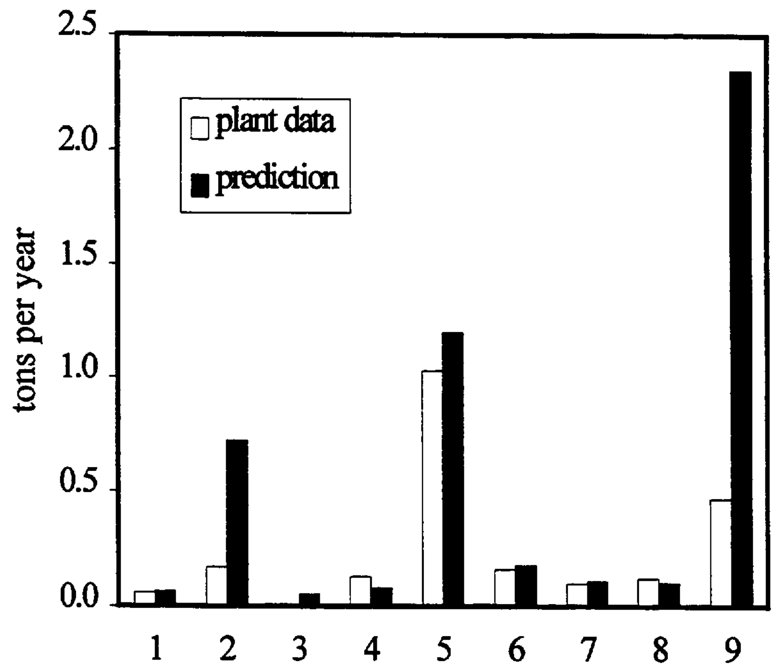

Figure 3-5: Result Comparisons for n-Hexane

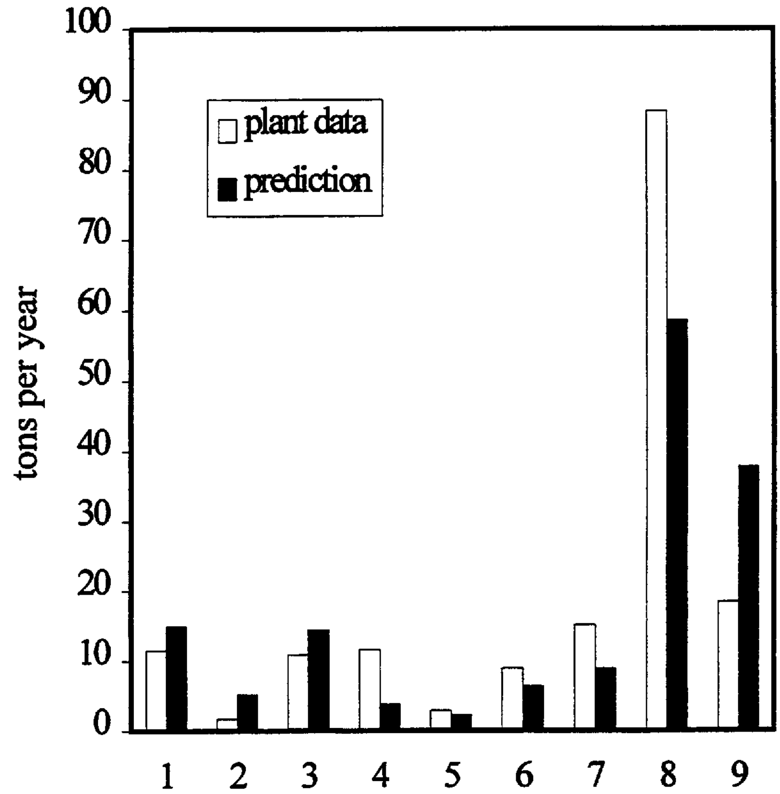

Figure 3-6: Result Comparisons for Total BTEX

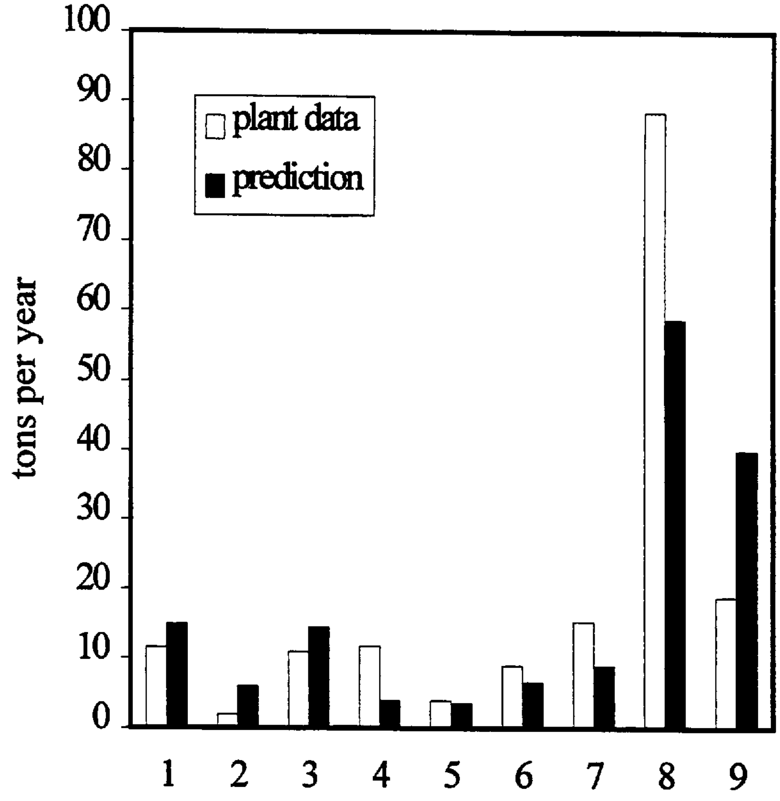

Figure 3-7: Result Comparisons for Total HAPs

3.3 STATISTICAL ANALYSIS ON RESULT COMPARISONS

Results of the comparison for all six cases will be analyzed using average standard deviation for each component as defined in the following:

$$\text{Average Standard Deviation} = \frac{\sum_{i=1}^{n}\left(\frac{|\text{prediction} - \text{actual}|}{\text{actual}} \times 100\%\right)}{n}$$

The variable n, which is the total number of emissions being considered for each component, is nine. Results of the calculations were summarized in Table 3-15.

Table 3-15: Average Standard Deviation for Each Component

	Average Standard Deviation (%)
Benzene	58
Toluene	67
Ethylbenzene	136
Xylenes	92
n-Hexane	78
Total BTEX	63
Total HAPs	64

Predictions within a factor of two of actual emissions are considered acceptable. This acceptance criterion is equivalent to an average standard deviation of 100%. It can be observed from Table 3-15 that only ethylbenzene prediction was out of the acceptable range. Predictions for the other four species were good. It is also observed that predictions for total BTEX and total HAPs are well within the acceptable range.

SECTION 4

DISCUSSION & RECOMMENDATIONS

This section will discuss the model results and recommendations for the AMINECalc model.

4.1 DISCUSSION

Model predictions for all HAPs components except for ethylbenzene are considered acceptable as most of the predictions were within a factor of two of measured emissions. Predictions for Case 3 would have been more refined if sufficient process information was known, especially the feed gas composition.

Model predictions for the total BTEX and HAPs were well within the acceptable limits. However, due to the lack of the experimental vapor-liquid equilibrium (VLE) data for BTEX and n-hexane in amine solutions, an estimation method has been used to calculate emissions of these species. It should be noted that Henry's constants in water were used in the program for these components. Therefore, BTEX emissions predicted by this model should be viewed as guidelines for emission estimates and not for engineering design of amine units. The acquisition of the solubility data of these hydrocarbons in amine solutions will improve the accuracy of the model prediction.

A project sponsored by the Gas Processor's Association (GPA) to experimentally determine the solubility of the HAP species in amine solutions has been implemented. This work is currently conducted at a university in France. The project is to be completed by 1999. As a member of the GPA, DBR will have access to these data once they are available. In order to improve the reliability of the AMINECalc prediction on BTEX and n-hexane, it is highly recommended that the AMINECalc model should then be revised by incorporating these measured values into the property library.

In the process of generating the prediction for Case 2, it was found that the program flexibility could be improved if users are allowed to specify a separate control factor for each component. A new feature as such will take into consideration control measures such as the integration of a BTEX stripper employed in some amine units.

4.2 RECOMMENDATIONS

The following recommendations are proposed for future work on the model:

- Incorporate measured BTEX solubilities in amine solutions when they are available to improve the accuracy of the predictions.
- Add an option to allow users to specify a separate control factor for each of the BTEX components and n-hexane to increase the flexibility of the model.

REFERENCES

1. Radian International LLC, Gas Research Institute, *"BTEX and Other VOC Emissions from a Natural Gas Amine Treater"*, February 1996.

2. Radian International LLC, Report on South-Tex Treaters Inc., fax received December 10, 1997.

3. Radian International LLC, Process Data of a MEA Unit, fax received November 10, 1997.

4. Skinner F.D., Reif D.L., Wilson A.C., Radian International LLC, and Evans J.M., Gas Research Institute, "*Absorption of BTEX and Other Organics and Distribution between Natural Gas Sweetening Unit Streams*", SPE 37881, pp 17-27, March 1997.

APPENDIX A

TEST CASE SIMULATIONS

Test Case 1

Project Name:	AMINECalc Evaluation Test Case #1	
Model:	Gas Model	
Amine:	DEA	
Lean Amine Pressure:	1015.000	[psia]
Lean Amine Temperature:	118.000	[F]
Lean Amine Flowrate:	122.000	[gal/min]
Lean Amine Weight:	23.000	[%]
H2S Loading:	0.000	[mol/mol]
CO2 Loading:	0.001	[mol/mol]
Emission Control Efficiency	95.000	
Operating Hours/Day:	24	[hours/day]
Operating Days/Year:	365	[days/year]
Gas Feed Pressure:	1055.000	[psia]
Gas Feed Temperature:	84.000	[F]
Gas Feed Flowrate:	11.070	[MMSCFD]
Number of Trays in Column:	20	
Flash Tank Pressure:	120.000	[psia]
H2S	0.00000	[%]
CO2	6.88888	[%]
DEA	0.00000	[%]
H2O	0.00000	[%]
N2	1.63973	[%]
O2	0.25996	[%]
C1	81.08686	[%]
C2	6.40896	[%]
C3	1.81971	[%]
i-C4	0.44893	[%]
n-C4	0.52991	[%]
i-C5	0.27396	[%]
n-C5	0.18197	[%]
Hexanes	0.06409	[%]
Heptanes	0.02740	[%]
Octanes	0.00000	[%]
Nonanes	0.00000	[%]
C10+	0.23816	[%]
MeSH	0.00000	[%]
EtSH	0.00000	[%]
Benzene	0.03499	[%]
Toluene	0.02110	[%]
Ethylbenzene	0.00070	[%]
Xylenes	0.00500	[%]
n-C6	0.06969	[%]
224Trimeth	0.00000	[%]

AMINECalc Stream Results

Stream 1 Gas Feed to Absorber

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00000	0.000	0.000
CO2	0.06889	3684.987	16139.970
DEA	0.00000	0.000	0.000
H2O	0.00000	0.000	0.000
N2	0.01640	558.308	2445.349
O2	0.00260	101.106	442.836
C1	0.81087	15811.460	69253.040
C2	0.06409	2342.378	10259.440
C3	0.01820	975.320	4271.831
i-C4	0.00449	317.154	1389.110
n-C4	0.00530	374.364	1639.685
i-C5	0.00274	240.251	1052.283
n-C5	0.00182	159.580	698.948
Hexanes	0.00064	67.131	294.029
Heptanes	0.00027	33.372	146.165
C10+	0.00238	411.876	1803.988
Benzene	0.00035	33.221	145.504
Toluene	0.00021	23.630	103.500
Ethylbenzene	0.00001	0.903	3.956
Xylenes	0.00005	6.452	28.259
n-C6	0.00070	72.997	319.720
Total:	1.00000	25214.500	110437.600

Pressure	1055.000	[psia]
Temperature	84.000	[F]

AMINECalc Stream Results

Stream 2 Rich Amine From Absorber

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00000	0.000	0.000
CO2	0.02879	3677.802	16108.500
DEA	0.04728	14427.920	63193.220
H2O	0.92285	48262.190	211384.800
N2	0.00001	0.788	3.452
O2	0.00000	0.260	1.139
C1	0.00095	44.454	194.703
C2	0.00007	6.347	27.799
C3	0.00002	2.188	9.582
i-C4	0.00000	0.063	0.274
n-C4	0.00000	0.074	0.324
i-C5	0.00000	0.068	0.297
n-C5	0.00000	0.045	0.197
Hexanes	0.00000	0.040	0.176
Heptanes	0.00000	0.013	0.057
C10+	0.00000	0.163	0.713
Benzene	0.00001	3.116	13.646
Toluene	0.00000	1.174	5.144
Ethylbenzene	0.00000	0.065	0.287
Xylenes	0.00000	0.256	1.122
n-C6	0.00000	0.180	0.790
Total:	1.00000	66427.200	290946.200

Pressure	1055.000	[psia]
Temperature	150.166	[F]

AMINECalc Stream Results

Stream 3 Flash Gas Vent Flow from Flash Tank

	----- Controlled -----		----- Uncontrolled -----	
Component	[lb/h]	[ton/yr]	[lb/h]	[ton/yr]
H2S	0.000	0.000	0.000	0.000
CO2	31.241	136.832	31.241	136.832
DEA	0.000	0.000	0.000	0.000
H2O	0.096	0.419	1.913	8.376
N2	0.037	0.164	0.748	3.276
O2	0.012	0.052	0.237	1.037
C1	2.007	8.792	40.144	175.829
C2	0.288	1.260	5.752	25.191
C3	0.101	0.441	2.015	8.825
i-C4	0.003	0.013	0.062	0.272
n-C4	0.004	0.017	0.073	0.322
i-C5	0.003	0.014	0.067	0.294
n-C5	0.002	0.010	0.045	0.195
Hexanes	0.002	0.009	0.039	0.173
Heptanes	0.001	0.003	0.013	0.057
C10+	0.008	0.035	0.160	0.702
Benzene	0.034	0.147	0.671	2.940
Toluene	0.020	0.089	0.409	1.790
Ethylbenzene	0.001	0.003	0.017	0.075
Xylenes	0.005	0.022	0.103	0.449
n-C6	0.008	0.036	0.165	0.722
Total:	33.873	148.359	83.873	367.358

Pressure	120.000	[psia]
Temperature	150.166	[F]

AMINECalc Stream Results

Stream 4 Rich Amine Feed to Regenerator

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00000	0.000	0.000
CO2	0.02858	3646.556	15971.640
DEA	0.04734	14427.920	63193.220
H2O	0.92396	48260.270	211376.400
N2	0.00000	0.040	0.176
O2	0.00000	0.023	0.101
C1	0.00009	4.311	18.883
C2	0.00001	0.596	2.608
C3	0.00000	0.173	0.757
i-C4	0.00000	0.000	0.002
n-C4	0.00000	0.001	0.002
i-C5	0.00000	0.001	0.003
n-C5	0.00000	0.000	0.002
Hexanes	0.00000	0.001	0.004
Heptanes	0.00000	0.000	0.001
C10+	0.00000	0.002	0.011
Benzene	0.00001	2.445	10.708
Toluene	0.00000	0.766	3.354
Ethylbenzene	0.00000	0.048	0.212
Xylenes	0.00000	0.154	0.674
n-C6	0.00000	0.015	0.067
Total:	1.00000	66343.330	290578.800

Pressure	120.000	[psia]
Temperature	150.166	[F]

AMINECalc Stream Results

Stream 5 Acid Gas Flow from Regenerator

Component	----- Controlled ----- [lb/h]	[ton/yr]	----- Uncontrolled ----- [lb/h]	[ton/yr]
H2S	0.000	0.000	0.000	0.000
CO2	3640.516	15945.190	3640.516	15945.190
DEA	0.000	0.000	0.000	0.000
H2O	0.000	0.000	0.000	0.000
N2	0.002	0.009	0.040	0.176
O2	0.001	0.006	0.023	0.101
C1	0.216	0.945	4.311	18.883
C2	0.030	0.130	0.596	2.608
C3	0.009	0.037	0.173	0.757
i-C4	0.000	0.000	0.000	0.002
n-C4	0.000	0.000	0.001	0.002
i-C5	0.000	0.000	0.001	0.003
n-C5	0.000	0.000	0.000	0.002
Hexanes	0.000	0.000	0.001	0.004
Heptanes	0.000	0.000	0.000	0.001
C10+	0.000	0.000	0.002	0.011
Benzene	0.122	0.536	2.445	10.708
Toluene	0.038	0.168	0.766	3.354
Ethylbenzene	0.002	0.011	0.048	0.212
Xylenes	0.008	0.034	0.154	0.674
n-C6	0.001	0.003	0.015	0.067
Total:	3640.945	15947.070	3649.093	15982.760

Pressure	N/A	[psia]
Temperature	N/A	[F]

AMINECalc Stream Results

Stream 6 Lean Amine from Regenerator

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00000	0.000	0.000
CO2	0.00005	6.039	26.452
DEA	0.04869	14427.920	63193.230
H2O	0.95126	48302.170	211559.900
N2	0.00000	0.000	0.000
O2	0.00000	0.000	0.000
C1	0.00000	0.000	0.000
C2	0.00000	0.000	0.000
C3	0.00000	0.000	0.000
i-C4	0.00000	0.000	0.000
n-C4	0.00000	0.000	0.000
i-C5	0.00000	0.000	0.000
n-C5	0.00000	0.000	0.000
Hexanes	0.00000	0.000	0.000
Heptanes	0.00000	0.000	0.000
C10+	0.00000	0.000	0.000
Benzene	0.00000	0.000	0.000
Toluene	0.00000	0.000	0.000
Ethylbenzene	0.00000	0.000	0.000
Xylenes	0.00000	0.000	0.000
n-C6	0.00000	0.000	0.000
Total:	1.00000	62736.130	274779.600

Pressure	1015.000	[psia]
Temperature	118.000	[F]

AMINECalc Stream Results

Stream 7 Sweet Gas Flow from Absorber

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00000	0.000	0.000
CO2	0.00027	13.225	57.923
DEA	0.00000	0.001	0.002
H2O	0.00196	39.987	175.141
N2	0.01760	557.520	2441.897
O2	0.00279	100.846	441.698
C1	0.86888	15767.010	69058.330
C2	0.06868	2336.031	10231.640
C3	0.01951	973.133	4262.249
i-C4	0.00482	317.091	1388.836
n-C4	0.00569	374.290	1639.361
i-C5	0.00294	240.183	1051.985
n-C5	0.00195	159.535	698.751
Hexanes	0.00069	67.091	293.851
Heptanes	0.00029	33.358	146.107
C10+	0.00256	411.714	1803.276
Benzene	0.00034	30.105	131.857
Toluene	0.00022	22.456	98.355
Ethylbenzene	0.00001	0.838	3.671
Xylenes	0.00005	6.196	27.137
n-C6	0.00075	72.816	318.930
Total:	1.00000	21523.430	94271.000

Pressure	1015.000	[psia]
Temperature	118.141	[F]

Test Case 2

Project Name:	AMINECalc Evaluation Test Case #2	
Model:	Gas Model	
Amine:	DEA	
Lean Amine Pressure:	1015.000	[psia]
Lean Amine Temperature:	94.000	[F]
Lean Amine Flowrate:	115.280	[gal/min]
Lean Amine Weight:	32.000	[%]
H2S Loading:	0.000	[mol/mol]
CO2 Loading:	0.010	[mol/mol]
Emission Control Efficiency	95.000	
Operating Hours/Day:	24	[hours/day]
Operating Days/Year:	365	[days/year]
Gas Feed Pressure:	1020.000	[psia]
Gas Feed Temperature:	94.000	[F]
Gas Feed Flowrate:	14.660	[MMSCFD]
Number of Trays in Column:	20	
Flash Tank Pressure:	114.000	[psia]
H2S	0.00000	[%]
CO2	7.14950	[%]
DEA	0.00000	[%]
H2O	0.00000	[%]
N2	0.68240	[%]
O2	0.00000	[%]
C1	83.77310	[%]
C2	4.35490	[%]
C3	1.78140	[%]
i-C4	0.46140	[%]
n-C4	0.55360	[%]
i-C5	0.29480	[%]
n-C5	0.20300	[%]
Hexanes	0.14000	[%]
Heptanes	0.10940	[%]
Octanes	0.05680	[%]
Nonanes	0.00760	[%]
C10+	0.26670	[%]
MeSH	0.00000	[%]
EtSH	0.00000	[%]
Benzene	0.03890	[%]
Toluene	0.02720	[%]
Ethylbenzene	0.00110	[%]
Xylenes	0.01540	[%]
n-C6	0.08280	[%]
224Trimeth	0.00000	[%]

AMINECalc Stream Results

Stream 1 Gas Feed to Absorber

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00000	0.000	0.000
CO2	0.07149	5064.650	22182.790
DEA	0.00000	0.000	0.000
H2O	0.00000	0.000	0.000
N2	0.00682	307.700	1347.702
C1	0.83773	21632.790	94750.010
C2	0.04355	2107.822	9232.104
C3	0.01781	1264.424	5538.085
i-C4	0.00461	431.674	1890.698
n-C4	0.00554	517.933	2268.510
i-C5	0.00295	342.367	1499.544
n-C5	0.00203	235.755	1032.589
Hexanes	0.00140	194.199	850.576
Heptanes	0.00109	176.453	772.852
Octanes	0.00057	104.438	457.431
Nonanes	0.00008	15.690	68.721
C10+	0.00267	610.812	2675.311
Benzene	0.00039	48.910	214.224
Toluene	0.00027	40.341	176.690
Ethylbenzene	0.00001	1.880	8.233
Xylenes	0.00015	26.317	115.267
n-C6	0.00083	114.855	503.056
Total:	1.00000	33239.010	145584.400

Pressure	1020.000	[psia]
Temperature	94.000	[F]

AMINECalc Stream Results

Stream 2 Rich Amine From Absorber

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00000	0.000	0.000
CO2	0.04405	4958.677	21718.640
DEA	0.07131	19177.170	83994.580
H2O	0.88362	40724.430	178370.000
N2	0.00000	0.273	1.197
C1	0.00093	38.252	167.542
C2	0.00005	3.591	15.729
C3	0.00002	1.783	7.808
i-C4	0.00000	0.054	0.236
n-C4	0.00000	0.065	0.283
i-C5	0.00000	0.061	0.268
n-C5	0.00000	0.042	0.184
Hexanes	0.00000	0.073	0.321
Heptanes	0.00000	0.044	0.193
Octanes	0.00000	0.018	0.080
Nonanes	0.00000	0.004	0.018
C10+	0.00000	0.152	0.668
Benzene	0.00001	2.878	12.607
Toluene	0.00001	1.266	5.546
Ethylbenzene	0.00000	0.085	0.374
Xylenes	0.00000	0.660	2.891
n-C6	0.00000	0.179	0.785
Total:	1.00000	64909.760	284299.900

Pressure	1020.000	[psia]
Temperature	150.391	[F]

AMINECalc Stream Results

Stream 3 Flash Gas Vent Flow from Flash Tank

	----- Controlled -----		----- Uncontrolled -----	
Component	[lb/h]	[ton/yr]	[lb/h]	[ton/yr]
H2S	0.000	0.000	0.000	0.000
CO2	55.070	241.205	55.070	241.205
DEA	0.000	0.000	0.000	0.001
H2O	0.102	0.445	2.031	8.897
N2	0.013	0.057	0.262	1.149
C1	1.762	7.718	35.245	154.372
C2	0.166	0.726	3.318	14.533
C3	0.083	0.366	1.669	7.309
i-C4	0.003	0.012	0.054	0.235
n-C4	0.003	0.014	0.064	0.281
i-C5	0.003	0.013	0.061	0.266
n-C5	0.002	0.009	0.042	0.183
Hexanes	0.004	0.015	0.072	0.315
Heptanes	0.002	0.010	0.044	0.191
Octanes	0.001	0.004	0.018	0.079
Nonanes	0.000	0.001	0.004	0.017
C10+	0.008	0.033	0.151	0.660
Benzene	0.037	0.162	0.739	3.237
Toluene	0.025	0.111	0.509	2.228
Ethylbenzene	0.001	0.006	0.026	0.116
Xylenes	0.015	0.066	0.301	1.319
n-C6	0.008	0.036	0.167	0.731
Total:	57.308	251.012	99.847	437.320

Pressure	114.000	[psia]
Temperature	150.391	[F]

AMINECalc Stream Results

Stream 4 Rich Amine Feed to Regenerator

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00000	0.000	0.000
CO2	0.04362	4903.603	21477.420
DEA	0.07141	19177.170	83994.580
H2O	0.88487	40722.400	178361.100
N2	0.00000	0.011	0.050
C1	0.00007	3.008	13.175
C2	0.00000	0.273	1.196
C3	0.00000	0.114	0.498
i-C4	0.00000	0.000	0.001
n-C4	0.00000	0.000	0.002
i-C5	0.00000	0.001	0.002
n-C5	0.00000	0.000	0.001
Hexanes	0.00000	0.001	0.006
Heptanes	0.00000	0.001	0.002
Octanes	0.00000	0.000	0.001
Nonanes	0.00000	0.000	0.000
C10+	0.00000	0.002	0.008
Benzene	0.00001	2.139	9.369
Toluene	0.00000	0.758	3.318
Ethylbenzene	0.00000	0.059	0.258
Xylenes	0.00000	0.359	1.572
n-C6	0.00000	0.012	0.054
Total:	1.00000	64809.910	283862.600

Pressure	114.000	[psia]
Temperature	150.391	[F]

AMINECalc Stream Results

Stream 5 Acid Gas Flow from Regenerator

	----- Controlled -----		----- Uncontrolled -----	
Component	[lb/h]	[ton/yr]	[lb/h]	[ton/yr]
H2S	0.000	0.000	0.000	0.000
CO2	4823.331	21125.830	4823.331	21125.830
DEA	0.000	0.000	0.000	0.000
H2O	0.000	0.000	0.000	0.000
N2	0.001	0.002	0.011	0.050
C1	0.150	0.659	3.008	13.175
C2	0.014	0.060	0.273	1.196
C3	0.006	0.025	0.114	0.498
i-C4	0.000	0.000	0.000	0.001
n-C4	0.000	0.000	0.000	0.002
i-C5	0.000	0.000	0.001	0.002
n-C5	0.000	0.000	0.000	0.001
Hexanes	0.000	0.000	0.001	0.006
Heptanes	0.000	0.000	0.001	0.002
Octanes	0.000	0.000	0.000	0.001
Nonanes	0.000	0.000	0.000	0.000
C10+	0.000	0.000	0.002	0.008
Benzene	0.107	0.468	2.139	9.369
Toluene	0.038	0.166	0.758	3.318
Ethylbenzene	0.003	0.013	0.059	0.258
Xylenes	0.018	0.078	0.359	1.572
n-C6	0.001	0.002	0.012	0.054
Total:	4823.669	21127.300	4830.069	21155.340

Pressure	N/A	[psia]
Temperature	N/A	[F]

AMINECalc Stream Results

Stream 6 Lean Amine from Regenerator

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00000	0.000	0.000
CO2	0.00075	80.273	351.588
DEA	0.07457	19177.170	83994.580
H2O	0.92468	40751.490	178488.500
N2	0.00000	0.000	0.000
C1	0.00000	0.000	0.000
C2	0.00000	0.000	0.000
C3	0.00000	0.000	0.000
i-C4	0.00000	0.000	0.000
n-C4	0.00000	0.000	0.000
i-C5	0.00000	0.000	0.000
n-C5	0.00000	0.000	0.000
Hexanes	0.00000	0.000	0.000
Heptanes	0.00000	0.000	0.000
Octanes	0.00000	0.000	0.000
Nonanes	0.00000	0.000	0.000
C10+	0.00000	0.000	0.000
Benzene	0.00000	0.000	0.000
Toluene	0.00000	0.000	0.000
Ethylbenzene	0.00000	0.000	0.000
Xylenes	0.00000	0.000	0.000
n-C6	0.00000	0.000	0.000
Total:	1.00000	60008.930	262834.700

Pressure 1015.000 [psia]
Temperature 94.000 [F]

AMINECalc Stream Results

Stream 7 Sweet Gas Flow from Absorber

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00000	0.000	0.000
CO2	0.00283	186.245	815.739
DEA	0.00000	0.000	0.001
H2O	0.00100	27.058	118.512
N2	0.00733	307.426	1346.505
C1	0.89877	21594.540	94582.470
C2	0.04673	2104.231	9216.377
C3	0.01912	1262.642	5530.278
i-C4	0.00496	431.620	1890.462
n-C4	0.00595	517.869	2268.226
i-C5	0.00317	342.306	1499.276
n-C5	0.00218	235.713	1032.405
Hexanes	0.00150	194.126	850.256
Heptanes	0.00118	176.409	772.658
Octanes	0.00061	104.420	457.351
Nonanes	0.00008	15.686	68.704
C10+	0.00287	610.660	2674.643
Benzene	0.00039	46.032	201.617
Toluene	0.00028	39.075	171.144
Ethylbenzene	0.00001	1.795	7.860
Xylenes	0.00016	25.657	112.375
n-C6	0.00089	114.676	502.271
Total:	1.00000	28338.180	124119.100

Pressure	1015.000	[psia]
Temperature	95.129	[F]

Test Case 3

Project Name:	AMINECalc Evaluation Test Case #3	
Model:	Gas Model	
Amine:	MEA	
Lean Amine Pressure:	742.900	[psia]
Lean Amine Temperature:	101.400	[F]
Lean Amine Flowrate:	610.500	[gal/min]
Lean Amine Weight:	27.200	[%]
H2S Loading:	0.001	[mol/mol]
CO2 Loading:	0.010	[mol/mol]
Emission Control Efficiency	95.000	
Operating Hours/Day:	24	[hours/day]
Operating Days/Year:	365	[days/year]
Gas Feed Pressure:	698.700	[psia]
Gas Feed Temperature:	86.600	[F]
Gas Feed Flowrate:	107.100	[MMSCFD]
Number of Trays in Column:	20	
Flash Tank Pressure:	53.400	[psia]
H2S	0.19990	[%]
CO2	5.49820	[%]
MEA	0.00000	[%]
H2O	0.00000	[%]
N2	0.00000	[%]
O2	0.00000	[%]
C1	87.46920	[%]
C2	5.29810	[%]
C3	1.49950	[%]
i-C4	0.00000	[%]
n-C4	0.00000	[%]
i-C5	0.00000	[%]
n-C5	0.00000	[%]
Hexanes	0.00000	[%]
Heptanes	0.00000	[%]
Octanes	0.00000	[%]
Nonanes	0.00000	[%]
C10+	0.00000	[%]
MeSH	0.00000	[%]
EtSH	0.00000	[%]
Benzene	0.00480	[%]
Toluene	0.00120	[%]
Ethylbenzene	0.00010	[%]
Xylenes	0.00010	[%]
n-C6	0.02890	[%]
224Trimeth	0.00000	[%]

AMINECalc Stream Results

Stream 1 Gas Feed to Absorber

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00200	801.013	3508.375
CO2	0.05498	28454.420	124628.300
MEA	0.00000	0.000	0.000
H2O	0.00000	0.000	0.000
C1	0.87469	165013.200	722745.400
C2	0.05298	18734.040	82053.710
C3	0.01500	7775.591	34056.510
Benzene	0.00005	44.091	193.114
Toluene	0.00001	13.002	56.948
Ethylbenzene	0.00000	1.248	5.468
Xylenes	0.00000	1.248	5.468
n-C6	0.00029	292.868	1282.740
Total:	1.00000	221130.700	968536.000

Pressure	698.700	[psia]
Temperature	86.600	[F]

Stream 2 Rich Amine From Absorber

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00172	847.680	3712.774
CO2	0.04560	29056.690	127266.200
MEA	0.09461	83687.750	366546.100
H2O	0.85740	223700.400	979791.300
C1	0.00063	146.665	642.381
C2	0.00004	15.887	69.584
C3	0.00001	5.327	23.332
Benzene	0.00000	1.111	4.866
Toluene	0.00000	0.262	1.146
Ethylbenzene	0.00000	0.023	0.100
Xylenes	0.00000	0.020	0.088
n-C6	0.00000	0.292	1.281
Total:	1.00000	337462.200	1478059.000

Pressure	698.700	[psia]
Temperature	169.983	[F]

AMINECalc Stream Results

Stream 3 Flash Gas Vent Flow from Flash Tank

	----- Controlled -----		----- Uncontrolled -----	
Component	[lb/h]	[ton/yr]	[lb/h]	[ton/yr]
H2S	0.693	3.035	13.855	60.682
CO2	92.613	405.639	92.613	405.639
MEA	0.020	0.088	0.401	1.758
H2O	1.181	5.174	23.626	103.480
C1	6.912	30.272	138.234	605.453
C2	0.751	3.288	15.013	65.757
C3	0.254	1.114	5.088	22.284
Benzene	0.020	0.088	0.404	1.768
Toluene	0.006	0.024	0.111	0.486
Ethylbenzene	0.001	0.002	0.010	0.044
Xylenes	0.000	0.002	0.010	0.042
n-C6	0.014	0.060	0.274	1.199
Total:	102.465	448.787	289.638	1268.595

Pressure	53.400	[psia]
Temperature	169.983	[F]

Stream 4 Rich Amine Feed to Regenerator

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00169	833.841	3652.160
CO2	0.04549	28964.010	126860.200
MEA	0.09469	83687.350	366544.400
H2O	0.85809	223676.800	979687.900
C1	0.00004	8.442	36.974
C2	0.00000	0.875	3.833
C3	0.00000	0.240	1.050
Benzene	0.00000	0.707	3.097
Toluene	0.00000	0.151	0.660
Ethylbenzene	0.00000	0.013	0.056
Xylenes	0.00000	0.010	0.046
n-C6	0.00000	0.019	0.082
Total:	1.00000	337172.500	1476790.000

Pressure	53.400	[psia]
Temperature	169.983	[F]

AMINECalc Stream Results

Stream 5 Acid Gas Flow from Regenerator

	----- Controlled -----		----- Uncontrolled -----	
Component	[lb/h]	[ton/yr]	[lb/h]	[ton/yr]
H2S	39.358	172.384	787.159	3447.696
CO2	28361.100	124219.500	28361.100	124219.500
MEA	0.000	0.000	0.000	0.000
H2O	0.000	0.000	0.000	0.000
C1	0.422	1.849	8.442	36.974
C2	0.044	0.192	0.875	3.833
C3	0.012	0.053	0.240	1.050
Benzene	0.035	0.155	0.707	3.097
Toluene	0.008	0.033	0.151	0.660
Ethylbenzene	0.001	0.003	0.013	0.056
Xylenes	0.001	0.002	0.010	0.046
n-C6	0.001	0.004	0.019	0.082
Total:	28400.980	124394.200	29158.710	127713.000

Pressure	N/A	[psia]
Temperature	N/A	[F]

Stream 6 Lean Amine from Regenerator

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00010	46.682	204.464
CO2	0.00099	602.911	2640.704
MEA	0.09915	83689.680	366554.600
H2O	0.89976	223993.000	981072.500
C1	0.00000	0.000	0.000
C2	0.00000	0.000	0.000
C3	0.00000	0.000	0.000
Benzene	0.00000	0.000	0.000
Toluene	0.00000	0.000	0.000
Ethylbenzene	0.00000	0.000	0.000
Xylenes	0.00000	0.000	0.000
n-C6	0.00000	0.000	0.000
Total:	1.00000	308332.200	1350472.000

Pressure	742.900	[psia]
Temperature	101.400	[F]

AMINECalc Stream Results

Stream 7 Sweet Gas Flow from Absorber

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00000	0.015	0.065
CO2	0.00000	0.639	2.800
MEA	0.00000	1.929	8.448
H2O	0.00146	292.513	1281.185
C1	0.92618	164866.500	722103.000
C2	0.05610	18718.150	81984.120
C3	0.01588	7770.264	34033.180
Benzene	0.00005	42.980	188.250
Toluene	0.00001	12.740	55.801
Ethylbenzene	0.00000	1.226	5.368
Xylenes	0.00000	1.228	5.380
n-C6	0.00031	292.576	1281.459
Total:	1.00000	192000.800	840949.100

Pressure	742.900	[psia]
Temperature	101.423	[F]

Test Case 4

Project Name:	AMINECalc Evaluation Test Case #4	
Model:	Gas Model	
Amine:	DEA	
Lean Amine Pressure:	1025.000	[psia]
Lean Amine Temperature:	105.000	[F]
Lean Amine Flowrate:	99.000	[gal/min]
Lean Amine Weight:	31.800	[%]
H2S Loading:	0.000	[mol/mol]
CO2 Loading:	0.010	[mol/mol]
Emission Control Efficiency	95.000	
Operating Hours/Day:	24	[hours/day]
Operating Days/Year:	365	[days/year]
Gas Feed Pressure:	1025.000	[psia]
Gas Feed Temperature:	105.000	[F]
Gas Feed Flowrate:	9.520	[MMSCFD]
Number of Trays in Column:	20	
Flash Tank Pressure:	123.000	[psia]
H2S	0.00000	[%]
CO2	6.98000	[%]
DEA	0.00000	[%]
H2O	0.00000	[%]
N2	0.00000	[%]
O2	0.00000	[%]
C1	84.00000	[%]
C2	3.95000	[%]
C3	1.75000	[%]
i-C4	0.53000	[%]
n-C4	0.53000	[%]
i-C5	0.23500	[%]
n-C5	0.23500	[%]
Hexanes	0.19000	[%]
Heptanes	1.36570	[%]
Octanes	0.00000	[%]
Nonanes	0.00000	[%]
C10+	0.00000	[%]
MeSH	0.00000	[%]
EtSH	0.00000	[%]
Benzene	0.02000	[%]
Toluene	0.01080	[%]
Ethylbenzene	0.00060	[%]
Xylenes	0.00290	[%]
n-C6	0.20000	[%]
224Trimeth	0.00000	[%]

AMINECalc Stream Results

Stream 1 Gas Feed to Absorber

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00000	0.000	0.000
CO2	0.06980	3210.940	14063.680
DEA	0.00000	0.000	0.000
H2O	0.00000	0.000	0.000
C1	0.84000	14086.080	61696.000
C2	0.03950	1241.526	5437.793
C3	0.01750	806.626	3532.964
i-C4	0.00530	322.001	1410.338
n-C4	0.00530	322.001	1410.338
i-C5	0.00235	177.229	776.251
n-C5	0.00235	177.229	776.251
Hexanes	0.00190	171.149	749.622
Heptanes	0.01366	1430.442	6265.227
Benzene	0.00020	16.330	71.523
Toluene	0.00011	10.402	45.559
Ethylbenzene	0.00001	0.666	2.917
Xylenes	0.00003	3.218	14.096
n-C6	0.00200	180.157	789.075
Total:	1.00000	22156.000	97041.630

Pressure 1025.000 [psia]
Temperature 105.000 [F]

Stream 2 Rich Amine From Absorber

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00000	0.000	0.000
CO2	0.03395	3254.807	14255.810
DEA	0.07145	16362.250	71665.440
H2O	0.89357	35068.130	153595.800
C1	0.00095	33.318	145.930
C2	0.00004	2.828	12.384
C3	0.00002	1.519	6.652
i-C4	0.00000	0.054	0.238
n-C4	0.00000	0.054	0.238
i-C5	0.00000	0.043	0.187
n-C5	0.00000	0.043	0.187
Hexanes	0.00000	0.086	0.377
Heptanes	0.00000	0.482	2.112
Benzene	0.00001	1.283	5.619
Toluene	0.00000	0.440	1.927
Ethylbenzene	0.00000	0.040	0.176
Xylenes	0.00000	0.109	0.476
n-C6	0.00000	0.380	1.663
Total:	1.00000	54725.860	239695.200

Pressure 1025.000 [psia]
Temperature 151.217 [F]

AMINECalc Stream Results

Stream 3 Flash Gas Vent Flow from Flash Tank

Component	----- Controlled ----- [lb/h]	[ton/yr]	----- Uncontrolled ----- [lb/h]	[ton/yr]
H2S	0.000	0.000	0.000	0.000
CO2	7.401	32.415	7.401	32.415
DEA	0.000	0.000	0.000	0.000
H2O	0.057	0.249	1.137	4.979
C1	1.468	6.431	29.364	128.610
C2	0.125	0.548	2.503	10.962
C3	0.069	0.301	1.372	6.007
i-C4	0.003	0.012	0.054	0.236
n-C4	0.003	0.012	0.054	0.236
i-C5	0.002	0.009	0.042	0.184
n-C5	0.002	0.009	0.042	0.184
Hexanes	0.004	0.019	0.084	0.367
Heptanes	0.024	0.104	0.473	2.072
Benzene	0.012	0.051	0.232	1.017
Toluene	0.006	0.029	0.130	0.569
Ethylbenzene	0.000	0.002	0.009	0.040
Xylenes	0.002	0.008	0.037	0.164
n-C6	0.017	0.074	0.339	1.486
Total:	9.195	40.271	43.272	189.530

Pressure	123.000	[psia]
Temperature	151.217	[F]

Stream 4 Rich Amine Feed to Regenerator

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00000	0.000	0.000
CO2	0.03391	3247.403	14223.380
DEA	0.07152	16362.250	71665.440
H2O	0.89444	35066.990	153590.800
C1	0.00011	3.955	17.324
C2	0.00000	0.325	1.422
C3	0.00000	0.147	0.645
i-C4	0.00000	0.001	0.002
n-C4	0.00000	0.001	0.002
i-C5	0.00000	0.001	0.002
n-C5	0.00000	0.001	0.002
Hexanes	0.00000	0.002	0.011
Heptanes	0.00000	0.009	0.040
Benzene	0.00001	1.051	4.601
Toluene	0.00000	0.310	1.358
Ethylbenzene	0.00000	0.031	0.137
Xylenes	0.00000	0.071	0.313
n-C6	0.00000	0.040	0.177
Total:	1.00000	54682.590	239505.700

Pressure	123.000	[psia]
Temperature	151.217	[F]

AMINECalc Stream Results

Stream 5 Acid Gas Flow from Regenerator

	----- Controlled -----		----- Uncontrolled -----	
Component	[lb/h]	[ton/yr]	[lb/h]	[ton/yr]
H2S	0.000	0.000	0.000	0.000
CO2	3178.913	13923.400	3178.913	13923.400
DEA	0.000	0.000	0.000	0.000
H2O	0.000	0.000	0.000	0.000
C1	0.198	0.866	3.955	17.324
C2	0.016	0.072	0.325	1.422
C3	0.007	0.032	0.147	0.645
i-C4	0.000	0.000	0.001	0.002
n-C4	0.000	0.000	0.001	0.002
i-C5	0.000	0.000	0.001	0.002
n-C5	0.000	0.000	0.001	0.002
Hexanes	0.000	0.000	0.002	0.011
Heptanes	0.000	0.002	0.009	0.040
Benzene	0.053	0.230	1.051	4.601
Toluene	0.015	0.068	0.310	1.358
Ethylbenzene	0.002	0.007	0.031	0.137
Xylenes	0.004	0.015	0.071	0.313
n-C6	0.002	0.009	0.040	0.177
Total:	3179.210	13924.710	3184.858	13949.440

Pressure	N/A	[psia]
Temperature	N/A	[F]

Stream 6 Lean Amine from Regenerator

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00000	0.000	0.000
CO2	0.00074	68.490	299.980
DEA	0.07394	16362.250	71665.440
H2O	0.92532	35091.370	153697.600
C1	0.00000	0.000	0.000
C2	0.00000	0.000	0.000
C3	0.00000	0.000	0.000
i-C4	0.00000	0.000	0.000
n-C4	0.00000	0.000	0.000
i-C5	0.00000	0.000	0.000
n-C5	0.00000	0.000	0.000
Hexanes	0.00000	0.000	0.000
Heptanes	0.00000	0.000	0.000
Benzene	0.00000	0.000	0.000
Toluene	0.00000	0.000	0.000
Ethylbenzene	0.00000	0.000	0.000
Xylenes	0.00000	0.000	0.000
n-C6	0.00000	0.000	0.000
Total:	1.00000	51522.110	225663.000

Pressure	1025.000	[psia]
Temperature	105.000	[F]

AMINECalc Stream Results

Stream 7 Sweet Gas Flow from Absorber

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00000	0.000	0.000
CO2	0.00058	24.624	107.849
DEA	0.00000	0.000	0.001
H2O	0.00133	23.243	101.801
C1	0.90126	14052.770	61550.070
C2	0.04238	1238.699	5425.408
C3	0.01879	805.108	3526.312
i-C4	0.00570	321.946	1410.101
n-C4	0.00570	321.946	1410.101
i-C5	0.00253	177.187	776.065
n-C5	0.00253	177.187	776.065
Hexanes	0.00204	171.063	749.245
Heptanes	0.01468	1429.959	6263.115
Benzene	0.00020	15.047	65.905
Toluene	0.00011	9.962	43.632
Ethylbenzene	0.00001	0.626	2.740
Xylenes	0.00003	3.109	13.619
n-C6	0.00215	179.778	787.413
Total:	1.00000	18952.250	83009.440

Pressure	1025.000	[psia]
Temperature	105.217	[F]

Test Case 5

Project Name:	AMINECalc Evaluation Test Case #5	
Model:	Gas Model	
Amine:	DEA	
Lean Amine Pressure:	1018.000	[psia]
Lean Amine Temperature:	110.000	[F]
Lean Amine Flowrate:	104.000	[gal/min]
Lean Amine Weight:	32.400	[%]
H2S Loading:	0.000	[mol/mol]
CO2 Loading:	0.001	[mol/mol]
Emission Control Efficiency	95.000	
Operating Hours/Day:	24	[hours/day]
Operating Days/Year:	365	[days/year]
Gas Feed Pressure:	1023.000	[psia]
Gas Feed Temperature:	105.000	[F]
Gas Feed Flowrate:	25.000	[MMSCFD]
Number of Trays in Column:	20	
Flash Tank Pressure:	122.000	[psia]
H2S	0.00000	[%]
CO2	7.13000	[%]
DEA	0.00000	[%]
H2O	0.00000	[%]
N2	0.37000	[%]
O2	0.00000	[%]
C1	84.51000	[%]
C2	4.62000	[%]
C3	1.74000	[%]
i-C4	0.41200	[%]
n-C4	0.45900	[%]
i-C5	0.21100	[%]
n-C5	0.13700	[%]
Hexanes	0.15300	[%]
Heptanes	0.00550	[%]
Octanes	0.00000	[%]
Nonanes	0.00000	[%]
C10+	0.00000	[%]
MeSH	0.00000	[%]
EtSH	0.00000	[%]
Benzene	0.02340	[%]
Toluene	0.01680	[%]
Ethylbenzene	0.00130	[%]
Xylenes	0.00900	[%]
n-C6	0.20200	[%]
224Trimeth	0.00000	[%]

AMINECalc Stream Results

Stream 1 Gas Feed to Absorber

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00000	0.000	0.000
CO2	0.07130	8613.295	37725.590
DEA	0.00000	0.000	0.000
H2O	0.00000	0.000	0.000
N2	0.00370	284.509	1246.128
C1	0.84510	37215.350	163000.500
C2	0.04620	3813.325	16702.080
C3	0.01740	2106.137	9224.726
i-C4	0.00412	657.326	2879.041
n-C4	0.00459	732.313	3207.476
i-C5	0.00211	417.882	1830.290
n-C5	0.00137	271.326	1188.387
Hexanes	0.00153	361.923	1585.196
Heptanes	0.00005	15.128	66.259
Benzene	0.00023	50.173	219.755
Toluene	0.00017	42.490	186.104
Ethylbenzene	0.00001	3.788	16.593
Xylenes	0.00009	26.228	114.877
n-C6	0.00202	477.833	2092.874
Total:	1.00000	55089.030	241285.800

Pressure	1023.000	[psia]
Temperature	105.000	[F]

Stream 2 Rich Amine From Absorber

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00000	0.000	0.000
CO2	0.04643	4685.451	20521.930
DEA	0.07268	17519.970	76736.190
H2O	0.87983	36347.930	159201.200
N2	0.00000	0.135	0.592
C1	0.00098	35.976	157.571
C2	0.00005	3.586	15.707
C3	0.00002	1.655	7.249
i-C4	0.00000	0.040	0.174
n-C4	0.00000	0.044	0.194
i-C5	0.00000	0.036	0.159
n-C5	0.00000	0.023	0.103
Hexanes	0.00000	0.079	0.346
Heptanes	0.00000	0.002	0.008
Benzene	0.00001	1.768	7.744
Toluene	0.00000	0.645	2.825
Ethylbenzene	0.00000	0.106	0.465
Xylenes	0.00000	0.318	1.394
n-C6	0.00000	0.362	1.584
Total:	1.00000	58598.130	256655.500

Pressure	1023.000	[psia]
Temperature	140.929	[F]

AMINECalc Stream Results

Stream 3 Flash Gas Vent Flow from Flash Tank

	----- Controlled -----		----- Uncontrolled -----	
Component	[lb/h]	[ton/yr]	[lb/h]	[ton/yr]
H2S	0.000	0.000	0.000	0.000
CO2	43.237	189.373	43.237	189.373
DEA	0.000	0.000	0.000	0.000
H2O	0.065	0.285	1.303	5.709
N2	0.006	0.029	0.129	0.565
C1	1.639	7.180	32.789	143.611
C2	0.164	0.718	3.276	14.350
C3	0.077	0.336	1.534	6.717
i-C4	0.002	0.009	0.040	0.173
n-C4	0.002	0.010	0.044	0.193
i-C5	0.002	0.008	0.036	0.157
n-C5	0.001	0.006	0.023	0.101
Hexanes	0.004	0.017	0.077	0.338
Heptanes	0.000	0.000	0.002	0.008
Benzene	0.019	0.085	0.385	1.688
Toluene	0.013	0.056	0.257	1.124
Ethylbenzene	0.001	0.006	0.028	0.120
Xylenes	0.007	0.032	0.144	0.631
n-C6	0.017	0.074	0.336	1.473
Total:	45.256	198.222	83.639	366.332

Pressure	122.000	[psia]
Temperature	140.929	[F]

Stream 4 Rich Amine Feed to Regenerator

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00000	0.000	0.000
CO2	0.04607	4642.209	20332.530
DEA	0.07278	17519.970	76736.190
H2O	0.88105	36346.630	159195.500
N2	0.00000	0.006	0.028
C1	0.00009	3.189	13.967
C2	0.00000	0.310	1.358
C3	0.00000	0.121	0.531
i-C4	0.00000	0.000	0.001
n-C4	0.00000	0.000	0.001
i-C5	0.00000	0.000	0.001
n-C5	0.00000	0.000	0.001
Hexanes	0.00000	0.002	0.008
Heptanes	0.00000	0.000	0.000
Benzene	0.00001	1.383	6.056
Toluene	0.00000	0.388	1.702
Ethylbenzene	0.00000	0.079	0.345
Xylenes	0.00000	0.174	0.764
n-C6	0.00000	0.025	0.111
Total:	1.00000	58514.490	256289.100

Pressure	122.000	[psia]
Temperature	140.929	[F]

AMINECalc Stream Results

Stream 5 Acid Gas Flow from Regenerator

	----- Controlled -----		----- Uncontrolled -----	
Component	[lb/h]	[ton/yr]	[lb/h]	[ton/yr]
H2S	0.000	0.000	0.000	0.000
CO2	4634.875	20300.410	4634.875	20300.410
DEA	0.000	0.000	0.000	0.000
H2O	0.000	0.000	0.000	0.000
N2	0.000	0.001	0.006	0.028
C1	0.159	0.699	3.189	13.967
C2	0.016	0.068	0.310	1.358
C3	0.006	0.026	0.121	0.531
i-C4	0.000	0.000	0.000	0.001
n-C4	0.000	0.000	0.000	0.001
i-C5	0.000	0.000	0.000	0.001
n-C5	0.000	0.000	0.000	0.001
Hexanes	0.000	0.000	0.002	0.008
Heptanes	0.000	0.000	0.000	0.000
Benzene	0.069	0.303	1.383	6.056
Toluene	0.019	0.085	0.388	1.702
Ethylbenzene	0.004	0.018	0.079	0.345
Xylenes	0.009	0.039	0.174	0.764
n-C6	0.001	0.006	0.025	0.111
Total:	4635.158	20301.650	4640.554	20325.280

Pressure	N/A	[psia]
Temperature	N/A	[F]

Stream 6 Lean Amine from Regenerator

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00000	0.000	0.000
CO2	0.00008	7.334	32.121
DEA	0.07590	17519.990	76736.240
H2O	0.92403	36554.040	160104.000
N2	0.00000	0.000	0.000
C1	0.00000	0.000	0.000
C2	0.00000	0.000	0.000
C3	0.00000	0.000	0.000
i-C4	0.00000	0.000	0.000
n-C4	0.00000	0.000	0.000
i-C5	0.00000	0.000	0.000
n-C5	0.00000	0.000	0.000
Hexanes	0.00000	0.000	0.000
Heptanes	0.00000	0.000	0.000
Benzene	0.00000	0.000	0.000
Toluene	0.00000	0.000	0.000
Ethylbenzene	0.00000	0.000	0.000
Xylenes	0.00000	0.000	0.000
n-C6	0.00000	0.000	0.000
Total:	1.00000	54081.360	236872.400

Pressure	1018.000	[psia]
Temperature	110.000	[F]

AMINECalc Stream Results

Stream 7 Sweet Gas Flow from Absorber

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00000	0.000	0.000
CO2	0.03377	3935.177	17235.780
DEA	0.00000	0.011	0.051
H2O	0.00432	206.115	902.767
N2	0.00383	284.374	1245.536
C1	0.87531	37179.370	162842.900
C2	0.04785	3809.739	16686.370
C3	0.01803	2104.482	9217.477
i-C4	0.00427	657.287	2878.867
n-C4	0.00476	732.268	3207.282
i-C5	0.00219	417.845	1830.132
n-C5	0.00142	271.302	1188.285
Hexanes	0.00159	361.844	1584.850
Heptanes	0.00006	15.126	66.251
Benzene	0.00023	48.405	212.012
Toluene	0.00017	41.845	183.279
Ethylbenzene	0.00001	3.682	16.128
Xylenes	0.00009	25.910	113.482
n-C6	0.00209	477.471	2091.290
Total:	1.00000	50572.260	221502.700

Pressure	1018.000	[psia]
Temperature	150.291	[F]

Test Case 6

Project Name:	AMINECalc Evaluation Test Case #6	
Model:	Gas Model	
Amine:	DEA	
Lean Amine Pressure:	1008.000	[psia]
Lean Amine Temperature:	80.000	[F]
Lean Amine Flowrate:	611.000	[gal/min]
Lean Amine Weight:	28.500	[%]
H2S Loading:	0.001	[mol/mol]
CO2 Loading:	0.010	[mol/mol]
Emission Control Efficiency	95.000	
Operating Hours/Day:	24	[hours/day]
Operating Days/Year:	365	[days/year]
Gas Feed Pressure:	1012.000	[psia]
Gas Feed Temperature:	80.000	[F]
Gas Feed Flowrate:	54.800	[MMSCFD]
Number of Trays in Column:	15	
Flash Tank Pressure:	100.000	[psia]
H2S	1.00000	[%]
CO2	10.00000	[%]
DEA	0.00000	[%]
H2O	0.00000	[%]
N2	1.45000	[%]
O2	0.00000	[%]
C1	82.17000	[%]
C2	2.68000	[%]
C3	0.55000	[%]
i-C4	0.16000	[%]
n-C4	0.00000	[%]
i-C5	0.00000	[%]
n-C5	0.05800	[%]
Hexanes	1.00000	[%]
Heptanes	0.81400	[%]
Octanes	0.00000	[%]
Nonanes	0.00000	[%]
C10+	0.00000	[%]
MeSH	0.00000	[%]
EtSH	0.00000	[%]
Benzene	0.02750	[%]
Toluene	0.02620	[%]
Ethylbenzene	0.00090	[%]
Xylenes	0.01040	[%]
n-C6	0.05300	[%]
224Trimeth	0.00000	[%]

AMINECalc Stream Results

Stream 1 Gas Feed to Absorber

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.01000	2050.301	8980.165
CO2	0.10000	26480.140	115981.100
DEA	0.00000	0.000	0.000
H2O	0.00000	0.000	0.000
N2	0.01450	2444.009	10704.580
C1	0.82170	79317.280	347403.800
C2	0.02680	4848.833	21237.530
C3	0.00550	1459.287	6391.569
i-C4	0.00160	559.557	2450.819
n-C5	0.00058	251.790	1102.824
Hexanes	0.01000	5185.199	22710.780
Heptanes	0.00814	4907.754	21495.600
Benzene	0.00028	129.250	566.106
Toluene	0.00026	145.252	636.195
Ethylbenzene	0.00001	5.749	25.181
Xylenes	0.00010	66.435	290.980
n-C6	0.00053	274.816	1203.672
Total:	1.00000	128125.700	561180.900

Pressure 1012.000 [psia]
Temperature 80.000 [F]

Stream 2 Rich Amine From Absorber

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00434	2079.464	9107.897
CO2	0.04020	24855.550	108865.500
DEA	0.06104	90164.020	394911.700
H2O	0.89338	226134.600	990452.600
N2	0.00001	3.265	14.302
C1	0.00097	217.535	952.787
C2	0.00003	13.012	56.991
C3	0.00001	3.284	14.384
i-C4	0.00000	0.091	0.399
n-C5	0.00000	0.059	0.257
Hexanes	0.00000	3.299	14.450
Heptanes	0.00000	1.598	7.001
Benzene	0.00001	13.392	58.655
Toluene	0.00000	5.936	26.000
Ethylbenzene	0.00000	0.481	2.108
Xylenes	0.00000	2.170	9.506
n-C6	0.00000	0.559	2.450
Total:	1.00000	343498.300	1504497.000

Pressure 1012.000 [psia]
Temperature 136.233 [F]

AMINECalc Stream Results

Stream 3 Flash Gas Vent Flow from Flash Tank

	----- Controlled -----		----- Uncontrolled -----	
Component	[lb/h]	[ton/yr]	[lb/h]	[ton/yr]
H2S	2.460	10.773	49.191	215.454
CO2	505.082	2212.222	505.082	2212.222
DEA	0.000	0.000	0.000	0.002
H2O	0.586	2.565	11.711	51.292
N2	0.159	0.694	3.173	13.896
C1	10.259	44.933	205.176	898.655
C2	0.614	2.691	12.287	53.815
C3	0.156	0.686	3.129	13.705
i-C4	0.005	0.020	0.091	0.398
n-C5	0.003	0.013	0.058	0.256
Hexanes	0.163	0.712	3.254	14.252
Heptanes	0.079	0.347	1.587	6.951
Benzene	0.201	0.880	4.016	17.590
Toluene	0.158	0.691	3.155	13.819
Ethylbenzene	0.008	0.036	0.166	0.729
Xylenes	0.064	0.279	1.273	5.574
n-C6	0.027	0.117	0.536	2.347
Total:	520.024	2277.659	803.885	3520.955

Pressure	100.000	[psia]
Temperature	136.233	[F]

Stream 4 Rich Amine Feed to Regenerator

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00425	2030.305	8892.585
CO2	0.03946	24350.380	106652.900
DEA	0.06116	90164.020	394911.700
H2O	0.89506	226122.900	990401.300
N2	0.00000	0.093	0.407
C1	0.00005	12.372	54.187
C2	0.00000	0.726	3.181
C3	0.00000	0.155	0.680
i-C4	0.00000	0.000	0.001
n-C5	0.00000	0.000	0.001
Hexanes	0.00000	0.046	0.201
Heptanes	0.00000	0.011	0.049
Benzene	0.00001	9.376	41.068
Toluene	0.00000	2.780	12.178
Ethylbenzene	0.00000	0.315	1.380
Xylenes	0.00000	0.897	3.930
n-C6	0.00000	0.024	0.104
Total:	1.00000	342694.400	1500976.000

Pressure	100.000	[psia]
Temperature	136.233	[F]

AMINECalc Stream Results

Stream 5 Acid Gas Flow from Regenerator

Component	Controlled [lb/h]	Controlled [ton/yr]	Uncontrolled [lb/h]	Uncontrolled [ton/yr]
H2S	100.054	438.230	2001.083	8764.593
CO2	23972.970	104999.800	23972.970	104999.800
DEA	0.000	0.000	0.000	0.000
H2O	0.000	0.000	0.000	0.000
N2	0.005	0.020	0.093	0.407
C1	0.619	2.709	12.372	54.187
C2	0.036	0.159	0.726	3.181
C3	0.008	0.034	0.155	0.680
i-C4	0.000	0.000	0.000	0.001
n-C5	0.000	0.000	0.000	0.001
Hexanes	0.002	0.010	0.046	0.201
Heptanes	0.001	0.002	0.011	0.049
Benzene	0.469	2.054	9.376	41.068
Toluene	0.139	0.608	2.780	12.178
Ethylbenzene	0.016	0.069	0.315	1.380
Xylenes	0.045	0.196	0.897	3.930
n-C6	0.001	0.006	0.024	0.104
Total:	24074.370	105443.900	26000.850	113881.800

Pressure N/A [psia]
Temperature N/A [F]

Stream 6 Lean Amine from Regenerator

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00006	29.222	127.992
CO2	0.00064	377.413	1653.040
DEA	0.06390	90164.020	394911.700
H2O	0.93540	226201.000	990743.400
N2	0.00000	0.000	0.000
C1	0.00000	0.000	0.000
C2	0.00000	0.000	0.000
C3	0.00000	0.000	0.000
i-C4	0.00000	0.000	0.000
n-C5	0.00000	0.000	0.000
Hexanes	0.00000	0.000	0.000
Heptanes	0.00000	0.000	0.000
Benzene	0.00000	0.000	0.000
Toluene	0.00000	0.000	0.000
Ethylbenzene	0.00000	0.000	0.000
Xylenes	0.00000	0.000	0.000
n-C6	0.00000	0.000	0.000
Total:	1.00000	316771.600	1387436.000

Pressure 1008.000 [psia]
Temperature 80.000 [F]

AMINECalc Stream Results

Stream 7 Sweet Gas Flow from Absorber

Component	Mol Fraction	[lb/h]	[tons/yr]
H2S	0.00000	0.059	0.259
CO2	0.00844	2002.003	8768.622
DEA	0.00000	0.000	0.001
H2O	0.00068	66.402	290.838
N2	0.01617	2440.744	10690.280
C1	0.91480	79099.750	346451.000
C2	0.02984	4835.821	21180.540
C3	0.00613	1456.003	6377.185
i-C4	0.00179	559.466	2450.420
n-C5	0.00065	251.732	1102.567
Hexanes	0.01116	5181.900	22696.330
Heptanes	0.00908	4906.156	21488.600
Benzene	0.00028	115.858	507.450
Toluene	0.00028	139.316	610.195
Ethylbenzene	0.00001	5.268	23.073
Xylenes	0.00011	64.265	281.474
n-C6	0.00059	274.256	1201.221
Total:	1.00000	101399.000	444120.100

Pressure	1008.000	[psia]
Temperature	81.871	[F]

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