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APPENDIX

A) Data for plant2

Table A1 Chemical exergy of every heavy oil

	API	specific gravity	heating value (kJ/kg)	C	H	O	N	S	water	Bch (kJ/kg)	rate (kg/sec)	Bch kWatts
crude	42.5	0.81	46070.9	86.3	13.6	0.0	0.0	0.1	0.0	49661.3	52.3	2598425.9
high speed diesel	40.1	0.82	45909.4	86.4	13.5	0.1	0.0	0.0	0.0	49186.2	18.0	884589.2
Reformate	48.0	0.79	46421.6	86.0	14.0					49588.9	7.4	366659.1
kerosene	46.1	0.80	46304.1	86.0	14.0					49463.5	6.6	328086.5
residue	26.9	0.89	41003.2	86.5	11.7	0.3	0.2	1.3	0.0	56389.6	18.0	1017654.9

Table A2 Chemical exergy of fuel gas

FUEL gas		B std kJ/mole	% mole	kg mole/hr	Bch(kW)
kg mole/hr	H2	236.10	0.61	80.50	5279.60
132.27	H2s	812.00	0.00	0.04	8.18
	CH4	831.65	0.13	16.99	3925.02
	C2H6	1495.84	0.13	16.99	7059.70
	C3H8	2154.00	0.06	8.28	4957.02
	C4H10	2805.80	0.04	4.89	3814.99
	C5H12	3463.30	0.03	4.57	4397.65
Total					29442.16

Table A3 Chemical exergy of isomerate

Isomerate					
kgmole/hr		B std kJ/mole	%mole	kgmole/hr	Bch (kW)
257.36	isobutane	2805.80	0.00	0.38	294.06
	normalbutane	2805.80	0.01	1.73	1346.48
	isopentane	3461.80	0.28	71.73	68971.88
	normalpentane	3461.80	0.09	23.59	22685.10
	cyclopentane	3461.80	0.02	3.88	3729.93
	22Dimethylbutane	4114.50	0.16	40.18	45928.09
	23Dimethylbutane	4114.50	0.05	13.68	15637.19
	2methylpentane	4761.70	0.17	44.31	58606.91
	3methylpentane	5413.10	0.09	23.66	35581.42
	normalhexane	4114.50	0.06	14.91	17036.74
	Methylcyclopentane	3910.80	0.03	7.88	8556.85
	Cyclohexane	3909.20	0.03	7.98	8661.16
	Benzene	3298.50	0.00	0.00	0.00
	Normalheptane	4761.70	0.01	3.46	4578.94
	Total				291614.75

Table A4 Chemical exergy of naphtha from plant 3

Naphtha from plant3					
kgmol/hr	naphthene	mole%	B std kJ/mol	kgmol/hr	Bch (KW)
286.35	c5H10	1.17	3200.00	3.35	2978.04
	c6h12	9.68	3909.20	27.72	30099.41
	c7H14	8.60	4556.90	24.63	31171.85
	c8H16	2.61	5205.90	7.47	10807.64
	c9H18	0.17	5857.70	0.49	792.08
	paraffin			0.00	0.00
	c4h10	0.91	2805.80	2.61	2030.92
	c5h12	25.18	3461.80	72.10	69334.98

	c6h14	28.89	4114.50	82.73	94549.51
	c7H16	13.88	4761.70	39.75	52570.99
	c8h18	3.90	5413.10	11.17	16792.11
	c9h20	0.38	6064.90	1.09	1833.17
	aromatic			0.00	0.00
	c6h6	2.05	3298.50	5.87	5378.55
	toluene	2.00	3931.00	5.73	6253.57
	ethylbenzene	0.58	4587.90	1.66	2116.59
	Propylbenzene	0.00	5249.00	0.00	0.00
					326709.41

Table A5 Chemical exergy of lpg product

Kgmole/hr	LPG Product				
		B std kJ/mole	%vol.	kgmole/hr	Bch (kW)
0.34	C2H6S	2134.00	0.001	0.00	0.20
	H2S	812.00	0.000	0.00	0.00
	C2H6	1495.84	0.002	0.00	0.35
	C3H8	2154.00	0.369	0.13	75.91
	iC4H10	2805.80	0.225	0.08	60.16
	C4H10	2805.80	0.400	0.14	107.18
	C5H12	3463.30	0.004	0.00	1.20
	Total		1.00		245.00

Table A6 Chemical exergy of liquid sulfur product

	sulfur				
kgmole/hr		B std kJ/mole	%mole.	kgmole/hr	Bch (kW)
47.83	sulfur	609.60	0.95	45.44	7694.25
	water	0.90	0.05	2.39	0.60
	Total		1.00		7694.85

Table A7 Chemical exergy of sour water

	sour water				
kgmol/hr		Bstd(kJ/mole)	mole%	kgmol/hr	Bch (kW)
386.30	H2s	812.00	0.00	0.91	206.09
	H2O	0.90	1.00	384.51	96.13
	NH3	337.90	0.00	0.88	82.35
					384.57

Table A8 Chemical exergy of steam and water

Stream Name		DEMIN	SH	BFWOUT	WATEROUT	SHFROMWHB
Stream Phase		Water	Vapor	Water	Water	Vapor
Temperature	K	308.150	581.150	381.150	323.150	582.150
Pressure	BAR (GA)	8.000	20.400	10.000	3.000	22.000
Enthalpy	M*/J/SEC	0.855	20.432	0.516	1.396	13.958
Sp. Enthalpy	KJ/KG	147.478	3038.175	453.537	209.658	3036.101
Sp. Entropy	KJ/KG-K	0.505	6.762	1.396	0.704	6.727
Molecular Weight		18.015	18.015	18.015	18.015	18.015
Total Mass	KG/HR	20870.039	24210.000	4094.122	23965.594	16550.000
Dry Total Mass Rate	KG/HR					
B standard	kJ/kg	54.600	54.600	54.600	54.600	54.600
B total	kJ/kg	51.602	1077.627	92.265	54.591	1085.987
B total	kJ/sec	299.147	7247.043	104.929	363.421	4992.526

Table A9 Chemical exergy of cooling water

Stream Name		WS	WR
Stream Phase		Water	Water
Temperature	K	301.15	311.15
Pressure	BAR(GA)	4.10	4.10
Enthalpy	M*/J/SEC	13.08	17.71
Sp. Enthalpy	KJ/KG	117.89	159.65

Sp. Entropy	KJ/KG-K	0.41	0.55
Molecular Weight		18.01	18.01
Total Mass	KG/SEC	110.95	110.95
Dry Total Mass Rate	KG/SEC		
B standard		54.60	54.60
B all	kW	5611.28	5734.21

Table A10 Exergy of mixing of plant 2

B of mixing (kW)	CRU	NTU	GOTU	FGTU	ISOU	Total
	223.8	794.46	274.28	31.8	108.7	1433.1

Table A 11 Summary table of feeds and products and utilities of plant2

Stream	Flow(m ³ /hr)	Temperature °C	Pressure barg
Feed			
Crude	231.85	32	20
Naphtha from plant3	35.7	45	5
<u>Products</u>			
Sulfur	1.366	140	3.5
Kerosene	30	37	6.45
Isomerase	31.7	35	4
HSD	78.5	36	4
LPG	8.41	31	16.4
Reformate	33.8	32	6.5
Sourwater	7	42.9	2.5
Fuel gas out	6.4	55	4.8
Fuel oil	72.8	86	13
Utility in			
Fuel oil	0.7	95	7.9
Demin water	20.9	35	8
SH	24.21 t/hr	308	20.4
<u>Utility out</u>			
BFWOUT	4.1	108	10
Water	24	50	3
Burner	kgmole/hr		
Stack	1930.25	182	1
Cooling tower in	1540	28	4.2
Cooling tower out	1540	35	4.2
B credit out			
SH out from WHB	ton/hr		
	16.55	309	22

B) Data for TPU

Table B1 B of mixing of TPU

	kg/sec	kg/hr	mw	Kgmol/hr	XI	R (kJ/kg mol k)	T0	ai (acti co.)	ni*ln(aixi)	ΔB mixing (kW)
crude	52.38	188561.84	199.93	943.16	1.000	8.314	298.00	1.00	0.00	
LPG	0.46	1640.50	54.08	30.33	0.032	8.314	298.00	1.00	-104.26	1027.6
fuel	0.05	181.29	48.74	3.72	0.004	8.314	298.00	1.00	-20.59	
naphtha	8.68	31245.52	90.00	347.17	0.368	8.314	298.00	1.00	-346.97	
kerosene	8.73	31440.00	140.00	224.57	0.238	8.314	298.00	1.00	-322.27	
Diesel	11.91	42886.49	230.00	186.46	0.198	8.314	298.00	1.00	-302.26	
gasoil	3.50	12590.44	275.00	45.78	0.049	8.314	298.00	1.00	-138.51	
residue	17.35	62470.00	478.00	130.69	0.139	8.314	298.00	1.00	-258.30	
total	50.68	182454.24		968.73	1.027				-1493.15	

Table B2 Exergy of SL, SM, Condensate, BFW of TPU

Stream Name		SL	SM	CONDEN	BFW
Stream Phase		Vapor	Vapor	Water	Water
Temperature	K	423.15	549.15	318.15	381.149994
Pressure	KPA	451.325	1191.325	601.325	2491.32495
Enthalpy	M*KJ/HR	2.319763	1.137541	0.806431	1.38439751
Sp. Enthalpy	KJ/KG	2748.537	2993.533	188.9539	454.556946
Sp. Entropy	KJ/KG-K	6.866109	6.942054	0.638378	1.39439273
Molecular Weight		18.015	18.015	18.015	18.0149994
Total Mass	KG/SEC	0.234444	0.105556	1.18552	0.84600002
Dry Total Mass Rate	KG/SEC				
Stream Phase		Vapor	Vapor	Water	Water
Total Molar Rate	KG-MOL/SEC	0.013014	0.005859	0.065807	0.04696087
Total Molar Rate	KG-MOL/SEC	0.013014	0.005859	0.065807	0.04696087
Bstd kJ/kg		54.6	54.6	54.6	54.6
B kJ/kg		757.0362	979.4007	53.31723	93.6279126
B KW		177.4829	103.3812	63.20865	79.2092155

Table B3 Chemical exergy of fuel gas in 2F101, 2F102 of TPU

Flow rate (kgmol/hr)	Flow rate (kgmol/hr)			F101	F102		F101	F102
F101	F102	chemical exergy	%mole	kgmole/hr	kgmole/hr	Bchi KJ/Mole	B kW	
60.62	55.55	H2	66.14	40.09	36.74	236.10	2629.33	2409.49
		CH4	8.06	4.89	4.48	831.65	1128.65	1034.28
		C2H6	8.12	4.92	4.51	1495.84	2045.16	1874.16
		C3H8	7.93	4.81	4.40	2154.00	2876.10	2635.62
		C4H10	1.89	1.15	1.05	2805.80	892.90	818.24
		C5	2.93	1.78	1.63	3463.30	1708.61	1565.75
					total	10986.69	11280.76	10337.54

Table B4 Chemical exergy of fuel oil in 2F101of TPU

	API	specific gravity	heating value (kJ/kg)	C	H	O	N	S	water	Bch (kJ/kg)	kg/hr	Bch kJ/sec
Fuel oil	20.4	0.9	43575.0	84.7	11.0	0.4	0.2	4.0	0.0	85076.5	185.0	4372.0

Table B5 Electric power of TPU

Electricity		
	amp	kW
2p101	20.00	10.53
2p102	30.00	15.80
2p103	20.00	10.53
2p104	65.00	34.23
2p105	46.00	24.22
2p106	32.00	16.85
2p107	40.00	21.06
2p108	70.00	36.86
2p109	0.00	0.00
2p110	35.00	18.43

2p111	20.00	10.53
2p112	110.00	57.92
2p113	80.00	42.12
2p114	0.00	0.00
2p115	0.00	0.00
2p116	0.00	0.00
2p117	68.00	35.80
2p118	0.00	0.00
2p119	0.00	0.00
2p120	0.00	0.00
2p121	75.00	39.49
2p122	0.00	0.00
2a101	36.00	18.96
2a102	24.00	12.64
Total		405.96

Table B6 Stream properties table of TPU

Stream	Total Mass (kg/hr)	Temperature (°C)	Pressure (barg)
CURDE	188561.9	32.0	20.0
LPG	1640.5	40.0	19.0
NAPTHA	31245.5	105.0	3.7
KERO	28662.1	268.0	9.0
GASOIL	12590.4	40.0	7.5
AIRIN	8438.4	38.0	0.0
BFW	3045.6	107.0	23.1
GASOUT	181.3	39.0	8.1
AIR	37818.7	30.0	0.0
FLUEGAS	39243.2	538.0	1.0
AIR	32414.2	30.0	0.0
FLUEGASF101	19463.4	532.0	0.0
FLUEF102	18214.3	531.0	0.0
HOTOILIN	33167.9	280.0	10.0
HOOUT2F304	33167.9	310.0	10.0
DO	42886.5	182.0	10.0
RC	71840.4	89.0	13.0
SL	844.0	150.0	4.5
SM	380.0	276.0	11.8
CONDEN	4267.9	45.0	5.9
BFW	3045.6	108.0	24.6

C) Data for NTU

Table C1 Chemical exergy of H₂ of NTU

Kgmol/hr		B std kJ/mol	H2 make up		Bch (kW)
			%vol.	kgmol/hr	
325.3571	H2	236.1	0.7792208	253.52501	16627.02
	CH4	831.65	0.1052777	34.252847	7912.884
	C2H6	1495.84	0.0671456	21.846304	9077.382
	C3H8	2154	0.0309478	10.069079	6024.665
	iC4H10	2805.8	0.0055264	1.7980497	1401.38
	C4H10	2805.8	0.0058027	1.8879522	1471.449
	C5H12	3463.3	0.0022106	0.7192199	691.9095
	C6H14	4118.5	0.0038685	1.2586348	1439.913
					44646.6

Table C2 Chemical exergy of naphtha of NTU

Naphtha from c105						
Kgmol/hr	naphthene	mole%	B std kJ/mol	kgmol/hr	Bch (kW)	
317.13	c5H10	0.55	3200.00	1.74	1550.41	
	c6h12	5.12	3909.20	16.24	17631.56	
	c7H14	9.79	4556.90	31.05	39299.33	
	c8H16	8.01	5205.90	25.40	36733.41	
	c9H18	4.13	5857.70	13.10	21311.31	
	c10H20	0.59	6511.50	1.87	3384.28	
	parafin				0.00	0.00
	c4h10	0.23	2805.80	0.73	568.48	
	c5h12	11.99	3461.80	38.02	36564.03	
	c6h14	13.71	4114.50	43.48	49692.11	
	c7H16	12.50	4761.70	39.64	52433.03	
	c8h18	12.02	5413.10	38.12	57317.00	
	c9h20	9.48	6064.90	30.06	50648.30	

	c10h22	2.35	6716.80	7.45	13904.75
	aromatic			0.00	0.00
	c6h6	0.96	3298.50	3.04	2789.46
	toluene	2.85	3931.00	9.04	9869.17
	ethylbenzene	4.44	4587.90	14.08	17944.44
	Propylbenzene	1.28	5249.00	4.06	5918.61
				317.13	417559.67

Table C3 Chemical exergy of naphtha from plant 3 of NTU

		Naphtha from plant3			
kgmol/hr	naphthene	mole%	B std kJ/mole	kgmole/hr	Bch (kW)
220.58	c5H10	1.17	3200.00	2.58	2294.03
	c6h12	9.68	3909.20	21.35	23186.01
	c7H14	8.60	4556.90	18.97	24012.14
	c8H16	2.61	5205.90	5.76	8325.29
	c9H18	0.17	5857.70	0.37	610.15
	c10H20		6511.50	0.00	0.00
	paraffin			0.00	0.00
	c4h10	0.91	2805.80	2.01	1564.45
	c5h12	25.18	3461.80	55.54	53409.75
	c6h14	28.89	4114.50	63.73	72832.87
	c7H16	13.88	4761.70	30.62	40496.21
	c8h18	3.90	5413.10	8.60	12935.21
	c9h20	0.38	6064.90	0.84	1412.12
	c10h22	0.00	6716.80	0.00	0.00
	aromatic			0.00	0.00
	c6h6	2.05	3298.50	4.52	4143.17
	toluene	2.00	3931.00	4.41	4817.21
	ethylbenzene	0.58	4587.90	1.28	1630.44

	Propylbenzene	0.00	5249.00	0.00	0.00
					251669.05

Table C4 Chemical exergy of naphtha from plant 3 of NTU

B std kJ/mol	Gas out 2D201		Bch (kW)
	%vol.	kgmol/hr	
236.10	89.63	278.79	18284.16
831.65	5.56	17.31	3998.01
1495.84	2.44	7.60	3156.05
2154.00	0.82	2.56	1534.07
2805.80	0.03	0.10	74.94
2805.80	0.13	0.42	327.22
3463.30	1.37	4.28	4112.97
812.00	0.00	0.00	0.00
		311.05	31487.42

Table C5 Chemical exergy of Gas out 2D202 of NTU

KGMOL/hr		Gas out 2D202			Bch (kW)
		B std kJ/mole	%vol.	kgmole/hr	
22.90	H2	236.10	18.01	4.12	270.53
	CH4	831.65	7.92	1.81	418.99
	C2H6	1495.84	23.34	5.35	2221.10
	C3H8	2154.00	21.57	4.94	2955.37
	iC4H10	2805.80	6.17	1.41	1100.38
	C4H10	2805.80	9.93	2.27	1771.54
	C5H12	3463.30	13.06	2.99	2878.07
	H2S	812.00	0.00	0.00	0.00
				22.90	11615.99

Table C6 Chemical exergy of treated light naphtha of NTU

TLN					
kgmol/hr	paraffin	%vol.	B stdkj/mole/hr	kgmol/hr	Bch (kW)
236.18	c4h10	1	2805.8	2.3618	1840.7607
	c5h12	30.9	3461.8	72.97962	70178.013
	c6h14	45.53	4114.5	107.53275	122900.98
	c7h16	5.75	4761.7	13.58035	17962.653
	naphthene			0	0
	c5h10	1.96	3200	4.629128	4114.7804
	c6h12	13.1	3909.2	30.93958	33596.946
	aromatic			0	0
	c6h6	3.1	3298.5	7.32158	6708.3977
					257302.53

Table C7 Chemical exergy of treated heavy naphtha of NTU

THN					
kgmol/hr	paraffin	B std kJ/mole		kgmol/hr	Bch (kW)
300.47	c6h14	4114.50	0.45	1.35	1545.36
	c7h16	4761.70	22.45	67.46	89223.36
	c818	5413.10	15.22	45.73	68763.96
	c9h20	6064.90	12.04	36.17	60931.87
	c10h22	6716.80	2.41	7.24	13510.76
	naphthene			0.00	0.00
	c6h12	3909.20	6.26	18.81	20425.02
	c7h14	4556.90	16.37	49.19	62261.33
	c8h16	5205.90	10.24	30.77	44493.44
	c9h18	5857.70	3.71	11.15	18138.49
	aromatic			0.00	0.00
	c6h6	3298.50	0.40	1.20	1101.23
	c7h8	3931.00	4.36	13.10	14305.06

	c8h10	4587.90	4.80	14.42	18380.42
	c9h12	5249.10	1.32	3.97	5783.08
					418863.37

Table C8 Exergy of water and steam of NTU

Stream Name		E203IN	E203OUT	E206IN	E206OUT	E209	E209OUT	SHE208IN	E208OUT	SHE207IN	E207OUT
Stream Phase		Water	Water	Water	Water	Water	Water	Vapor	Water	Vapor	Water
Temp	K	301.15	308.16	301.15	308.16	301.15	308.16	583.85	410.10	583.85	353.94
P	BAR (GA)	4.00	4.00	4.00	4.00	4.00	4.00	21.00	18.00	21.00	18.00
H	M*/J/SEC	0.97	1.21	0.44	0.55	1.37	1.71	4.94	0.94	2.19	0.24
Sp. H	KJ/KG	117.88	147.15	117.88	147.14	117.88	147.14	3042.82	577.07	3042.82	339.69
Sp. S	KJ/KG-K	0.41	0.51	0.41	0.51	0.41	0.51	6.76	1.71	6.76	1.08
Molecular Weight		18.01	18.01	18.01	18.01	18.01	18.01	18.01	18.01	18.01	18.01
Total Mass	KG/SEC	8.20	8.20	3.76	3.76	11.62	11.62	1.62	1.62	0.72	0.72
Dry Total Mass Rate	KG/SEC										
	B std	54.60	54.60	54.60	54.60	54.60	54.60	54.60	55.60	56.60	57.60
	B kJ/kg	50.56	51.20	50.56	51.20	50.56	51.20	1083.50	124.35	1085.50	74.44
	B kW	414.62	419.86	190.07	192.47	587.50	594.91	1757.68	201.73	780.65	53.53

Table C9 Exergy of mixing of NTU

	kgmol/hr	XI	R(kJ/kg mol k)	T0	ai(acti co)	ni*ln(aixi)	DELB mixing (kW)
feed	898.10	1.000	8.31	298.00	1.00	0.00	
gasout 2D201	311.05	0.346	8.31	298.00	1.00	-329.81	794.47
gasout 2D202	22.90	0.025	8.31	298.00	1.00	-84.02	
treated light naphtha	236.18	0.263	8.31	298.00	1.00	-315.46	
treated heavy naphtha	300.47	0.335	8.31	298.00	1.00	-328.99	
sourwater	27.59	0.031	8.31	298.00	1.00	-96.09	

Table C10 Stream properties table of NTU

Stream Name	Total Mass (kg/hr)	Temperature (°C)	Pressure (barg)
NAP2C105	32104.7	108.0	4.0
NFROMPL3	19201.0	45.0	5.0
H2MAKEUP	2535.7	22.0	22.4
THN	31730.7	58.0	5.0
TLN	18925.4	38.0	4.7
SHE208IN	5840.0	310.7	21.0
E208OUT	5840.0	136.9	18.0
SHE207IN	2589.0	310.7	21.0
E206OUT	2589.0	80.8	18.0
STACK	5177.6	758.0	0.0
SOURWATER	498.0	42.9	7.5
GASOUTD202	847.1	47.0	7.6
GASOUTD201	1519.6	39.0	18.0
FUEL	244.1	40.0	1.3
E203IN	29520.0	28.0	4.0
E203OUT	29520.0	35.0	4.0
E206IN	13532.4	28.0	4.0
E206OUT	13532.4	35.0	4.0
E209	41828.4	28.0	4.0
E209OUT	41828.4	35.0	4.0
AIRIN	19911.6	38.0	0.0

D) Data for GOTU**Table D1** Chemical exergy of heavy oil of GOTU

	API	Spgr.	heating value (kJ/kg)	C	H	S	water	Bch (kJ/kg)	rate (kg/sec)	Bch kWatts
gasoil	35.00	0.85	45535.67	86.10	13.20	0.81	0.00	56425.93	17.31	976780.25

feed										
gasoil product	33.50	0.86	45419.76	86.10	14.00	0.03	0.00	54135.70	17.52	948707.12
wild gasolene	65.90	0.72	47366.89	86.10	13.60	0.31	0.00	53585.84	0.35	18640.13

Table D2 Chemical exergy of Poor amine in GOTU

	Poor amine					
kgmol/hr		Bstd	mw	mole%	kgmol/hr	Bch (kW)
514.41	H ₂ s	812.00	34.00	0.00	0.36	80.14
	DEA	2468.88	105.14	0.07	35.14	24098.43
	H ₂ O	0.90	18.00	0.93	478.92	119.73
						24298.30

Table D3 Chemical exergy of H₂ make up in GOTU

			H ₂ make up				
kgmol/hr		B std kJ/mol			Mole%	kgmol/hr	Bch (kW)
0.31	H ₂ s	812.00	0.00	0.01	0.001	0.00	0.07
	H ₂	236.10	0.21	10.50	0.810	0.25	16.31
	CH ₄	831.65	0.27	1.66	0.128	0.04	9.06
	C ₃ H ₈	2154.00	0.05	0.12	0.010	0.00	1.75
	iC ₄ H ₁₀	2805.80	0.08	0.13	0.010	0.00	2.47
	C ₅ H ₁₂	3463.30	0.39	0.54	0.042	0.01	12.28
			1.00	12.96	1.000		41.92



Table D4 Chemical exergy of sour water in GOTU

	sour water						
kgmol/hr		wt.	Bstd	mw	mole%	kgmol/hr	Bch (kW)
290.810	H ₂ s	0.004	812.000	34.000	0.002	0.688	155.143
	H ₂ O	0.993	0.900	18.000	0.995	289.462	72.365
	NH ₃	0.002	337.900	17.000	0.002	0.661	61.996
							289.504

Table D5 Chemical exergy of rich amine in GOTU

	Rich amine						
kgmol/hr		wt.	Bstd	mw	mole%	kgmol/hr	Bch (kW)
520.53	H ₂ s	0.05	812.00	34.00	0.0348	18.09	4081.36
	CH ₄	0.00	831.65	16.00	0.0002	0.10	23.58
	C ₂ H ₆	0.00	1495.84	30.00	0.0001	0.05	22.62
	C ₃ H ₈	0.00	2154.00	44.00	0.0000	0.01	5.56
	DEA	0.29	2468.88	105.14	0.0659	34.31	23532.95
	H ₂ O	0.67	0.90	18.00	0.8990	467.95	116.99
					1.0000		27783.05

Table D6 Chemical exergy of sour gas in GOTU

		sour gas			
kgmol/hr		B std kJ/mole	%mole	kgmol/hr	Bch (kW)
66.46	H ₂	236.10	0.744	49.45	3243.34
	H ₂ S	812.00	0.007	0.43	97.93
	ch ₄	831.65	0.199	13.19	3047.95
	c ₂ h ₆	1495.84	0.041	2.76	1144.99
	c ₃ h ₈	2154.00	0.004	0.23	140.52
	nc ₄	2805.80	0.002	0.10	79.35
	c ₅	3463.30	0.001	0.04	39.45
	water	0.90	0.004	0.25	0.06
					7793.60

Table D7 Exergy of steam and water in GOTU

Stream Name		E3712IN	E3712 OUT	E3709IN	E3709 OUT	E3708in	E3708 OUT	BFWTO E3706	SHTOEJE CTOR
Stream Phase		Water	Water	Water	Water	Water	Water	Water	Vapor
Temperature	K	301.15	308.16	301.15	307.52	301.15	308.16	379.85	583.15
Pressure	BAR (GA)	4.00	4.00	4.00	4.00	4.00	4.00	23.90	21.00
Enthalpy	M*/J/SE C	1.21	1.51	0.44	0.54	2.17	2.71	0.22	0.49
Sp. Enthalpy	KJ/KG	117.88	147.15	117.88	144.48	117.88	147.15	449.07	3041.19
Sp. Entropy	KJ/KG- K	0.41	0.51	0.41	0.50	0.41	0.51	1.38	6.76
Molecular Weight		18.01	18.01	18.01	18.01	18.01	18.01	18.01	18.01
Total Mass	KG/SE C	10.25	10.25	3.76	3.76	18.45	18.45	0.48	0.16
Dry Total Mass Rate	KG/SE C								
Stream Phase		Water	Water	Water	Water	Water	Water	Water	Vapor
	B std	54.60	54.60	54.60	54.60	54.60	54.60	54.60	54.60
	B kJ/kg	50.56	51.20	50.56	51.12	50.56	51.20	92.44	1082.70
	B kW	518.28	524.82	190.07	192.15	932.91	944.67	44.69	175.64

Table D8 Chemical exergy of fuel gas to 2F3701in GOTU

		Fuel gas 2F3701			
kgmol/hr		%	kgmol/hr	B std kJ/mol	B kW
39.81	H2	69.57	27.70	236.10	1816.44
	CH4	8.48	3.38	831.65	779.72
	C2H6	8.54	3.40	1495.84	1412.87
	C3H8	8.34	3.32	2154.00	1986.91
	C4H10	1.99	0.79	2805.80	616.85
	C5	3.08	1.23	3463.30	1180.37
	Total				7793.15

Table D9 Electric power in GOTU

	Amp	kilowatt
2P3701	60.35	31.78
2P3702	55.00	28.96
2P3703	8.50	4.48
2P3704	170.00	89.51
2P3705	4.50	2.37
2P3706	18.00	9.48
2P3707	1.40	0.74
2A3701	112.00	58.97
2A3702	56.00	29.49
2A3703	56.00	29.49
2K3701	12.00	6.32
2K3702	337.00	177.45
total	485.75	469.02

Table D10 Stream properties table of GOTU

Stream	Total Mass (kg/hr)	Temperature (°C)	Pressure (barg)
H2MAKEUP	2.4	37.6	4.1
GASOILFEED	62319.0	173.8	4.0
POORAMINE	12336.7	44.7	46.0
WATER	2509.4	37.6	7.0
WILDGASO	1252.3	37.6	8.0
RICAMINE	12660.4	45.1	40.0
BFWTOE3706	1740.5	106.7	23.9
SHTOEJECTOR	584.0	310.0	21.0
TGASOIL	63088.7	174.0	10.6
AIRINF3701	9705.6	30.0	0.0
E3712IN	36900.0	28.0	4.0
E3712OUT	36900.0	35.0	4.0
E3709IN	13532.4	28.0	4.0
E3709OUT	13532.4	34.4	4.0
E3708IN	66420.0	28.0	4.0
E3708OUT	66420.0	35.0	4.0
SOURGAS	433.9	43.0	6.0
SOURWATER	5249.3	42.9	2.5
STACK	10071.6	610.0	0.0

E) Data for Deethanizer unit

Table E1 Chemical exergy of LPG feed dethannizer unit

			LPG mix		
kgmol/hr		B std kJ/mole	kgmol/hr	%	Bch (kW)
161.45	H2	236.10	0.02	0.0002	1.59
	H2S	812.00	1.07	0.0066	241.24
	ch4	831.65	0.11	0.0007	25.27
	c2h6	1495.84	6.15	0.0381	2555.37
	c3h8	2154.00	54.33	0.3365	32506.63
	ic4	2805.80	26.35	0.1632	20536.89
	nc4	2805.80	70.47	0.4365	54922.92
	c5	3463.30	2.43	0.0151	2338.51
	c6	4118.50	0.52	0.0032	597.90
					113726.32

Table E2 Chemical exergy of LPG product of dethannizer unit

kgmol/hr		B std kJ/mol	kgmol/hr	%vol.	Bch (kW)
151.22	H2	236.10	0.0000	0.0000	0.00
	H2S	812.00	0.5298	0.0035	119.50
	ch4	831.65	0.0000	0.0000	0.00
	C2h6	1495.84	0.5752	0.0038	239.01
	C3h8	2154.00	50.7099	0.3353	30341.43
	ic4	2805.80	26.1875	0.1732	20410.26
	nc4	2805.80	70.2370	0.4645	54741.95
	c5	3463.30	2.9820	0.0197	2868.81
	c6	4118.50	0.0000	0.0000	0.00
	Total				108720.97

Table E3 Chemical exergy of off gas of dethannizer unit

			off gas		
kgmol/hr		B std kJ/mol	kgmol/hr	%	Bch (kW)
8.22	H2	236.10	0.02	0.0030	1.60
	H2S	812.00	0.53	0.0647	120.09
	ch4	831.65	0.11	0.0136	25.77
	c2h6	1495.84	5.67	0.6896	2356.28
	c3h8	2154.00	3.60	0.4378	2154.01
	ic4	2805.80	0.11	0.0136	86.94
	nc4	2805.80	0.10	0.0120	76.67
	c5	3463.30	0.00	0.0000	0.00
	c6	4118.50	0.00	0.0000	0.00
					4821.35

Table E4 Exergy of steam and water of dethannizer unit

Stream Name		SL	COND	WS	WR	WSE133	WRE133
Stream Phase		Vapor	Mixed	Water	Water	Water	Water
Temperature	K	452.15	421.41	301.15	308.15	301.15	308.15
Pressure	BAR(GA)	3.50	3.50	5.00	5.00	5.00	5.00
Enthalpy	M*/J/SEC	0.54	0.28	0.34	0.43	0.98	1.22
Sp. Enthalpy	KJ/KG	2812.89	1441.54	117.27	146.54	117.97	147.24
Sp. Entropy	KJ/KG-K	7.01	3.76	0.42	0.52	0.41	0.51
Molecular Weight		18.01	18.01	18.01	18.01	18.01	18.01
Total Mass	KG/HR	687.00	687.00	10504.80	10504.80	29772.00	29772.00
Dry Total Mass Rate	KG/HR						
	B std	54.60	54.60	54.60	54.60	54.60	54.60
	B kJ/kg	777.47	374.68	46.47	46.52	50.66	51.30
	B kW	148.37	71.50	135.59	135.75	418.99	424.27

Table E5 Electric power of dethannizer unit

	Amp	kilowatt
2p121 A/b	75.00	39.49
2p122	10.00	5.27
total		44.76

Table E6 Stream properties table of dethanizer

Stream	Total Mass (kg/hr)	Temperature (°C)	Pressure (barg)
LPGFEED	8466.9	39.0	7.5
LPGPRO	8091.2	33.0	20.0
OFFGAS	361.5	41.0	18.0
SL	687.0	179.0	3.5
COND	687.0	148.3	3.5
WSE133	29772.0	28.0	5.0
WRE133	29772.0	35.0	5.0
WS E131	10504.8	28.0	5.0
WRE131	10504.8	35.0	5.0

F) Data for ISOU

Table F1 Chemical exergy of treated light naphtha in isomerization unit

	Light naphtha				
kgmol/hr		B std kJ/mol	kgmol/hr	%Mole	Bch (kW)
290.43	isobutane	2805.80	0.77	0.0019	422.52
	normalbutane	2805.80	16.32	0.0396	8955.33
	isopentane	3461.80	40.86	0.0991	27663.35
	normalpentane	3461.80	99.47	0.2411	67343.95
	cyclopentane	3461.80	8.38	0.0203	5673.49
	2,2-Dimethylbutane	4114.50	1.93	0.0047	1553.03
	2,3-Dimethylbutane	4114.50	5.60	0.0136	4506.19
	2-methylpentane	4761.70	43.69	0.1059	40686.33
	3-methylpentane	5413.10	33.46	0.0811	35422.28
	normalhexane	4114.50	111.03	0.2692	89343.28
	Methylcyclopentane	3910.80	19.60	0.0475	14990.85
	Cyclohexane	3909.20	13.52	0.0328	10336.39
	Benzene	3298.50	10.42	0.0253	6721.85
	Normalheptane	4761.70	7.47	0.0181	9880.53
	Total				323499.37

Table F2 Chemical exergy of H₂ feed in isomerization unit

		H ₂ feed		
kgmol/hr		B std kJ/mol	%	Bch (kW)
116.25	H ₂	236.10	0.7077	5395.54
	ch ₄	831.65	0.1105	2966.22
	c ₂ h ₆	1495.84	0.0852	4117.71
	c ₃ h ₈	2154.00	0.0554	3853.27
	ic ₄	2805.80	0.0124	1122.32
	nc ₄	2805.80	0.0145	1317.17
	ic ₅	3463.30	0.0086	962.03

	nc5	3463.30	0.0057	634.94
				20369.19

Table F3 Chemical exergy of isomerate in isomerization unit

kgmol/hr		B std kJ/mol	kgmol/hr	%vol.	Bch (kW)
271.13	isobutane	2805.80	0.40	0.0015	309.79
	normalbutane	2805.80	1.82	0.0067	1418.52
	isopentane	3461.80	75.56	0.2787	72662.22
	normalpentane	3461.80	24.85	0.0917	23898.87
	cyclopentane	3461.80	4.09	0.0151	3929.50
	22Dimethylbutane	4114.50	42.34	0.1561	48385.47
	23Dimethylbutane	4114.50	14.41	0.0532	16473.85
	2methylpentane	4761.70	46.68	0.1722	61742.68
	3methylpentane	5413.10	24.93	0.0919	37485.19
	normalhexane	4114.50	15.70	0.0579	17948.29
	Methylcyclopentane	3910.80	8.30	0.0306	9014.68
	Cyclohexane	3909.20	8.40	0.0310	9124.57
	Benzene	3298.50	0.00	0.0000	0.00
	Normalheptane	4761.70	3.65	0.0135	4823.93
	Total				307217.57

Table F4 Chemical exergy of gasout in isomerization unit

kgmol/hr		B std kJ/mol	GASOUT kgmol/hr	%	Bch (kW)
60.73	H2	236.10	20.62	0.13	535.73
	ch4	831.65	13.43	0.15	2109.57
	c2h6	1495.84	10.24	0.12	2986.74
	c3h8	2154.00	13.82	0.16	5804.52
	ic4	2805.80	13.47	0.16	7369.49
	nc4	2805.80	13.34	0.15	7298.36

	ic5	3463.30	1.51	0.19	10870.70
	nc5	3463.30	0.09	0.00	60.78
	Total				37035.89

Table F5 Exergy of steam, condensate and water in isomerization unit

		in	out					
Stream Name		HPSTEAM	CPH	SHTOE2809	CPH	SHTOE2804	CPHOUT	SHE2808
Stream Phase		Vapor	Mixed	Vapor	Mixed	Vapor	Water	Vapor
Temperature	K	583.85	490.54	583.85	490.54	583.85	355.68	583.85
Pressure	BAR (GA)	21.00	21.00	21.00	21.00	21.00	21.00	21.00
Enthalpy	M*J/SEC	2.10	1.52	2.10	1.52	0.10	0.01	0.68
Sp. Enthalpy	KJ/KG	3047.02	2206.78	3047.02	2206.78	3047.02	347.02	3047.02
Sp. Entropy	KJ/KG-K	6.91	5.40	6.91	5.40	6.91	1.15	6.91
Molecular Weight		18.01	18.01	18.01	18.01	18.01	18.01	18.01
Total Mass	KG/HR	2485.00	2485.00	2485.00	2485.00	120.00	120.00	800.00
Dry Total Mass Rate	KG/HR							
Exergy standard		54.60	54.60	54.60	54.60	54.60	54.60	54.60
B		1042.71	652.55	1042.71	652.55	1042.71	57.78	1042.71
B kW		719.76	450.44	719.76	450.44	34.76	1.93	231.71

Table F6 Electric power in isomerization unit

	Amp	kilowatt
2k2801	240.00	126.37
2A2801	11.00	5.79
2A2802	8.00	4.21
2A2803	10.00	5.27
2E2805		0.00
2P2801	150.00	78.98
2P2802	2.00	1.05
2P2803	0.40	0.21

2P2804	18.00	9.48
2P2805	7.00	3.69
2P2806	80.00	42.12
2P2807	5.50	2.90
total		280.07

Table F7 Stream properties table of isomerization

Stream	Total Mass (kg/hr)	Temperature (°C)	Pressure (barg)
TLN	23178.5	100.0	10.0
H2	881.4	27.0	19.1
GASOUT	1999.3	31.0	11.0
ISOMERATE	21846.8	34.0	4.2
SHTOE2809	2485.0	583.8	21.0
CPH	2485.0	490.5	21.0
SHTOE2804	120.0	583.8	21.0
CPHOUT	120.0	355.7	21.0
SHE2808	800.0	583.8	21.0
CPHOUT2808	800.0	377.1	21.0

G) Data for CRU.

Table G1 Chemical exergy of heavy naphtha feed in catalytic reforming unit

kgmol/hr	Components	%vol.	kgmol/hr	Bch std kJ/mol	Bch (kW)
232.15	c6n	0.0330	7.66	3909.20	8319.70
	c6p	0.0063	1.46	4114.50	1671.72
	c7n	0.1330	30.88	4556.90	39086.52
	c7p	0.2296	53.31	4761.70	70508.23
	c8n	0.1146	26.61	5205.90	38475.68
	c8p	0.1878	43.60	5413.10	65561.29
	c9n	0.0376	8.73	5857.70	14204.33
	c9p	0.1322	30.69	6064.90	51708.39
	c10p	0.0267	6.20	6716.80	11565.90
	c6a	0.0026	0.60	3298.50	553.09
	c7a	0.0360	8.36	3931.00	9126.65
	c8a	0.0515	11.96	4587.90	15237.97
	c9a	0.0090	2.09	5249.10	3046.72
	tot	1.0000			329066.20

Table G2 Chemical exergy of Reformate in catalytic reforming unit

			Reformate			
kgmol/hr	ref		%vol.	kgmol/hr	Bch std kJ/mol	Bch(kW)
248.2	c4p	5.8	0.061	15.1	2805.8	11799.4
	c5n	0.1	0.015	3.7	3461.8	3579.9
	c5p	15.5	0.155	38.3	3461.8	36872.7
	c6n	0.3	0.003	0.7	3909.2	808.5
	c6p	4.4	0.048	11.9	4114.5	13615.5
	c7n	0.5	0.005	1.3	4556.9	1633.6
	c7p	10.9	0.102	25.2	4761.7	33326.6
	c8p	3.5	0.035	8.8	5413.1	13210.6
	c9p	0.3	0.003	0.7	6064.9	1254.4
	c7ole	0.3	0.003	0.7	4604.6	888.8

	c6a	8.8	0.088	21.8	3298.5	20011.2
	c7a	20.4	0.200	49.7	3931.0	54310.2
	c8a	19.6	0.175	43.3	4587.9	55210.9
	c9a	9.5	0.095	23.7	5249.1	34486.8
	tot	99.9				281009.2

Table G3 Chemical exergy of H₂ to ISOU from catalytic reforming unit

		H21			
kgmol/hr	Components	Bch std kJ/mol	molefraction	kgmol/hr	Bch (kW)
0.34	H2	236.10	83.16	0.28	18.55
	ch4	831.65	6.20	0.02	4.87
	c2h6	1495.84	5.73	0.02	8.10
	c3h8	2154.00	3.23	0.01	6.57
	ic4	2805.80	0.78	0.00	2.07
	nc4	2805.80	0.58	0.00	1.54
	ic5	3463.30	0.23	0.00	0.75
	nc5	3463.30	0.09	0.00	0.29
total				0.34	42.74

Table G4 Chemical exergy of H₂ to NTU from catalytic reforming unit

		H22			
kgmol/hr		Bch std kJ/mol	molefraction	kgmol/hr	Bch(kW)
39.1	H2	236.1	83.160	32.495	2131.1
	ch4	831.7	6.200	2.423	559.7
	c2h6	1495.8	5.730	2.239	930.3
	c3h8	2154.0	3.230	1.262	755.2
	ic4	2805.8	0.780	0.305	237.5
	nc4	2805.8	0.580	0.227	176.6
	ic5	3463.3	0.230	0.090	86.5
	nc5	3463.3	0.090	0.035	33.8
				total	4910.8

Table G5 Chemical exergy of LPG to deethanizer from catalytic reforming unit

kgmol/hr		Bch std kJ/mol	molefraction	kgmole/hr	Bch(kW)
57.203	H2	236.100	1.000	0.572	37.516
	ch4	831.650	4.000	2.288	528.587
	c2h6	1495.840	1.790	1.024	425.456
	c3h8	2154.000	43.100	24.654	14751.605
	ic4	2805.800	25.400	14.530	11324.179
	nc4	2805.800	24.100	13.786	10744.595
	ic5	3463.300	0.520	0.297	286.161
	nc5	3463.300	0.120	0.069	66.037
				total	38164.136

Table G6 Chemical exergy of fuel gas to FG TU from CRU unit

			top2c302		
kgmol/hr		Bch std kJ/mole	molefraction	kgmo/hr	Bch(kW)
14.714	H2	236.100	22.190	3.265	214.132
	ch4	831.650	12.120	1.783	411.976
	c2h6	1495.840	49.840	7.333	3047.133
	c3h8	2154.000	12.320	1.813	1084.638
	ic4	2805.800	1.320	0.194	151.377
	nc4	2805.800	1.320	0.194	151.377
	ic5	3463.300	0.690	0.102	97.671
	nc5	3463.300	0.200	0.029	28.311
				total	5186.614

Table G7 Chemical exergy of fuel gas to FG TU from 2D302 CRU

		2d302	kgmo/hr	Bch(kW)
kgmol/hr	Bch std kJ/mol	molefraction		
0.123	236.100	79.570	0.098	6.398
	831.650	5.990	0.007	1.697

	1495.840	6.680	0.008	3.403
	2154.000	4.680	0.006	3.433
	2805.800	1.330	0.002	1.271
	2805.800	1.080	0.001	1.032
	3463.300	0.480	0.001	0.566
	3463.300	0.190	0.000	0.224
Total			0.123	18.023

Table G8 Chemical exergy of fuel gas to 2F301, 302, 303, 304

				2F301	2F302	2F303	2F304
2F301	fuel gas for burner	mole%	Bch std (kj/mol)	Bch (kw)	Bch (kw)	Bch (kw)	Bch (kw)
18.679kg mol/hr	H2	69.570	236.1	852.3	1391.2	659.6	771.1
2F302	C1	8.478	831.65	365.8334	597.1942	283.1463	330.9912
30.4920k gmol/hr	C2	8.541	1495.8	662.9	1082.1	513.1	599.8
2F303	C3	8.341	2154.0	932.2	1521.8	721.5	843.5
14.4571 kgmol/hr	Ic4	1.988	2805.8	289.4	472.5	224.0	261.9
2F304	nC4	3.082	2805.8	448.7	732.4	347.3	405.9
16.9 kgmol/hr	C5+	0.026	3463.3	4.7	7.7	3.6	4.3
	total	100.026		3556.0	5804.9	2752.3	3217.3

Table G9 Exergy of steam and BFW in CRU

Stream Name		BFW	SATSH	SHTOCOM301	SLOUTCO M
Stream Phase		Water	Vapor	Vapor	Vapor
Temperature	K	381.15	495.57	583.85	452.15
Pressure	BAR(GA)	23.00	23.00	21.00	3.50
Enthalpy	M*/J/SEC	0.35	2.20	8.20	7.58
Sp. Enthalpy	KJ/KG	454.24	2830.78	3042.82	2812.89
Sp. Entropy	KJ/KG-K	1.47	6.65	6.76	7.01
Molecular Weight		18.01	18.01	18.01	18.01

Total Mass	KG/SEC	0.78	0.78	2.69	2.69
Dry Total Mass Rate	KG/SEC				
				Vapor	Vapor
				0.15	0.15
				0.15	0.15
		54.60	54.60	54.60	54.60
	B kJ/kg	69.92	904.54	1083.50	777.47
	B kW	54.38	703.53	2919.43	2094.86

Table G10 Electric power in CRU

	2P310	2P308	2A301	2P302	2P305	2P303	2P306	2P307	2A302	total
amp	0.40	0.40	80.00	100.00	75.00	27.00	12.30	11.00	16.00	
kilowatt	0.18	0.18	36.68	45.86	34.39	12.38	5.64	5.04	7.34	147.70

Table G11 Exergy of stack gas from 4 burners in CRU

	flue gas %	Bch (kJ/mol)	2F301			2F302			2F303			2F304		
			kgmol/hr	kgmol/hr	kW	kgmol/hr	kgmol/hr	kW	kgmol/hr	kgmol/hr	kW	kgmol/hr	kgmol/hr	kW
co2	0.077	19.9	over all is	15.2	83.9	over all is	24.8	136.9	over all is	11.8	64.9	over all is	13.8	75.9
h2o	0.285	9.5	196.1	55.8	147.3	320.4	91.1	240.4	151.9	43.2	114.0	177.6	50.5	133.2
n2	0.633	0.7		124.3	24.9		203.0	40.6		96.3	19.3		112.5	22.5
O2	0.005	4.0		0.9	1.0		1.5	1.7		0.7	0.8		0.8	0.9
total				196.1	257.0		320.4	419.6		151.9	199.0		177.6	232.6

Table G12 Exergy of mixing in CRU

		mass fraction					
	Kgmol/hr	Xi	R(kJ/kg mol k)	T0	ai(activi co)	ni*ln(aixi)	DELB mixing (kW)
feed	343.700	1.000	8.314	298.000	1.000	0.000	
Reformat	232.400	0.676	8.314	298.000	1.000	-90.940	223.812
H2	39.416	0.115	8.314	298.000	1.000	-85.359	
LPG	57.203	0.166	8.314	298.000	1.000	-102.574	
top2c302	14.700	0.043	8.314	298.000	1.000	-46.333	
						-325.207	

Table G13 Stream properties table of Catalytic reforming

Stream	Total Mass (kg/hr)	Temperature (° C)	Pressure (barg)
HN1	26650.4	58.0	22.0
LPG	2950.0	34.0	11.5
TOP2C302	367.7	46.0	10.0
H21	2.3	30.0	28.8
H22	267.3	30.0	20.1
2D302	1.0	34.3	12.0
REF1	23042.9	33.0	6.5
STACKF304	4915.5	340.0	0.0
STACKF301	5444.1	380.0	0.0
STACKF302	8894.1	380.0	0.0
STACKF303	4216.3	380.0	0.0
AIRTO4BURNER	116451.5	30.0	0.0
BFW	7717.9	108.0	23.9
SH(outfrom)2E309	7717.0	310.7	21.0
SHTO2k301	9700.0	310.7	21.0
SLOUT2k301	9700.0	179.0	3.5
F304	209.3	35.0	3.3
E302	92268.0	28.0	3.0
E302OUT	92268.0	35.0	3.0
E303IN	78732.0	28.0	3.0
E303OUT	78732.0	35.0	3.0
E306IN	86112.0	28.0	3.0
E306OUT	86112.0	35.0	3.0
2E307IN	25344.0	28.0	3.0
2E307OUT	25344.0	35.0	3.0

H) Data for LPGU

Table H1 Chemical exergy of LPG feed from 2C105

kgmole/hr		B std kj/mole	kgmole/ r	Bch (kW)
0.12	C2H6 S	2134.00	0.0023	1.39
	H2S	812.00	0.0023	0.53
	CH4	831.65	0.0000	0.00
	C2H6	1495.84	0.0003	0.12
	C3H8	2154.00	0.0432	25.85
	iC4H 10	2805.80	0.0263	20.49
	C4H1 0	2805.80	0.0469	36.56
	C5H1 2	3463.30	0.0004	0.41
				85.35

Table H2 Chemical exergy of LPG feed from 2C106

kgmole/hr		B std kj/mole	%vol.	kgmole/hr	Bch (kW)
0.03	C2H6S	2134.00	0.0192	0.0005	0.31
	H2S	812.00	0.0192	0.0005	0.12
	CH4	831.65	0.0000	0.0000	0.00
	C2H6	1495.84	0.0023	0.0001	0.03
	C3H8	2154.00	0.3547	0.0096	5.73
	iC4H10	2805.80	0.2159	0.0058	4.54
	C4H10	2805.80	0.3851	0.0104	8.10

	C5H12	3463.30	0.0035	0.0001	0.09
					18.92

Table H3 Chemical exergy of LPG feed from plant3

kgmol/hr		B std kj/mole	%vol.	kgmole/hr	Bch (kW)
0.48	C2H6S	2134.00	0.0192	0.0092	5.45
	H2S	812.00	0.0192	0.0092	2.07
	CH4	831.65	0.0000	0.0000	0.00
	C2H6	1495.84	0.0023	0.0011	0.46
	C3H8	2154.00	0.3547	0.1696	101.50
	iC4H10	2805.80	0.2159	0.1032	80.46
	C4H10	2805.80	0.3851	0.1841	143.52
	C5H12	3463.30	0.0035	0.0017	1.61
					335.08

Table H4 Chemical exergy of LPG product

kgmol/hr		B std kj/mole	%vol.	kgmol/hr	Bch (kW)
0.61	C2H6S	2134.00	0.0010	0.0006	0.36
	H2S	812.00	0.0000	0.0000	0.01
	CH4	831.65	0.0000	0.0000	0.00
	C2H6	1495.84	0.0024	0.0015	0.62
	C3H8	2154.00	0.3685	0.2264	135.46

	iC4H10	2805.80	0.2243	0.1378	107.38
	C4H10	2805.80	0.4001	0.2458	191.54
	C5H12	3463.30	0.0036	0.0022	2.15
					437.52

Table H5 Exergy duty of this unit(2E1601)

STREAM ID	CAUSTIC	CAUSTICOUT
MOLAR RATE, KG-MOL/HR	18.6736	18.6736
WEIGHT RATE, KG/HR	337.3320	337.3320
LV RATE, M3/HR	.3370	.3370
GV RATE, M3/HR	456.8577	456.8577
ENTHALPY, M*J/SEC	-5798	-4889
ENTROPY, M*J/SEC C	.0313	.0316
Ts = 179 C from SL		
$W=Q*((Ts-To)/Ts)$		
W=78.204469 kW		

Table H6 Electric power of unit

	Electric	
	Amp	Kwatt
2P1601a/b	4	2.106174

Table H7 Stream properties table of LPG treating unit

Stream	Flow(m ³ /hr)	Temperature (°C)	Pressure (barg)
<u>Feed</u>			
LPG from c105	2.98	34	19

LPG from c106	0.66	32	19
LPG from plant3	11.7	36	19
fresh caustic 3-10%wt			
Air	3.259nm/hr	30	3
Products	m ³ /hr		
Treated LPG	15.03	33	16.2
vent gas from 2d1601	2.9	50	2.6

I) Data for FG TU

Table I1 Chemical exergy of fuel gas feed

kgmol/hr		B std kj/mole	%mole	kgmol/hr	Bch (kW)
332.95	H2	236.10	0.6200	206.43	13538.30
	H2S	812.00	0.0271	9.03	2035.86
	co2	19.87	0.0000	0.00	0.00
	ch4	831.65	0.1224	40.75	9414.53
	c2h6	1495.84	0.1005	33.46	13903.61
	c3h8	2154.00	0.0593	19.73	11807.93
	nc4	2805.80	0.0351	11.68	9100.84
	c5	3463.30	0.0310	10.32	9929.52
	DEA	2468.88	0.0000	0.00	0.00
	water	0.90	0.0029	0.98	0.24
			0.9983		69730.84

Table I2 Chemical exergy of rich amine

	kgmol/hr		B std kj/mole	%mole	kgmol/hr	Bch (kW)
	528.00					0.00
H2s		H2S	812.00	0.0348	18.36	4141.80
c1		ch4	831.65	0.0002	0.10	23.94
c2		c2h6	1495.84	0.0001	0.06	22.97
c3		c3h8	2154.00	0.0000	0.01	5.64
DEA		DEA	2468.88	0.0617	32.60	22355.17

water		water	0.90	0.9018	476.14	119.04
	1.00			0.9986		26668.56

Table I3 Chemical exergy of lean amine

	lean amine				
kgmol/hr		B std kJ/mole	%mole	kgmol/hr	Bch (kW)
291.26	H2S	812.00	0.0007	0.19	43.19
	DEA	2468.88	0.1277	37.19	25504.78
	water	0.90	0.8730	254.27	63.57
	Total		1.0013		25611.54

Table I4.1 Chemical exergy of acid gas

		acid gas			
KGMOL/hr		B std kJ/mol	%mole	kgmol/hr	Bch (kW)
10.71	H2	236.10	0.0000	0.00	0.00
	H2S	812.00	0.8769	9.39	2118.13
	co2	19.87	0.0412	0.44	2.43
	ch4	831.65	0.0016	0.02	4.00
	c2h6	1495.84	0.1010	1.08	449.51
	water	0.90	0.0690	0.74	0.18
					2574.26

Table I4.2 Chemical exergy of sweet gas

kgmol/hr		B std kJ/mole	%mole	kgmol/hr	Bch (kW)
298.38	H2	236.10	0.6120	182.61	11976.09
	H2S	812.00	0.0000	0.00	0.00
	co2	19.87	0.0000	0.00	0.00
	ch4	831.65	0.1043	31.12	7189.09
	c2h6	1495.84	0.1106	33.00	13712.38
	c3h8	2154.00	0.0665	19.84	11871.38
	nc4	2805.80	0.0465	13.87	10813.77

	c5	3463.30	0.0450	13.43	12917.25
	DEA	2468.88	0.0000	0.00	0.00
	water	0.90	0.0177	5.28	1.32
			1.0026		68481.28

Table I5 Exergy of steam and water of FG TU

Stream Name		SLTOE2403	BFW	SLMIX	CPLOUT
Stream Phase		Vapor	Water	Mixed	Water
Temperature	K	458.15	381.15	421.41	309.57
Pressure	BAR(GA)	3.50	23.90	3.50	3.50
Enthalpy	M*/J/SEC	1.88	0.03	1.91	0.11
Sp. Enthalpy	KJ/KG	2825.86	454.56	2630.07	153.00
Sp. Entropy	KJ/KG-K	7.04	1.39	6.58	0.52
Molecular Weight		18.01	18.01	18.01	18.01
Total Mass	KG/SEC	0.67	0.06	0.73	0.73
Dry Total Mass Rate	KG/SEC				
	B std	54.60	54.60	54.60	54.60
	B kJ/kg	781.94	93.63	722.38	51.36
	B kW	521.30	5.62	524.93	37.32

Table I6 Electric power of FG TU

	2P2401	2P2402	2P2403	2P2404	2p2408	2p2409	2p2410	2A2401	2A2402	total
Amp	5.46	36.00	119.00	15.40	1.00	1.00	5.40	18.00	24.00	225.26
kwatt	2.87	18.96	62.66	8.11	0.53	0.53	2.84	9.48	12.64	118.61

Table I7 Stream properties table of FG TU

Stream	Flow(m ³ /hr)	Temperature (°C)	Pressure (barg)
Feed			
Fuel gas	7.30km ³ /hr	37	5.62
Rich amine	11.01m ³ /hr	44	30
DEA	1 m ³ /hr	30	1
Products			
sweet gas	7.3 Km ³ /hr	40	
Acid gas to sulfur unit	262nm/hr	70	0.353
HC from 2D2401	none		
Lean amine to 3700	11.99	46.9	30
Utility in			
SL to 2j2403	1.93 lton/hr	143.7	3.5
BFW to 2J2403	216kg/hr	108	23.9

J) Data for SRU

Table J1 Chemical exergy of acid gas of sulfur recovery unit

			acid gas		
kgmol/hr		B std kj/mole	%mole	kgmol/hr	Bch (kW)
45.08	H ₂ S	812	92.7	41.78916	9425.7772
	NH ₃	337.9	0.6	0.27048	25.387553
	H ₂	236.1	1	0.4508	29.564967
	H ₂ O	0.9	5.7	2.56956	0.64239
					9481.3721

Table J2.1 Chemical exergy of liquid sulfur product of sulfur recovery unit

kgmol/hr		B std kj/mole	%mole	mass		kgmol/hr	Bch (kW)
40.42	sulfur	609.6	1	1.08	1	40.42	6844.4533

Table J2.2 Chemical exergy of fuel gas

kgmol/hr		B std kj/mole	%mole	kgmol/hr	Bch (kW)
4.92	H ₂	236.10	0.696	3.42	224.39
	C ₁	831.65	0.085	0.42	96.32
	C ₂	1495.84	0.085	0.42	174.53
	C ₃	2154.00	0.083	0.41	245.44
	iC ₄	2805.80	0.020	0.10	76.20
	nC ₄	2805.80	0.031	0.15	118.13
	C ₅₊	3463.30	0.026	0.13	123.79
					1058.80

Table J3 Chemical exergy of stack gas

KGMOL/hr		B std kj/mole	%mole	kgmol/hr	Bch (kW)
504.32	H ₂ S	812.00	0.00	0.00	0.00
	NH ₃	337.90	0.00	0.00	0.00
	H ₂	236.10	0.52	2.62	171.99
	HC'S	0.00	0.00	0.00	0.00

	H2O	0.90	16.72	84.32	21.08
	SO2	313.40	0.15	0.76	65.86
	CO	275.10	0.04	0.20	15.42
	CO2	19.87	1.15	5.80	32.01
	N2	0.72	70.00	353.03	70.61
	O2	3.97	11.42	57.59	63.51
			100.00		440.47

Table J4 Exergy of steam and water

Stream Name		BFW	SH	SL1	SL2
Stream Phase		Water	Vapor	Vapor	Water
Temperature	K	388.15	491.15	423.15	395.15
Pressure	BAR(GA)	29.00	20.70	3.40	1.10
Enthalpy	M*J/SEC	0.58	2.36	0.69	0.03
Sp. Enthalpy	KJ/KG	484.51	2805.57	2749.38	512.21
Sp. Entropy	KJ/KG-K	1.47	6.32	6.88	1.55
Molecular Weight		18.01	18.01	18.01	18.01
Total Mass	KG/SEC	1.20	0.84	0.25	0.06
Dry Total Mass Rate	KG/SEC				
		54.60	54.60	54.60	54.60
	B kJ/kg	100.79	976.70	754.32	105.17
	B kW	120.95	820.70	189.63	6.28

Table J5 Exergy of steam, condensate, and cooling water

Stream Name		WS	WR	SL3	CPL3
Stream Phase		Water	Water	Vapor	Mixed
Temperature	K	308.15	313.15	423.15	420.58
Pressure	BAR(GA)	4.10	4.10	3.40	3.40
Enthalpy	M*J/SEC	0.08	0.10	0.12	0.10
Sp. Enthalpy	KJ/KG	147.13	168.00	2749.38	2302.32
Sp. Entropy	KJ/KG-K	0.51	0.57	6.88	5.81

Molecular Weight		18.01	18.01	18.01	18.01
Total Mass	KG/SEC	0.56	0.60	0.04	0.04
Dry Total Mass Rate	KG/SEC				
		54.60	54.60	54.60	54.60
	B kJ/kg	51.21	52.06	754.32	624.16
	B kW	28.59	31.45	32.06	26.53

Table J6 Electric power of SRU

	2k2501	2k2502	2k2503	2p2501	2p2503	total
Amp	178	100	1	18	18	315
kilowatt	93.724733	52.65434	0.5265434	9.47778202	9.477782	165.8612

Table J7 Stream properties table of SRU

Stream	Total Mass(kg/hr)	Temperature(°C)	Pressure(barg)
ACIDGAS	1476.0	70.0	0.6
SULFUR	1296.0	140.0	4.0
STACKGAS	13566.0	300.0	0.0
FG	66.0	40.0	3.0
WS	2010.0	35.0	4.1
WR	2175.0	40.0	4.1
SL2	153.0	150.0	3.4
CPL2	153.0	147.4	3.4
BFW	4320.0	115.0	29.0
SH	3025.0	218.0	20.7
SL1	905.0	150.0	3.4
SL2	215.0	122.0	1.1
AIR	3452.0	30.0	0.6
AIR2	1706.0	30.0	0.1
QUENCH AIR	7965.0	38.0	0.0

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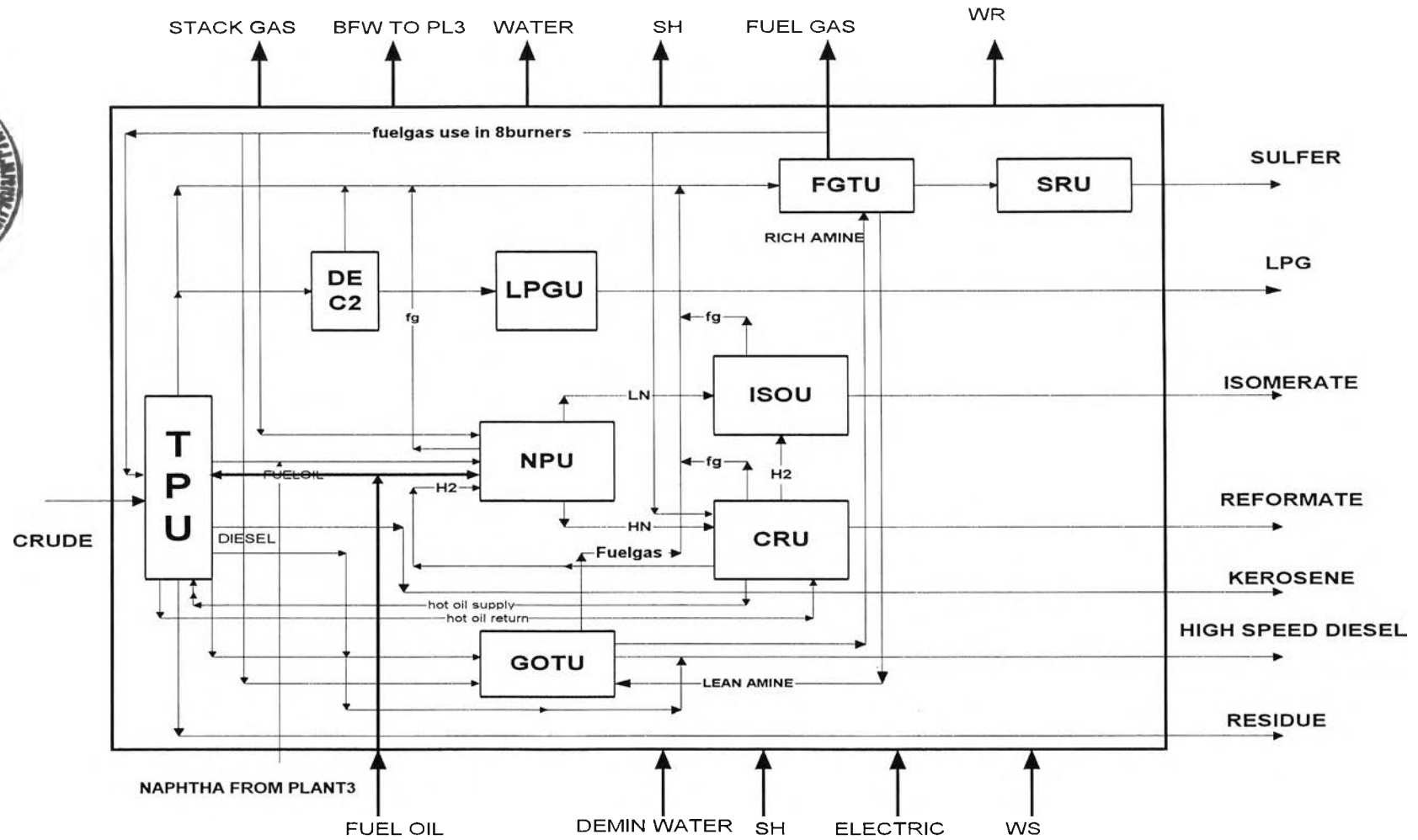


Figure 4.1 Simple process flow diagram of plant 2