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APPENDICES

Appendix A Chemical Reactions and Conversions

Pretreatment Reactions and Conversions			
	Reaction	**Conversion**	
1	$Cellulose_n + nWater \longrightarrow nGlucose$ $C_6H_{10}O_5 + H_2O \longrightarrow C_6H_{12}O_6$	Cellulose	0.070
2	$Cellulose_n + n/2Water \longrightarrow nCellobiose$ $C_6H_{10}O_5 + ½(H_2O) \longrightarrow ½C_{12}H_{22}O_{11}$	Cellulose	0.007
3	$Hemicellulose_n + nWater \longrightarrow nXylose$ $C_5H_8O_4 + H_2O \longrightarrow C_5H_{10}O_5$	Hemicellulose	0.900
4	$Hemicellulose_n \longrightarrow nFurfural + 2nWater$ $C_5H_8O_4 \longrightarrow C_5H_4O_2 + 2H_2O$	Hemicellulose	0.050
Overliming Reaction and Conversion			
	Reaction	**Conversion**	
5	Sulfuric-acid + Calcium-hydroxide (Lime) $\longrightarrow$ Gypsum $H_2SO_4 + Ca(OH)_2 \longrightarrow CaSO_4*2H_2O$	Lime	1.000
Ammonia Treating Reaction and Conversion			
6	Ammonia + Sulfuric-acid $\longrightarrow$ Ammonium sulphate $2NH_3 + H_2SO_4 \longrightarrow (NH_4)_2SO_4$	Ammonia	1.00
Saccharification Reactions and Conversions			
	Reaction	**Conversion**	
7	$Cellulose_n + n/2Water \longrightarrow nCellobiose$ $C_6H_{10}O_5 + ½(H_2O) \longrightarrow ½C_{12}H_{22}O_{11}$	Cellulose	0.012
8	$Cellulose_n + nWater \longrightarrow nGlucose$	Cellulose	0.900

	$C_6H_{10}O_5 + H_2O \longrightarrow C_6H_{12}O_6$		
9	$(Cellobiose)_n + nWater \longrightarrow 2nGlucose$ $C_{12}H_{22}O_{11} + H_2O \longrightarrow 2C_6H_{12}O_6$	Cellobiose	1.000
Seed Train Reactions and Conversions			
	Reaction	**Conversion**	
10	$Glucose \longrightarrow 2Ethanol + 2Carbon\ Dioxide$ $C_6H_{12}O_6 \longrightarrow 2C_2H_6O + 2CO_2$	Glucose	0.900
11	$Glucose + CSL + 0.018DAP \longrightarrow 6Z.\ mobilis + 2.4Water + 0.3Oxygen$ $C_6H_{12}O_6 + CSL + 0.018DAP \longrightarrow 6C_{1.8}H_{0.5}O_{0.2} + 2.4H_2O + 0.3O_2$	Glucose	0.040
12	$Glucose + 2Water \longrightarrow 2Glycerol + Oxygen$ $C_6H_{12}O_6 + 2H_2O \longrightarrow 2C_3H_8O_3 + O_2$	Glucose	0.004
13	$Glucose + 2Carbon\ Dioxide \longrightarrow 2Succinic\ Acid + Oxygen$ $C_6H_{12}O_6 + 2CO_2 \longrightarrow 2C_4H_6O_4 + O_2$	Glucose	0.006
14	$Glucose \longrightarrow 3Acetic\ Acid$ $C_6H_{12}O_6 \longrightarrow 3CH_3COOH$	Glucose	0.015
15	$Glucose \longrightarrow 2Lactic\ Acid$ $C_6H_{12}O_6 \longrightarrow 2CH_3CHOHCOOH$	Glucose	0.002
16	$3Xylose \longrightarrow 5Ethanol + 5Carbon\ Dioxide$ $3C_5H_5O_5 \longrightarrow 5C_2H_6O + 5CO2$	Xylose	0.800
17	$Xylose + 0.83CSL + 0.015DAP \longrightarrow 5Z.\ mobilis + 2Water + 0.25Oxygen$ $C_5H_{10}O_5 + 0.83CSL + 0.015DAP \longrightarrow 5C_{1.8}H_{0.5}O_{0.2} + 2H_2O + 0.25O_2$	Xylose	0.040
18	$3Xylose + 5Water \longrightarrow 5Glycerol + 2.5Oxygen$ $3C_5H_{10}O_5 + 5H_2O \longrightarrow 5C_3H_8O_3 + 2.5O_2$	Xylose	0.003
19	$Xylose + Water \longrightarrow Xylitol + 0.5Oxygen$ $C_5H_{10}O_5 + H_2O \longrightarrow C_5H_{12}O_5 + 0.5O_2$	Xylose	0.046
20	$3Xylose + 5Carbon\ Dioxide \longrightarrow 5Succinic\ Acid + 2.5Oxygen$ $3C_5H_{10}O_5 + 5CO_2 \longrightarrow 5C_4H_6O_4 + 2.5O_2$	Xylose	0.009
21	$2Xylose \longrightarrow 5Acetic\ Acid$ $2C_5H_{10}O_5 \longrightarrow 5CH_3COOH$	Xylose	0.014
22	$3Xylose \longrightarrow 5Lactic\ Acid$ $3C_5H_{10}O_5 \longrightarrow 5CH_3CHOHCOOH$	Xylose	0.002
Co-Fermentation Reactions and Conversions			
	Reaction	**Conversion**	

23	Glucose ⟶ 2Ethanol + 2Carbon-dioxide $C_6H_{12}O_6$ ⟶ $2C_2H_6O + 2CO_2$	Glucose	0.950
24	Glucose + CSL + 0.018DAP ⟶ 6Z mobilis + 2.4Water + 0.3Oxygen $C_6H_{12}O_6$ + CSL + 0.018DAP ⟶ $6C_{1.8}H_{0.5}O_{0.2} + 2.4H_2O + 0.3O_2$	Glucose	0.020
25	Glucose + 2Water ⟶ 2Glycerol + Oxygen $C_6H_{12}O_6 + 2H_2O$ ⟶ $2C_3H_8O_3 + O_2$	Glucose	0.004
26	Glucose + 2Carbon-dioxide ⟶ 2Succinic-Acid + Oxygen $C_6H_{12}O_6 + 2CO_2$ ⟶ $2C_4H_6O_4 + O_2$	Glucose	0.006
27	Glucose ⟶ 3Acetic-acid $C_6H_{12}O_6$ ⟶ $3CH_3COOH$	Glucose	0.015
28	Glucose ⟶ 2Lactic-acid $C_6H_{12}O_6$ ⟶ $2CH_3CHOHCOOH$	Glucose	0.002
29	3Xylose ⟶ 5Ethanol + 5Carbon-dioxide $3C_5H_{10}O_5$ ⟶ $5C_2H_6O + 5CO_2$	Xylose	0.850
30	Xylose + 0.83CSL + 0.015DAP ⟶ 5Z.mobilis + 2Water + 0.25Oxygen $C_5H_{10}O_5$ + 0.83CSL + 0.015DAP ⟶ $5C_{1.8}H_{0.5}O_{0.2} + 2H_2O + 0.25O_2$	Xylose	0.019
31	3Xylose + 5Water ⟶ 5Glycerol + 2.5Oxygen $3C_5H_{10}O_5 + 5H_2O$ ⟶ $5C_3H_8O_3 + 2.5O_2$	Xylose	0.003
32	Xylose + Water ⟶ Xylitol + 0.5Oxygen $C_5H_{10}O_5 + H_2O$ ⟶ $C_5H_{12}O_5 + 0.5O_2$	Xylose	0.046
33	3Xylose + 5Carbon-dioxide ⟶ 5Succinic-Acid + 2.5Oxygen $3C_5H_{10}O_5 + 5CO_2$ ⟶ $5C_4H_6O_4 + 2.5O_2$	Xylose	0.009
34	2Xylose ⟶ 5Acetic-acid $2C_5H_{10}O_5$ ⟶ $5CH_3COOH$	Xylose	0.014
35	3Xylose ⟶ 5Lactic-acid $3C_5H_{10}O_5$ ⟶ $5\ CH_3CHOHCOOH$	Xylose	0.002
Co-Fermentation Contamination Loss Reactions			

	Reaction	Conversion	
36	Glucose ⟶ 2Lactic-acid $C_6H_{12}O_6$ ⟶ $2CH_3CHOHCOOH$	Glucose	1.000
37	3Xylose ⟶ 5Lactic-acid $3C_5H_{10}O_5$ ⟶ $5\ CH_3CHOHCOOH$	Xylose	1.000

Appendix B Main Process Condition for Process Design

Table B1 Pretreatment reactor conditions

Agent	Diluted sulfuric acid
Acid concentration	1.1%
Residence time	2 minutes
Temperature	190 °C
Pressure	12.1 atm
Solids in the reactor	30%

Table B2 Blowdown tank conditions

Temperature	100 °C
Pressure	12.1 atm

Table B3 Hydrolysate conditioning conditions

Type	Overliming and reacidification
Agent	Lime and diluted sulfuric acid
Residence time	1 hour for overliming 4 hours for reacidification

Table B4 Saccharification conditions

Temperature	65 °C
Initial saccharification solids level	20%
Residence time	36 hours
Enzyme	Cellulase
Enzyme level	2% of cellulose

Table B5 Seed fermenters conditions

Inoculum level	10% of hydrolysate
Residence time	24 hours
Organism	*Zymomonas mobilis* strain
Corn steep liquor level	0.5%
Diammonium phosphate level	0.06%

Table B6 SSCF fermenters conditions

Temperature	41 °C
Inoculum level	10% of hydrolysate
Residence time	36 hours
Organism	*Zymomonas mobilis* strain
Enzyme	Cellulase
Enzyme level	2% of cellulose
Corn steep liquor level	0.28%
Diammonium phosphate level	0.06%

Table B7 Distillation column conditions

	Beer distillation	Rectification distillation
Pressure	1 atm	1 atm
Trays	32	60
Feed location	4	44
Reflux ratio	3	2.5

Appendix C Economic Data for Process Design (Base case of one feedstock)

Table C1 Raw materials and Product prices

Table C1.1 Raw materials and product prices

Raw materials prices				
Raw material	Price from literature		Price in USD ($1/30 Baht)	
	Value	Unit	Value	Unit
Cassava rhizome	0.5	Baht/kg	0.0167	$/kg
Water	29	Baht/m^3	0.001	$/kg
Sulfuric acid (93%)	35.2	Baht/kg	0.0352	$/kg
Lime	110	$/ton	0.11	$/kg
CSL	800	$/ton	0.8	$/kg
DAP	300	$/ton	0.3	$/kg
Cellulase	5	$/kg	5	$/kg
Product price				
Product	Price from literature		Price in USD ($1/30 Baht)	
	Value	Unit	Value	Unit
Ethanol	23.59	Baht/L	0.9966	$/kg

Table C1.2 Raw materials annual cost

Raw material	Quantity (kg/year)	Annual cost ($/year)	Cost per ethanol ($/liter)
Cassava rhizome	153,993,399.318	2,571,689.769	0.0520
Water	123,862,928.802	123,862.929	0.0025
Sulfuric acid (93%)	1,187,512.217	41,800.430	0.0008
Lime	769,258.466	84,618.431	0.0017
CSL	790,207.419	632,165.935	0.0128
DAP	213,540.117	64,062.035	0.0013
Cellulase	116,997.628	584,988.142	0.0128

LP steam (Pretreatment)	7,171,101.155	174,496.795	0.0035
HP steam (Pretreatment)	27,656,893.133	691,422.328	0.0140
Total		**4,969,106.794**	**0.1004**

Table C.1.3 Product annual revenue

Product	Quantity (kg/year)	Annual revenue ($/year)
Ethanol	39,356,225.007	39,222,413.842

Table C2 Utility prices

Table C2.1 Utility prices

Cooling water						
Cooling water	Price from literature		Price from calculation		Volume per energy	
	Value	Unit	Value	Unit	Value	Unit
CW 25-45 °C	2	Baht/m^3	0.796	$/GJ	11.94	m^3/GJ
Steam						
Steam	Price from literature		Price from calculation		Mass per energy	
	Value	Unit	Value	Unit	Value	Unit
LP steam	0.73	Baht/kg	11.68	$/GJ	480.12	kg/GJ
HP steam	0.75	Baht/kg	15.46	$/GJ	618.42	kg/GJ
Electricity						
Electricity	Price from literature		Price from calculation		Convert factor	
	Value	Unit	Value	Unit	Value	Unit
Electricity	3	Baht/kWh	22.78	$/GJ	0.0036	GJ/kWh

Table C2.2 Annual utility costs

Table C2.2.1 Annual cooling water cost

Unit	Quantity (MJ/hr)	Price ($/GJ)	Annual cost ($/year)	Cost per ethanol ($/liter)
E1	1,667.30	0.796	10,511.19	0.0002
E2	403.2	0.796	2,541.90	0.000051
E3	218.20	0.796	1,375.60	0.0000
E6	156.20	0.796	984.73	0.0000
E7	4,879.20	0.796	30,760.04	0.0006
Condenser T1	18,283.10	0.796	115,262.51	0.0023
Condenser T2	12,250.30	0.796	77,229.81	0.0016
R2	160.4	0.796	1,011.21	0.000002
R3	97.60	0.796	615.30	0.00001
R5	978.90	0.796	6,171.30	0.00012
R6	9,625.80	0.796	60,684.12	0.00123
R7	382.90	0.796	2,413.92	0.00005
Total			**299,050.44**	**0.00612**

Table C2.2.2 Annual LP steam cost

Unit	Quantity (MJ/hr)	Price ($/GJ)	Annual cost ($/year)	Cost per ethanol ($/litre)
E4	1,990.00	11.68	184,086.14	0.0037
E5	5,033.00	11.68	465,580.68	0.0094
Reboiler T1	23,692.70	11.68	2,191,707.43	0.0443
Reboiler T2	11,085.60	11.68	1,025,480.08	0.0207
R4	1,911.40	11.68	176,815.20	0.0036
Total			**4,043,669.53**	**0.0817**

Table C2.2.3 Annual HP steam cost

Unit	Quantity (MJ/hr)	Price ($/GJ)	Utility cost	Cost per ethanol ($/litre)
R1	9,311.00	15.46	1,140,068.64	0.0230
Total			**1,140,068.64**	**0.0230**

Table C2.2.4 Annual electricity cost

Unit	Quantity (kW)	Price ($/GJ)	Utility cost	Cost per ethanol ($/litre)
Feed Handling	276.01	27.78	218,617.41	0.00442
Pump 1	3.57	27.78	2,827.67	0.00006
S/P Separator	96.02	27.78	76,053.92	0.00154
Hydrocyclone	28.74	27.78	22,763.90	0.00046
Cooling Tower	380.00	27.78	300,984.08	0.00608
Total			**621,246.98**	**0.01255**

Total annual utility cost and cost per ethanol for the base case design equal to $6,114,546.81 and 0.1235 $/L respectively.

Table C3 Equipment Sizing and Purchase Cost for Process Design

Table C3.1 Mixers sizing and purchase cost

Unit	Material	Capacity (m^3)	Purchase cost ($)
M1	Stainless Steel	3.38	27,610.00
M2	Stainless Steel	0.78	12,358.00
M3	Stainless Steel	6.20	38,504.00
M4	Stainless Steel	2.28	22,250.00
M5	Stainless Steel	3.08	26,239.00
M6	Stainless Steel	3.10	26,332.00
M7	Stainless Steel	6.42	39,247.00
M8	Stainless Steel	0.53	9,999.00
M9	Stainless Steel	6.17	38,402.00
M10	Stainless Steel	6.23	38,606.00
M11	Stainless Steel	0.04	8,308.00
M12	Stainless Steel	12.12	55,602.00
Total			**343,457.00**

Table C3.2 Splitter sizing and purchase cost

Unit	Material	Capacity (m^3)	Purchase cost ($)
SP1	Stainless Steel	7.29	42,079.00

Table C3.3 Pumping sizing and purchase cost

Unit	Type	Material	Flow rate (m^3/s)	Purchase cost ($)
P1	Centrifugal	Stainless Steel	0.0068	8,123.00

Table C3.4 Flash drums sizing and purchase cost

Unit	Type	Material	Flow rate (kg/hr)	Height (m)	Diameter (m)	Purchase cost ($)
F1	Vertical	Stainless Steel	27435.947	4.81	1.20	53,591.00
F2	Vertical	Stainless Steel	34654.681	6.27	1.57	121,155.00
Total						**174,746.00**

Table C3.5 Heat exchangers sizing and purchase cost

Unit	Type	Material	U Value ($kW/m^2 K$)	Area (m^2)	Purchase cost ($)
E1	Floating shell & tube	Stainless Steel	1.4196	11.25	18,798.00
E2	Floating shell & tube	Stainless Steel	1.4196	3.04	17,936.00
E3	Floating shell & tube	Stainless Steel	1.4196	2.37	17,936.00
E4	Floating shell & tube	Stainless Steel	1.4196	21.85	23,436.00
E5	Floating shell & tube	Stainless Steel	1.4196	11.49	18,904.00
E6	Floating shell & tube	Stainless Steel	1.4120	0.44	17,936.00
E7	Floating shell & tube	Stainless Steel	2.2713	22.61	23,765.00
Total					**138,711.00**

Table C3.6 Reactors sizing and purchase cost

Unit	Type	Material	Capacity (m^3)	Purchase cost ($)
R1	Horizontal	Stainless Steel	0.84	78,535.00
R2	Vertical	Stainless Steel	16.28	70,605.00
R3	Vertical	Stainless Steel	16.30	425,433.00
R4	Vertical	Stainless Steel	32.63	1,181,071.00
R5-1	Vertical	Stainless Steel	0.01	17,578.00
R5-2	Vertical	Stainless Steel	0.12	17,578.00

R5-3	Vertical	Stainless Steel	1.17	31,485.00
R5-4	Vertical	Stainless Steel	11.73	103,050.00
R5-5	Vertical	Stainless Steel	117.33	332,426.00
R6	Horizontal	Stainless Steel	1,164.10	1,181,071.00
R7	Horizontal	Stainless Steel	8.72	103,050.00
Total				**3,541,882.00**

Table C3.7 distillation columns sizing and purchase cost

Unit	Detail	Specifications
T1	**Tower**	
	Material	Stainless Steel
	Height (m)	24.90
	Diameter (m)	1.68
	Purchase cost	391,752.00
	Tray	
	Type	Valve
	Material	Stainless Steel
	No. of trays	32
	Diameter (mm)	47.625
	Purchase cost	16,966.00
T1	**Vessel**	
	Type	Horizontal
	Material	Stainless Steel
	Height (m)	4.38
	Diameter (m)	1.10
	Purchase cost	21,474.00
	Condenser	
	Type	Fixed tube
	Material	Stainless Steel
	Area (m^2)	87.88

	Purchase cost	26,444.00
	Reboiler	
	Type	Floating shell & tube
	Material	Stainless Steel
	Area (m^2)	41.48
	Purchase cost	31,830.00
Total purchase cost of T1 ($)		**488,466.00**
T2	**Tower**	
	Material	Stainless Steel
	Height (m)	33.67
	Diameter (m)	1.52
	Purchase cost	522,384.00
	Tray	
	Type	Valve
	Material	Stainless Steel
	No. of trays	60
	Diameter (mm)	47.625
	Purchase cost	31,810.00
	Vessel	
	Type	Horizontal
	Material	Stainless Steel
	Height (m)	4.86
	Diameter (m)	1.21
	Purchase cost	37,348.00
T2	**Condenser**	
	Type	Fixed tube
	Material	Stainless Steel
	Area (m^2)	59.58
	Purchase cost	19,449.00
	Reboiler	
	Type	Floating shell & tube

	Material	Stainless Steel
	Area (m^2)	17.05
	Purchase cost	21,345.00
Total purchase cost of T2 ($)		**632,336.00**
Total purchase cost of distillation columns ($)		**1,120,802.00**

Table C3.8 Storage tanks sizing and purchase cost

Storage	Type	Material	Capacity (m^3)	Purchase cost ($)
Cassava rhizome	Cone roof	Carbon steel	11,022.94	735,695.00
Water	Cone roof	Carbon steel	5,053.53	382,133.00
Sulfuric acid	Floating roof	Stainless steel	52.75	329,258.00
DAP	Floating roof	Stainless steel	10.97	29,589.00
CSL	Cone roof	Carbon steel	65.75	29,589.00
Cellulase	Cone roof	Carbon steel	6.36	29,589.00
Lime	Cone roof	Carbon steel	26.84	29,589.00
Gypsum	Cone roof	Carbon steel	7.69	29,589.00
Solid waste	Cone roof	Carbon steel	761.06	111,171.00
Waste water	Cone roof	Stainless steel	911.45	187,568.00
Ethanol	Floating roof	Carbon steel	2,159.62	373,190.00
Total				**2,266,960.00**

Table C.3.9 Utility unit sizing and purchase cost

Unit	Capacity (m^3/h)	Purchase cost ($)
Cooling tower	452.02	896,217.00

Table C3.10 Additional units sizing and purchase cost (NREL, 2002)

Unit	Purchase cost ($)
Feed handling	7,475,195.00
Solid-liquid separator	5,002,153.00
Seed hold tank	195,274.00
Molecular sieve	3,112,319.00
Lime blower	141,078.00
Hydrocyclone	265,695.00
Total	**16,191,714.00**

Total equipment cost for base case design equals to $24,724,691.00.

Table C4 Total Capital Cost Analysis for Process Design

Description	Cost ($)
I. Manufacturing Fixed-capital Investment (Direct cost)	
Purchased Equipment Delivered	27,197,160.10
Purchased Equipment Installation	12,782,665.25
Instrumentation and Controls (installed)	9,790,977.64
Piping (Installed)	18,494,068.87
Electrical Systems (Installed)	2,991,687.61
Buildings (Including Services)	4,895,488.82
Yard Improvement	2,719,716.01
Service Facilities (Installed)	19,038,012.07
Land Cost	2,000,000.00
Total Direct Cost	**97,909,776.36**
II. Non-manufacturing Fixed-capital Investment (Indirect cost)	
Engineering and Supervision	8,975,062.83
Construction Expenses	11,150,835.64
Legal Expenses	1,087,886.40
Contractor's Fees	5,983,375.22
Contingency	11,966,750.44
Total Indirect Cost	**39,163,910.54**
III. Fixed-capital Investment (FCI) = Direct cost + Indirect cost	**137,073,686.90**
IV. Working capital Investments (WC)	**543,943.20**
V. Total Capital Investment (TCI) = Fixed-capital investment + Working capital	**137,617,630.11**

Table C5 Total Operating Cost Analysis for Process design

Items of Operating Cost	Factor	Basis	Cost, $/year
I. Variable Cost			
Raw Material	-	-	5,174,382.00
Operating Labor	0.02	Fixed Capital Investment	2,741,473.75
Operating Supervision	0.015	Operating Labor	411,221.06
Utilities	-	-	6,114,547.00
Maintenance and Repairs	0.06	Fixed Capital Investment	8,224,421.22
Operating Supplies	0.15	Maintenance and Supplies	1,233,663.15
Laboratory Charges	0.15	Operating Labor	411,221.06
Royalties	0.01	Total Product Cost	412,360.80
Total Variable Cost			**24,723,291.55**
II. Fixed Charges			
Property Taxes	0.02	Fixed Capital Investment	2,741,473.74
Insurance	0.01	Fixed Capital Investment	1,370,736.87
Total Fixed Charges			**4,112,210.61**
III. Manufacturing Cost			
Plant Overhead	0.6	Labor + Supervision + Maintenance	**6,826,269.60**
Total Manufacturing Cost			**28,835,502.16**
IV. General Expense			
Administration	0.2	Labor + Supervision + Maintenance	2,275,423.20
Distribution & selling	0.04	Total Product Cost	1,649,443.20
Research & Development	0.04	Total Product Cost	1,649,443.20
General Expense			**5,574,309.60**
V. Total Product Cost with Out Depreciation			**41,236,080.00**

Appendix D Stream Table of Process Design (Base case of one feedstock)

Table D1 Base case design

Stream Name		1	2	3	4	5	6	7	8
Phase		Solid	Vapor	Liquid	Liquid	Vapor	Mixed	Liquid	Mixed
Temperature	C	30.000	160.000	25.000	25.000	268.000	99.997	25.000	188.007
Pressure	ATM	1.000	6.000	1.000	1.000	13.000	1.000	1.000	12.100
Enthalpy	M*KJ/HR	-32.808	2.502	0.507	0.004	9.719	-30.306	0.510	-20.077
Molecular Weight		106.530	18.015	18.015	98.079	18.015	87.418	18.323	41.370
Vapor Weight Fraction		1.000	1.000	0.000	0.000	1.000	0.956	0.000	0.676
Liquid Weight Fraction		0.000	0.000	1.000	1.000	0.000	0.044	1.000	0.324
Total Mass Rate	KG/DAY	466646.665	21730.610	115717.862	2432.500	83808.767	488377.274	118150.362	690336.403
Total Weight Comp. Rates	KG/DAY								
Cellulose		139667.347	0.000	0.000	0.000	0.000	139667.347	0.000	139667.347
Hemicellulose		199398.120	0.000	0.000	0.000	0.000	199398.120	0.000	199398.120
Lignin		109008.661	0.000	0.000	0.000	0.000	109008.661	0.000	109008.661
Glucose		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Xylose		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cellobiose		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ethanol		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Water		0.000	21730.610	115717.862	0.000	83808.767	21730.610	115717.862	221257.239
Sulfuric Acid		0.000	0.000	0.000	2432.500	0.000	0.000	2432.500	2432.500
Furfural		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ammonia		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oxygen		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Carbon Dioxide		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Glycerol		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Succinic Acid		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Lactic Acid		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
HMF		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Xylitol		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Acetic Acid		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CornSteep Liquor		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ZM		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cellulase		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Lime		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CASO4		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ash		18572.537	0.000	0.000	0.000	0.000	18572.537	0.000	18572.537
DAMPHOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table D1 Base case design (cont'd)

Stream Name		9	10	11	12	13	14	15	16
Stream Description									
Phase		Mixed	Vapor	Liquid	Solid	Mixed	Liquid	Mixed	Mixed
Temperature	C	190.000	104.915	104.915	104.915	104.915	46.000	78.473	50.000
Pressure	ATM	12.100	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Enthalpy	M*KJ/HR	-2.550	7.098	6.441	-16.090	-9.648	2.066	6.579	4.832
Molecular Weight		44.789	18.774	39.659	92.512	52.441	18.015	25.166	25.166
Vapor Weight Fraction		0.386	1.000	0.000	1.000	0.427	0.000	0.003	0.003
Liquid Weight Fraction		0.614	0.000	1.000	0.000	0.573	1.000	0.997	0.997
Total Mass Rate	KG/DAY	690336.016	65772.632	358099.319	266464.065	624563.384	257147.593	458734.514	458734.514
Total Weight Comp. Rates	KG/DAY								
Cellulose		128912.961	0.000	0.000	128912.961	128912.961	0.000	644.565	644.565
Hemicellulose		9969.906	0.000	0.000	9969.906	9969.906	0.000	49.850	49.850
Lignin		109008.661	0.000	0.000	109008.661	109008.661	0.000	545.043	545.043
Glucose		10863.043	0.000	10863.043	0.000	10863.043	0.000	8581.804	8581.804
Xylose		203928.597	0.000	203928.597	0.000	203928.597	0.000	132553.588	132553.588
Cellobiose		1031.977	0.000	1031.977	0.000	1031.977	0.000	815.262	815.262
Ethanol		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Water		198364.958	62500.706	135864.252	0.000	135864.252	257147.593	310479.358	310479.358
Sulfuric Acid		2432.500	0.000	2432.499	0.000	2432.499	0.000	1921.675	1921.675
Furfural		7250.876	3271.926	3978.950	0.000	3978.950	0.000	3143.371	3143.371
Ammonia		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oxygen		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Carbon Dioxide		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Glycerol		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Succinic Acid		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Lactic Acid		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
HMF		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Xylitol		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Acetic Acid		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CornSteep Liquor		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ZM		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cellulase		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Lime		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CASO4		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ash		18572.537	0.000	0.000	18572.537	18572.537	0.000	0.000	0.000
DAMPHOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table D1 Base case design (cont'd)

Stream Name		17	18	19	20	21	22	23	24
Stream Description									
Phase		Solid	Mixed	Liquid	Mixed	Mixed	Mixed	Mixed	Mixed
Temperature	C	25.000	49.952	25.000	49.952	49.924	49.924	49.924	78.473
Pressure	ATM	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Enthalpy	M*KJ/HR	-0.260	4.572	0.002	4.730	4.732	4.827	0.227	-14.161
Molecular Weight		74.093	25.250	98.079	25.223	25.271	25.254	148.748	53.169
Vapor Weight Fraction		1.000	0.008	0.000	0.010	0.010	0.012	0.213	0.627
Liquid Weight Fraction		0.000	0.992	1.000	0.990	0.990	0.988	0.787	0.373
Total Mass Rate	KG/DAY	2331.086	461065.600	1166.022	461065.600	462231.622	462233.090	23334.254	422976.462
Total Weight Comp. Rates	KG/DAY								
Cellulose		0.000	644.565	0.000	644.565	644.565	644.565	644.565	128268.396
Hemicellulose		0.000	49.850	0.000	49.850	49.850	49.850	49.850	9920.056
Lignin		0.000	545.043	0.000	545.043	545.043	545.043	0.000	108463.618
Glucose		0.000	8581.804	0.000	8581.804	8581.804	8581.804	1115.634	2281.239
Xylose		0.000	132553.588	0.000	132553.588	132553.588	132553.588	17231.966	71375.009
Cellobiose		0.000	815.262	0.000	815.262	815.262	815.262	0.000	216.715
Ethanol		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Water		0.000	310479.358	0.000	311185.305	311185.305	311613.656	0.000	82532.487
Sulfuric Acid		0.000	1921.675	1166.022	0.000	1166.022	0.000	0.000	510.825
Furfural		0.000	3143.371	0.000	3143.371	3143.371	3143.371	6.287	835.580
Ammonia		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oxygen		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Carbon Dioxide		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Glycerol		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Succinic Acid		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Lactic Acid		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
HMF		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Xylitol		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Acetic Acid		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CornSteep Liquor		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ZM		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cellulase		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Lime		2331.086	2331.086	0.000	879.386	879.386	0.000	0.000	0.000
CASO4		0.000	0.000	0.000	2667.427	2667.427	4285.952	4285.952	0.000
Ash		0.000	0.000	0.000	0.000	0.000	0.000	0.000	18572.537
DAMPHOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table D1 Base case design (cont'd)

Stream Name		25	26	27	28	29	30	31	32
Stream Description									
Phase		Mixed	Mixed	Mixed	Mixed	Mixed	Solid	Liquid	Mixed
Temperature	C	49.924	60.841	65.000	65.000	65.000	25.000	25.000	41.147
Pressure	ATM	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Enthalpy	M*KJ/HR	4.600	-9.561	-9.156	1.514	0.151	0.000	0.002	-0.075
Molecular Weight		24.187	33.020	33.020	33.959	33.959	132.056	18.015	33.959
Vapor Weight Fraction		0.001	0.308	0.308	0.173	0.173	1.000	0.000	0.173
Liquid Weight Fraction		0.999	0.692	0.692	0.827	0.827	0.000	1.000	0.827
Total Mass Rate	KG/DAY	438898.836	861875.298	861875.298	861876.101	86187.610	55.504	430.541	86187.610
Total Weight Comp. Rates	KG/DAY								
Cellulose		0.000	128268.396	128268.396	11287.619	1128.762	0.000	0.000	1128.762
Hemicellulose		0.000	9920.056	9920.056	9920.056	992.006	0.000	0.000	992.006
Lignin		545.043	109008.661	109008.661	109008.661	10900.866	0.000	0.000	10900.866
Glucose		7466.169	9747.408	9747.408	139102.428	13910.243	0.000	0.000	13910.243
Xylose		115321.622	186696.630	186696.630	186696.630	18669.663	0.000	0.000	18669.663
Cellobiose		815.262	1031.977	1031.977	1624.718	162.472	0.000	0.000	162.472
Ethanol		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Water		311613.656	394146.144	394146.144	381179.963	38117.996	0.000	0.000	38117.996
Sulfuric Acid		0.000	510.825	510.825	510.825	51.082	0.000	0.000	51.082
Furfural		3137.084	3972.663	3972.663	3972.663	397.266	0.000	0.000	397.266
Ammonia		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oxygen		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Carbon Dioxide		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Glycerol		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Succinic Acid		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Lactic Acid		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
HMF		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Xylitol		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Acetic Acid		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CornSteep Liquor		0.000	0.000	0.000	0.000	0.000	0.000	430.541	0.000
ZM		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cellulase		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Lime		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CASO4		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ash		0.000	18572.537	18572.537	18572.537	1857.254	0.000	0.000	1857.254
DAMPHOS		0.000	0.000	0.000	0.000	0.000	55.504	0.000	0.000

Table D1 Base case design (cont'd)

Stream Name		33	34	35	36	37	38	39	40
Stream Description									
Phase		Mixed	Mixed	Vapor	Mixed	Mixed	Mixed	Mixed	Solid
Temperature	C	41.000	41.000	43.815	43.815	65.000	40.834	41.140	25.000
Pressure	ATM	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Enthalpy	M*KJ/HR	-0.079	-0.309	0.114	-0.423	1.363	-0.698	-1.121	-0.003
Molecular Weight		33.802	28.779	44.026	27.006	33.959	33.959	33.223	132.056
Vapor Weight Fraction		0.174	0.330	1.000	0.209	0.173	0.173	0.176	1.000
Liquid Weight Fraction		0.826	0.670	0.000	0.791	0.827	0.827	0.824	0.000
Total Mass Rate	KG/DAY	86802.817	86802.616	13835.256	72967.360	775688.491	775688.491	848655.851	591.587
Total Weight Comp. Rates	KG/DAY								
Cellulose		1128.762	1128.762	0.000	1128.762	10158.857	10158.857	11287.619	0.000
Hemicellulose		992.006	992.006	0.000	992.006	8928.051	8928.051	9920.056	0.000
Lignin		10900.866	10900.866	0.000	10900.866	98107.795	98107.795	109008.661	0.000
Glucose		13910.243	1299.626	0.000	1299.626	125192.185	125192.185	126491.811	0.000
Xylose		18669.663	3324.776	0.000	3324.776	168026.967	168026.967	171351.743	0.000
Cellobiose		162.472	162.472	0.000	162.472	1462.246	1462.246	1624.718	0.000
Ethanol		0.000	14041.176	1053.088	12988.088	0.000	0.000	12988.088	0.000
Water		38117.996	38144.248	19.072	38125.176	343061.967	343061.967	381187.143	0.000
Sulfuric Acid		51.082	51.082	0.000	51.082	459.742	459.742	510.825	0.000
Furfural		397.266	397.266	0.000	397.266	3575.397	3575.397	3972.663	0.000
Ammonia		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oxygen		0.000	38.169	38.169	0.000	0.000	0.000	0.000	0.000
Carbon Dioxide		0.000	13394.660	12724.927	669.733	0.000	0.000	669.733	0.000
Glycerol		0.000	16.455	0.000	16.455	0.000	0.000	16.455	0.000
Succinic Acid		0.000	50.688	0.000	50.688	0.000	0.000	50.688	0.000
Lactic Acid		0.000	9.267	0.000	9.267	0.000	0.000	9.267	0.000
HMF		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Xylitol		0.000	166.606	0.000	166.606	0.000	0.000	166.606	0.000
Acetic Acid		0.000	67.133	0.000	67.133	0.000	0.000	67.133	0.000
CornSteep Liquor		430.541	410.012	0.000	410.012	0.000	0.000	410.012	0.000
ZM		0.000	168.131	0.000	168.131	0.000	0.000	168.131	0.000
Cellulase		129.162	129.162	0.000	129.162	0.000	0.000	129.162	0.000
Lime		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CASO4		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ash		1857.254	1857.254	0.000	1857.254	16715.284	16715.284	18572.537	0.000
DAMPHOS		55.504	52.800	0.000	52.800	0.000	0.000	52.800	591.587

Table D1 Base case design (cont'd)

Stream Name		41	42	43	44	45	46	47	48
Stream Description									
Phase		Liquid	Solid	Liquid	Mixed	Mixed	Mixed	Liquid	Mixed
Temperature	C	25.000	25.000	25.000	25.000	41.001	41.001	41.001	41.001
Pressure	ATM	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Enthalpy	M*KJ/HR	0.009	-0.010	0.011	0.001	-1.115	-1.249	0.135	-2.463
Molecular Weight		18.015	22.840	18.015	18.338	33.091	32.815	161.569	28.117
Vapor Weight Fraction		0.000	1.000	0.000	0.083	0.176	0.177	0.000	0.323
Liquid Weight Fraction		1.000	0.000	1.000	0.917	0.824	0.823	1.000	0.677
Total Mass Rate	KG/DAY	1964.027	225.376	2476.754	2702.130	853913.595	844978.288	8935.307	844976.208
Total Weight Comp. Rates	KG/DAY								
Cellulose		0.000	0.000	0.000	0.000	11287.619	11287.619	0.000	1115.217
Hemicellulose		0.000	0.000	0.000	0.000	9920.056	9920.056	0.000	9920.056
Lignin		0.000	0.000	0.000	0.000	109008.661	109008.661	0.000	109008.661
Glucose		0.000	0.000	0.000	0.000	126491.811	122697.057	3794.754	6471.731
Xylose		0.000	0.000	0.000	0.000	171351.743	166211.191	5140.552	22685.334
Cellobiose		0.000	0.000	0.000	0.000	1624.718	1624.718	0.000	0.000
Ethanol		0.000	0.000	0.000	0.000	12988.088	12988.088	0.000	151177.439
Water		0.000	0.000	2476.754	2476.754	383663.897	383663.897	0.000	382439.825
Sulfuric Acid		0.000	0.000	0.000	0.000	510.825	510.825	0.000	510.825
Furfural		0.000	0.000	0.000	0.000	3972.663	3972.663	0.000	3972.663
Ammonia		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oxygen		0.000	0.000	0.000	0.000	0.000	0.000	0.000	214.011
Carbon Dioxide		0.000	0.000	0.000	0.000	669.733	669.733	0.000	132560.457
Glycerol		0.000	0.000	0.000	0.000	16.455	16.455	0.000	118.664
Succinic Acid		0.000	0.000	0.000	0.000	50.688	50.688	0.000	377.252
Lactic Acid		0.000	0.000	0.000	0.000	9.267	9.267	0.000	67.698
HMF		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Xylitol		0.000	0.000	0.000	0.000	166.606	166.606	0.000	1303.374
Acetic Acid		0.000	0.000	0.000	0.000	67.133	67.133	0.000	488.632
CornSteep Liquor		1964.027	0.000	0.000	0.000	2374.039	2374.039	0.000	2313.005
ZM		0.000	0.000	0.000	0.000	168.131	168.131	0.000	667.944
Cellulase		0.000	225.376	0.000	225.376	354.538	354.538	0.000	354.538
Lime		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CASO4		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ash		0.000	0.000	0.000	0.000	18572.537	18572.537	0.000	18572.537
DAMPHOS		0.000	0.000	0.000	0.000	644.387	644.387	0.000	636.346

Table D1 Base case design (cont'd)

Stream Name		49	50	51	52	53	54	55	56
Stream Description									
Phase		Liquid	Mixed	Vapor	Mixed	Liquid	Solid	Liquid	Liquid
Temperature	C	41.001	41.033	41.033	41.033	41.033	41.033	41.260	100.519
Pressure	ATM	1.000	1.000	1.000	1.000	1.000	1.000	4.760	4.760
Enthalpy	M*KJ/HR	0.035	-2.428	1.400	-3.827	3.875	-7.703	3.895	9.099
Molecular Weight		90.079	28.321	42.359	26.696	23.354	65.573	23.354	23.354
Vapor Weight Fraction		0.000	0.319	1.000	0.194	0.000	1.000	0.000	0.000
Liquid Weight Fraction		1.000	0.681	0.000	0.806	1.000	0.000	1.000	1.000
Total Mass Rate	KG/DAY	8935.236	853911.444	132460.320	721451.124	581175.824	140275.299	581175.824	581175.824
Total Weight Comp. Rates	KG/DAY								
Cellulose		0.000	1115.217	0.000	1115.217	0.000	1115.217	0.000	0.000
Hemicellulose		0.000	9920.056	0.000	9920.056	0.000	9920.056	0.000	0.000
Lignin		0.000	109008.661	0.000	109008.661	0.000	109008.661	0.000	0.000
Glucose		0.000	6471.731	0.000	6471.731	6471.731	0.000	6471.731	6471.731
Xylose		0.000	22685.334	0.000	22685.334	22685.334	0.000	22685.334	22685.334
Cellobiose		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ethanol		0.000	151177.439	8994.806	142182.633	142182.633	0.000	142182.633	142182.633
Water		0.000	382439.825	3819.392	378620.432	378620.432	0.000	378620.432	378620.432
Sulfuric Acid		0.000	510.825	0.000	510.825	510.825	0.000	510.825	510.825
Furfural		0.000	3972.663	79.553	3893.110	3893.110	0.000	3893.110	3893.110
Ammonia		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oxygen		0.000	214.011	211.671	2.340	2.340	0.000	2.340	2.340
Carbon Dioxide		0.000	132560.457	119337.922	13222.536	13222.536	0.000	13222.536	13222.536
Glycerol		0.000	118.664	0.001	118.663	118.663	0.000	118.663	118.663
Succinic Acid		0.000	377.252	0.000	377.252	377.252	0.000	377.252	377.252
Lactic Acid		8935.236	9002.934	0.026	9002.907	9002.907	0.000	9002.907	9002.907
HMF		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Xylitol		0.000	1303.374	0.000	1303.374	1303.374	0.000	1303.374	1303.374
Acetic Acid		0.000	488.632	5.209	483.423	483.423	0.000	483.423	483.423
CornSteep Liquor		0.000	2313.005	11.740	2301.265	2301.265	0.000	2301.265	2301.265
ZM		0.000	667.944	0.000	667.944	0.000	667.944	0.000	0.000
Cellulase		0.000	354.538	0.000	354.538	0.000	354.538	0.000	0.000
Lime		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CASO4		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ash		0.000	18572.537	0.000	18572.537	0.000	18572.537	0.000	0.000
DAMPHOS		0.000	636.346	0.000	636.346	0.000	636.346	0.000	0.000

Table D1 Base case design (cont'd)

Stream Name		57	58	59	60	61	62	63	64	65	66	S1
Stream Description												
Phase		Liquid	Vapor	Vapor	Liquid	Vapor	Liquid	Vapor	Vapor	Vapor	Liquid	Solid
Temperature	C	100.000	100.000	78.623	96.581	78.171	81.781	100.000	100.000	100.000	40.000	25.000
Pressure	ATM	4.760	4.760	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Enthalpy	M*KJ/HR	8.915	0.184	7.383	6.946	6.004	0.206	6.160	5.358	0.802	0.479	-0.006
Molecular Weight		23.097	42.600	39.093	20.261	42.170	25.700	42.170	45.714	18.928	45.714	22.840
Vapor Weight Fraction		0.000	1.000	1.000	0.000	1.000	0.000	1.000	1.000	1.000	0.000	1.000
Liquid Weight Fraction		1.000	0.000	0.000	1.000	0.000	1.000	0.000	0.000	0.000	1.000	0.000
Total Mass Rate	KG/DAY	567158.323	14017.501	144545.977	422612.346	126791.816	17754.161	126791.816	119261.288	7530.528	119261.288	129.162
Total Weight Comp. Rates	KG/DAY											
Cellulose		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hemicellulose		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Lignin		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Glucose		6471.731	0.000	0.000	6471.731	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Xylose		22685.334	0.000	0.000	22685.334	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cellobiose		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ethanol		141756.085	426.548	127964.379	13791.706	119262.811	8701.569	119262.811	118666.497	596.314	118666.497	0.000
Water		378279.674	340.758	16568.505	361711.169	7529.005	9039.500	7529.005	594.791	6934.214	594.791	0.000
Sulfuric Acid		510.825	0.000	0.000	510.825	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Furfural		3869.960	23.150	11.790	3858.170	0.000	11.790	0.000	0.000	0.000	0.000	0.000
Ammonia		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oxygen		0.000	2.340	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Carbon Dioxide		0.000	13222.536	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Glycerol		118.663	0.000	0.000	118.663	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Succinic Acid		377.252	0.000	0.000	377.252	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Lactic Acid		9002.907	0.000	0.000	9002.907	0.000	0.000	0.000	0.000	0.000	0.000	0.000
HMF		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Xylitol		1303.374	0.000	0.000	1303.374	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Acetic Acid		483.233	0.190	0.403	482.830	0.000	0.403	0.000	0.000	0.000	0.000	0.000
CornSteep Liquor		2299.287	1.979	0.900	2298.387	0.000	0.900	0.000	0.000	0.000	0.000	0.000
ZM		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cellulase		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	129.162
Lime		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CASO4		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ash		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
DAMPHOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Appendix E Results of Sustainability analysis

Table E1 Sustainability Results of alternative D case

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 1	Cellulose	1,988	-0,268	0,091	-0,358
OP 2	Cellulose	18,132	Non Defined	0,828	Non Defined
OP 3	Cellulose	17,891	-2,409	0,800	-3,208
OP 4	Cellulose	163,189	Non Defined	7,293	Non Defined
OP 5	Cellulose	2085,164	Non Defined	90,668	Non Defined
OP 6	Cellulose	190,737	Non Defined	7,542	Non Defined
OP 7	Cellulose	0,361	-0,049	0,018	-0,066
OP 8	Cellulose	3,294	Non Defined	0,162	Non Defined
OP 9	Cellulose	3,250	-0,438	0,156	-0,594
OP 10	Cellulose	29,643	Non Defined	1,424	Non Defined
OP 11	Cellulose	378,762	Non Defined	17,738	Non Defined
OP 12	Cellulose	34,647	Non Defined	1,486	Non Defined
OP 13	Cellulose	3,324	-0,448	0,153	-0,601
OP 14	Cellulose	30,319	Non Defined	1,398	Non Defined
OP 15	Cellulose	29,916	-4,028	1,349	-5,377
OP 16	Cellulose	272,875	Non Defined	12,308	Non Defined
OP 17	Cellulose	3486,685	Non Defined	153,039	Non Defined
OP 18	Cellulose	318,938	Non Defined	12,742	Non Defined
OP 19	Hemicellulose	17,682	137,663	0,807	136,856
OP 20	Hemicellulose	159,141	1238,971	7,105	1231,866
OP 21	Hemicellulose	3359,645	Non Defined	132,699	Non Defined
OP 22	Hemicellulose	0,941	7,324	0,046	7,278
OP 23	Hemicellulose	8,467	65,916	0,406	65,510
OP 24	Hemicellulose	178,741	Non Defined	7,658	Non Defined
OP 25	Hemicellulose	13,024	101,397	0,600	100,797
OP 26	Hemicellulose	117,217	912,575	5,281	907,294
OP 27	Hemicellulose	2474,577	Non Defined	98,754	Non Defined
OP 28	Lignin	193,335	-26,031	7,339	-33,370
OP 29	Lignin	1740,012	-234,275	64,262	-298,537
OP 30	Lignin	28,149	-3,790	1,144	-4,934
OP 31	Lignin	253,338	-34,109	10,035	-44,144
OP 32	Lignin	210,896	-28,395	8,075	-36,470
OP 33	Lignin	1898,067	-255,556	70,722	-326,277
OP 34	Glucose	0,092	0,000	0,007	-0,007
OP 35	Glucose	1,654	Non Defined	0,050	Non Defined
OP 36	Glucose	0,054	Non Defined	0,002	Non Defined
OP 37	Glucose	17,466	Non Defined	0,514	Non Defined
OP 38	Glucose	8,865	0,000	0,710	-0,710
OP 39	Glucose	159,330	Non Defined	4,690	Non Defined
OP 40	Glucose	5,202	Non Defined	0,148	Non Defined
OP 41	Glucose	0,017	0,000	0,001	-0,001
OP 42	Glucose	0,300	Non Defined	0,010	Non Defined

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 43	Glucose	0,010	Non Defined	0,000	Non Defined
OP 44	Glucose	3,173	Non Defined	0,100	Non Defined
OP 45	Glucose	1,610	0,000	0,132	-0,132
OP 46	Glucose	28,942	Non Defined	0,912	Non Defined
OP 47	Glucose	0,945	Non Defined	0,029	Non Defined
OP 48	Glucose	0,154	0,000	0,013	-0,013
OP 49	Glucose	2,766	Non Defined	0,085	Non Defined
OP 50	Glucose	0,090	Non Defined	0,003	Non Defined
OP 51	Glucose	29,206	Non Defined	0,867	Non Defined
OP 52	Glucose	14,824	0,000	1,191	-1,191
OP 53	Glucose	266,423	Non Defined	7,910	Non Defined
OP 54	Glucose	- 8,698	Non Defined	0,250	Non Defined
OP 55	Glucose	3,143	0,000	0,177	-0,177
OP 56	Glucose	56,487	Non Defined	0,316	Non Defined
OP 57	Glucose	1,844	Non Defined	0,009	Non Defined
OP 58	Glucose	596,504	Non Defined	2,764	Non Defined
OP 59	Glucose	302,760	0,000	16,753	-16,753
OP 60	Glucose	5441,397	Non Defined	25,325	Non Defined
OP 61	Glucose	177,654	Non Defined	0,657	Non Defined
OP 62	Xylose	8,527	0,000	0,682	-0,682
OP 63	Xylose	53,950	Non Defined	1,638	Non Defined
OP 64	Xylose	1,932	Non Defined	0,057	Non Defined
OP 65	Xylose	297,272	Non Defined	8,744	Non Defined
OP 66	Xylose	430,949	0,000	34,045	-34,045
OP 67	Xylose	2726,535	Non Defined	80,256	Non Defined
OP 68	Xylose	97,654	Non Defined	2,781	Non Defined
OP 69	Xylose	0,454	0,000	0,037	-0,037
OP 70	Xylose	2,870	Non Defined	0,093	Non Defined
OP 71	Xylose	0,103	Non Defined	0,003	Non Defined
OP 72	Xylose	15,816	Non Defined	0,498	Non Defined
OP 73	Xylose	22,927	0,000	1,859	-1,859
OP 74	Xylose	145,058	Non Defined	4,572	Non Defined
OP 75	Xylose	5,195	Non Defined	0,159	Non Defined
OP 76	Xylose	6,281	0,000	0,504	-0,504
OP 77	Xylose	39,738	Non Defined	1,217	Non Defined
OP 78	Xylose	1,423	Non Defined	0,042	Non Defined
OP 79	Xylose	218,958	Non Defined	6,497	Non Defined
OP 80	Xylose	317,419	0,000	25,157	-25,157
OP 81	Xylose	2008,253	Non Defined	59,626	Non Defined
OP 82	Xylose	71,928	Non Defined	2,067	Non Defined
OP 83	Cellobiose	1,830	Non Defined	0,028	Non Defined
OP 84	Cellobiose	16,473	Non Defined	0,247	Non Defined
OP 85	Cellobiose	0,332	Non Defined	0,006	Non Defined
OP 86	Cellobiose	2,992	Non Defined	0,048	Non Defined
OP 87	Cellobiose	3,060	Non Defined	0,048	Non Defined
OP 88	Cellobiose	27,544	Non Defined	0,417	Non Defined
OP 89	Cellobiose	3,041	Non Defined	0,007	Non Defined
OP 90	Cellobiose	27,373	Non Defined	0,053	Non Defined

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 91	Ethanol	44,476	0,000	0,000	0,000
OP 92	Ethanol	43,200	0,000	0,000	0,000
OP 93	Ethanol	421,756	3328,952	26,543	3302,409
OP 94	Ethanol	2,119	0,000	0,120	-0,120
OP 95	Ethanol	30,927	0,000	25,030	-25,030
OP 96	Ethanol	49,016	0,000	4,986	-4,986
OP 97	Ethanol	1,516	0,000	0,026	-0,026
OP 98	Ethanol	463,264	0,000	0,000	0,000
OP 99	Ethanol	4522,739	35698,302	284,641	35413,661
OP 100	Ethanol	22,727	0,000	1,290	-1,290
OP 101	Ethanol	331,644	0,000	268,412	-268,412
OP 102	Ethanol	525,629	0,000	53,466	-53,466
OP 103	Ethanol	16,257	0,000	0,284	-0,284
OP 104	H2O	109,495	-0,867	1,406	-2,273
OP 105	H2O	0,011	0,000	0,000	0,000
OP 106	H2O	0,390	-0,003	0,013	-0,016
OP 107	H2O	0,059	0,000	0,004	-0,005
OP 108	H2O	0,691	-0,005	0,044	-0,049
OP 109	H2O	0,819	-0,006	1,847	-1,853
OP 110	H2O	19,873	-0,157	5,915	-6,073
OP 111	H2O	0,019	0,000	0,001	-0,001
OP 112	H2O	0,148	Non Defined	0,005	Non Defined
OP 113	H2O	3,515	-0,028	0,106	-0,134
OP 114	H2O	0,533	-0,004	0,037	-0,042
OP 115	H2O	6,219	-0,049	0,372	-0,422
OP 116	H2O	7,373	-0,058	16,603	-16,662
OP 117	H2O	178,947	-1,417	52,658	-54,076
OP 118	H2O	0,174	-0,001	0,009	-0,011
OP 119	H2O	1,329	Non Defined	0,040	Non Defined
OP 120	H2O	16,008	Non Defined	0,419	Non Defined
OP 121	H2O	39,776	Non Defined	0,511	Non Defined
OP 122	H2O	585,150	-4,634	7,512	-12,146
OP 123	H2O	0,059	0,000	0,002	-0,002
OP 124	H2O	2,086	-0,017	0,070	-0,087
OP 125	H2O	0,317	-0,003	0,023	-0,026
OP 126	H2O	3,691	-0,029	0,233	-0,263
OP 127	H2O	4,376	-0,035	9,869	-9,903
OP 128	H2O	106,203	-0,841	31,612	-32,454
OP 129	H2O	0,103	-0,001	0,006	-0,007
OP 130	H2O	0,789	Non Defined	0,027	Non Defined
OP 131	H2O	18,783	-0,149	0,569	-0,718
OP 132	H2O	2,851	-0,023	0,199	-0,222
OP 133	H2O	33,233	-0,263	1,990	-2,253
OP 134	H2O	39,404	-0,312	88,730	-89,042
OP 135	H2O	956,308	-7,574	281,410	-288,984
OP 136	H2O	0,929	-0,007	0,049	-0,056
OP 137	H2O	7,101	Non Defined	0,215	Non Defined
OP 138	H2O	85,548	Non Defined	2,239	Non Defined

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 139	H2O	212,566	Non Defined	2,729	Non Defined
OP 140	H2O	423,020	-3,350	5,431	-8,781
OP 141	H2O	0,043	0,000	0,001	-0,002
OP 142	H2O	1,508	-0,012	0,051	-0,063
OP 143	H2O	0,229	-0,002	0,017	-0,019
OP 144	H2O	2,668	-0,021	0,169	-0,190
OP 145	H2O	3,164	-0,025	7,134	-7,159
OP 146	H2O	76,777	-0,608	22,853	-23,461
OP 147	H2O	0,075	-0,001	0,004	-0,005
OP 148	H2O	0,570	Non Defined	0,019	Non Defined
OP 149	H2O	13,579	-0,108	0,411	-0,519
OP 150	H2O	2,061	-0,016	0,144	-0,160
OP 151	H2O	24,025	-0,190	1,438	-1,629
OP 152	H2O	28,486	-0,226	64,145	-64,370
OP 153	H2O	691,339	-5,475	203,438	-208,914
OP 154	H2O	0,672	-0,005	0,035	-0,041
OP 155	H2O	5,133	Non Defined	0,155	Non Defined
OP 156	H2O	61,845	Non Defined	1,619	Non Defined
OP 157	H2O	153,669	Non Defined	1,973	Non Defined
OP 158	H2O	2,240	-0,018	0,008	-0,026
OP 159	H2O	0,340	-0,003	0,015	-0,017
OP 160	H2O	3,964	-0,031	0,131	-0,162
OP 161	H2O	4,700	-0,037	10,457	-10,494
OP 162	H2O	114,060	-0,903	30,505	-31,409
OP 163	H2O	0,111	-0,001	0,003	-0,004
OP 164	H2O	0,847	Non Defined	0,003	Non Defined
OP 165	H2O	0,213	-0,002	0,004	-0,005
OP 166	H2O	7,544	-0,060	0,157	-0,217
OP 167	H2O	1,145	-0,009	0,069	-0,078
OP 168	H2O	13,347	-0,106	0,673	-0,779
OP 169	H2O	15,826	-0,125	35,486	-35,611
OP 170	H2O	384,072	-3,042	109,392	-112,434
OP 171	H2O	0,373	-0,003	0,016	-0,019
OP 172	H2O	2,852	Non Defined	0,059	Non Defined
OP 173	H2O	67,927	-0,538	1,185	-1,723
OP 174	H2O	10,309	-0,082	0,588	-0,670
OP 175	H2O	120,182	-0,952	5,653	-6,605
OP 176	H2O	142,501	-1,129	319,051	-320,180
OP 177	H2O	3458,379	-27,390	973,289	-1000,679
OP 178	H2O	3,361	-0,027	0,133	-0,160
OP 179	H2O	25,680	Non Defined	0,448	Non Defined
OP 180	H2O	309,375	Non Defined	4,125	Non Defined
OP 181	H2O	10,862	-0,086	0,151	-0,237
OP 182	H2O	0,039	0,000	0,001	-0,002
OP 183	H2O	0,006	0,000	0,000	0,000
OP 184	H2O	0,069	-0,001	0,004	-0,005
OP 185	H2O	0,081	-0,001	0,183	-0,184
OP 186	H2O	1,971	-0,016	0,589	-0,605

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 187	H2O	0,015	Non Defined	0,001	Non Defined
OP 188	H2O	0,349	-0,003	0,011	-0,014
OP 189	H2O	0,053	0,000	0,004	-0,004
OP 190	H2O	0,617	-0,005	0,038	-0,042
OP 191	H2O	0,731	-0,006	1,648	-1,654
OP 192	H2O	17,751	-0,141	5,243	-5,384
OP 193	H2O	0,017	0,000	0,001	-0,001
OP 194	H2O	0,132	Non Defined	0,004	Non Defined
OP 195	H2O	1,588	Non Defined	0,043	Non Defined
OP 196	H2O	2,351	Non Defined	0,033	Non Defined
OP 197	H2O	58,479	-0,463	0,814	-1,278
OP 198	H2O	0,006	0,000	0,000	0,000
OP 199	H2O	0,208	-0,002	0,007	-0,009
OP 200	H2O	0,032	0,000	0,002	-0,003
OP 201	H2O	0,369	-0,003	0,024	-0,027
OP 202	H2O	0,437	-0,003	0,987	-0,990
OP 203	H2O	10,614	-0,084	3,171	-3,255
OP 204	H2O	0,010	0,000	0,001	-0,001
OP 205	H2O	0,079	Non Defined	0,003	Non Defined
OP 206	H2O	1,877	-0,015	0,059	-0,074
OP 207	H2O	0,285	-0,002	0,020	-0,022
OP 208	H2O	3,321	-0,026	0,202	-0,229
OP 209	H2O	3,938	-0,031	8,872	-8,903
OP 210	H2O	95,571	-0,757	28,227	-28,984
OP 211	H2O	0,093	-0,001	0,005	-0,006
OP 212	H2O	0,710	Non Defined	0,022	Non Defined
OP 213	H2O	8,549	Non Defined	0,233	Non Defined
OP 214	H2O	12,658	Non Defined	0,176	Non Defined
OP 215	H2O	42,458	-0,336	0,591	-0,928
OP 216	H2O	0,151	-0,001	0,005	-0,006
OP 217	H2O	0,023	0,000	0,002	-0,002
OP 218	H2O	0,268	-0,002	0,017	-0,019
OP 219	H2O	0,318	-0,003	0,716	-0,719
OP 220	H2O	7,706	-0,061	2,302	-2,363
OP 221	H2O	0,007	0,000	0,000	0,000
OP 222	H2O	0,057	Non Defined	0,002	Non Defined
OP 223	H2O	1,363	-0,011	0,043	-0,054
OP 224	H2O	0,207	-0,002	0,015	-0,016
OP 225	H2O	2,411	-0,019	0,147	-0,166
OP 226	H2O	2,859	-0,023	6,441	-6,464
OP 227	H2O	69,388	-0,550	20,494	-21,044
OP 228	H2O	0,067	-0,001	0,004	-0,004
OP 229	H2O	0,515	Non Defined	0,016	Non Defined
OP 230	H2O	6,207	Non Defined	0,169	Non Defined
OP 231	H2O	9,190	Non Defined	0,128	Non Defined
OP 232	H2O	127,896	-1,013	1,659	-2,672
OP 233	H2O	0,013	0,000	0,000	0,000
OP 234	H2O	0,456	-0,004	0,015	-0,019

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 235	H2O	0,069	-0,001	0,005	-0,006
OP 236	H2O	0,807	-0,006	0,051	-0,058
OP 237	H2O	0,956	-0,008	2,157	-2,165
OP 238	H2O	23,213	-0,184	6,913	-7,096
OP 239	H2O	0,023	0,000	0,001	-0,001
OP 240	H2O	0,172	Non Defined	0,006	Non Defined
OP 241	H2O	4,105	-0,033	0,125	-0,157
OP 242	H2O	0,623	-0,005	0,044	-0,049
OP 243	H2O	7,264	-0,058	0,436	-0,493
OP 244	H2O	8,613	-0,068	19,395	-19,463
OP 245	H2O	209,020	-1,655	61,536	-63,191
OP 246	H2O	0,203	-0,002	0,011	-0,012
OP 247	H2O	1,552	Non Defined	0,047	Non Defined
OP 248	H2O	18,698	Non Defined	0,492	Non Defined
OP 249	H2O	34,885	Non Defined	0,452	Non Defined
OP 250	H2O	610,143	-4,832	7,914	-12,747
OP 251	H2O	0,061	0,000	0,002	-0,002
OP 252	H2O	2,175	-0,017	0,074	-0,091
OP 253	H2O	0,330	-0,003	0,024	-0,027
OP 254	H2O	3,848	-0,030	0,244	-0,274
OP 255	H2O	4,563	-0,036	10,291	-10,327
OP 256	H2O	110,739	-0,877	32,977	-33,854
OP 257	H2O	0,108	-0,001	0,006	-0,007
OP 258	H2O	0,822	Non Defined	0,028	Non Defined
OP 259	H2O	19,585	-0,155	0,596	-0,751
OP 260	H2O	2,972	-0,024	0,208	-0,232
OP 261	H2O	34,652	-0,274	2,079	-2,354
OP 262	H2O	41,087	-0,325	92,525	-92,850
OP 263	H2O	997,154	-7,897	293,562	-301,460
OP 264	H2O	0,969	-0,008	0,051	-0,059
OP 265	H2O	7,404	Non Defined	0,225	Non Defined
OP 266	H2O	89,202	Non Defined	2,346	Non Defined
OP 267	H2O	166,425	Non Defined	2,159	Non Defined
OP 268	H2O	427,720	-3,388	5,548	-8,936
OP 269	H2O	0,043	0,000	0,001	-0,002
OP 270	H2O	1,525	-0,012	0,052	-0,064
OP 271	H2O	0,231	-0,002	0,017	-0,019
OP 272	H2O	2,698	-0,021	0,171	-0,192
OP 273	H2O	3,199	-0,025	7,214	-7,239
OP 274	H2O	77,630	-0,615	23,118	-23,733
OP 275	H2O	0,075	-0,001	0,004	-0,005
OP 276	H2O	0,576	Non Defined	0,019	Non Defined
OP 277	H2O	13,730	-0,109	0,418	-0,526
OP 278	H2O	2,084	-0,017	0,146	-0,162
OP 279	H2O	24,292	-0,192	1,458	-1,650
OP 280	H2O	28,803	-0,228	64,862	-65,090
OP 281	H2O	699,021	-5,536	205,792	-211,328
OP 282	H2O	0,679	-0,005	0,036	-0,041

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 283	H2O	5,190	Non Defined	0,158	Non Defined
OP 284	H2O	62,532	Non Defined	1,645	Non Defined
OP 285	H2O	116,667	Non Defined	1,513	Non Defined
OP 286	H2O	0,020	0,000	0,000	0,000
OP 287	H2O	0,035	0,000	0,001	-0,002
OP 288	H2O	0,041	0,000	0,092	-0,093
OP 289	H2O	1,006	-0,008	0,272	-0,280
OP 290	H2O	0,007	Non Defined	0,000	Non Defined
OP 291	Sulfuric Acid	43,362	Non Defined	1,504	Non Defined
OP 292	Sulfuric Acid	4,148	Non Defined	0,156	Non Defined
OP 293	Sulfuric Acid	43,973	Non Defined	1,541	Non Defined
OP 294	Furfural	63,100	0,000	2,634	-2,634
OP 295	Furfural	0,151	0,000	0,008	-0,008
OP 296	Furfural	0,012	0,000	0,008	-0,008
OP 297	Furfural	6,348	0,000	0,789	-0,789
OP 298	Furfural	0,038	0,000	0,002	-0,002
OP 299	Furfural	1,362	0,000	0,066	-0,066
OP 300	Furfural	0,112	0,000	0,074	-0,074
OP 301	Furfural	57,133	0,000	7,023	-7,023
OP 302	Furfural	0,342	0,000	0,020	-0,020
OP 303	Furfural	3,357	0,000	0,152	-0,152
OP 304	Furfural	0,008	0,000	0,000	0,000
OP 305	Furfural	0,338	0,000	0,043	-0,043
OP 306	Furfural	0,072	0,000	0,004	-0,004
OP 307	Furfural	0,006	0,000	0,004	-0,004
OP 308	Furfural	3,040	0,000	0,384	-0,384
OP 309	Furfural	0,018	0,000	0,001	-0,001
OP 310	Furfural	46,477	0,000	1,960	-1,960
OP 311	Furfural	0,112	0,000	0,006	-0,006
OP 312	Furfural	0,009	0,000	0,006	-0,006
OP 313	Furfural	4,676	0,000	0,583	-0,583
OP 314	Furfural	0,028	0,000	0,002	-0,002
OP 315	Furfural	1,004	0,000	0,049	-0,049
OP 316	Furfural	0,082	0,000	0,054	-0,054
OP 317	Furfural	42,082	0,000	5,191	-5,191
OP 318	Furfural	0,252	0,000	0,015	-0,015
OP 319	Ammonia	31,511	Non Defined	0,000	Non Defined
OP 320	Oxygen	1,412	-0,092	0,002	-0,094
OP 321	Oxygen	7,682	-0,501	0,011	-0,512
OP 322	Oxygen	0,053	-0,003	0,001	-0,004
OP 323	Carbon Dioxide	537,495	0,000	0,780	-0,780
OP 324	Carbon Dioxide	26,448	0,000	0,077	-0,077
OP 325	Carbon Dioxide	1,841	0,000	0,023	-0,023
OP 326	Carbon Dioxide	5249,432	0,000	7,749	-7,749
OP 327	Carbon Dioxide	365,355	0,000	3,948	-3,948
OP 328	Glycerol	0,661	-0,001	0,080	-0,080
OP 329	Glycerol	3,994	-0,005	0,473	-0,477
OP 330	Succinic Acid	1,931	0,000	0,139	-0,139

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 331	Succinic Acid	12,185	0,000	0,854	-0,854
OP 332	Lactic Acid	0,365	0,000	0,035	-0,035
OP 333	Lactic Acid	2,241	0,000	0,210	-0,210
OP 334	Lactic Acid	372,729	0,000	36,520	-36,520
OP 335	Xylitol	5,777	-0,004	0,909	-0,913
OP 336	Xylitol	39,415	-0,031	6,067	-6,097
OP 337	Acetic Acid	0,038	0,000	0,000	0,000
OP 338	Acetic Acid	2,615	0,000	0,171	-0,171
OP 339	Acetic Acid	0,232	0,000	0,000	0,000
OP 340	Acetic Acid	0,013	0,000	0,006	-0,006
OP 341	Acetic Acid	15,997	0,000	1,015	-1,015
OP 342	Acetic Acid	0,006	0,000	0,000	0,000
OP 343	CornSteep Liquor	0,106	-0,672	0,001	-0,673
OP 344	CornSteep Liquor	0,007	-0,042	0,015	-0,057
OP 345	CornSteep Liquor	13,027	-82,538	3,528	-86,066
OP 346	CornSteep Liquor	0,011	-0,071	0,000	-0,071
OP 347	CornSteep Liquor	0,402	Non Defined	0,003	Non Defined
OP 348	CornSteep Liquor	0,804	Non Defined	0,003	Non Defined
OP 349	CornSteep Liquor	0,511	-3,235	0,002	-3,237
OP 350	CornSteep Liquor	0,032	-0,203	0,073	-0,276
OP 351	CornSteep Liquor	62,735	-397,489	16,778	-414,268
OP 352	CornSteep Liquor	0,054	-0,342	0,001	-0,344
OP 353	CornSteep Liquor	1,938	Non Defined	0,007	Non Defined
OP 354	ZM	6,586	0,000	0,017	-0,017
OP 355	ZM	19,171	0,000	0,025	-0,025
OP 356	Cellulase	11,484	-454,754	0,015	-454,769
OP 357	Cellulase	4,307	-170,564	0,011	-170,575
OP 358	Ash	32,940	-4,435	6,847	-11,282
OP 359	Ash	296,458	-39,915	59,971	-99,886
OP 360	Ash	17,612	-2,371	3,693	-6,064
OP 361	Ash	158,511	-21,342	32,351	-53,693
OP 362	DAMPHOS	1,720	-4,086	0,004	-4,090
OP 363	DAMPHOS	0,025	Non Defined	0,000	Non Defined
OP 364	DAMPHOS	0,106	Non Defined	0,000	Non Defined
OP 365	DAMPHOS	19,367	-46,015	0,023	-46,038
OP 366	DAMPHOS	0,283	Non Defined	0,000	Non Defined
OP 367	AMSULFAT	12,325	-20,149	0,090	-20,238
OP 368	AMSULFAT	110,927	-181,338	0,675	-182,013

Table E2 Sustainability Results of alternative E case

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 1	Cellulose	1.988	-0.268	0.084	-0.351
OP 2	Cellulose	18.132	Non Defined	0.746	Non Defined
OP 3	Cellulose	17.891	-2.409	0.730	-3.139
OP 4	Cellulose	163.189	Non Defined	6.511	Non Defined
OP 5	Cellulose	2085.164	Non Defined	82.804	Non Defined
OP 6	Cellulose	190.737	Non Defined	7.542	Non Defined
OP 7	Cellulose	0.361	-0.049	0.016	-0.065
OP 8	Cellulose	3.294	Non Defined	0.146	Non Defined
OP 9	Cellulose	3.250	-0.438	0.144	-0.581
OP 10	Cellulose	29.643	Non Defined	1.282	Non Defined
OP 11	Cellulose	378.762	Non Defined	16.306	Non Defined
OP 12	Cellulose	34.647	Non Defined	1.486	Non Defined
OP 13	Cellulose	3.323	-0.447	0.140	-0.587
OP 14	Cellulose	30.309	Non Defined	1.244	Non Defined
OP 15	Cellulose	29.906	-4.026	1.219	-5.246
OP 16	Cellulose	272.783	Non Defined	10.865	Non Defined
OP 17	Cellulose	3485.507	Non Defined	138.181	Non Defined
OP 18	Cellulose	318.831	Non Defined	12.585	Non Defined
OP 19	Hemicellulose	17.682	137.663	0.743	136.921
OP 20	Hemicellulose	159.141	1238.971	6.491	1232.480
OP 21	Hemicellulose	3359.645	Non Defined	132.699	Non Defined
OP 22	Hemicellulose	0.941	7.324	0.043	7.281
OP 23	Hemicellulose	8.467	65.916	0.374	65.543
OP 24	Hemicellulose	178.741	Non Defined	7.656	Non Defined
OP 25	Hemicellulose	13.020	101.363	0.546	100.817
OP 26	Hemicellulose	117.177	912.267	4.771	907.495
OP 27	Hemicellulose	2473.741	Non Defined	97.543	Non Defined
OP 28	Lignin	193.335	-26.031	6.614	-32.644
OP 29	Lignin	1740.012	-234.275	57.331	-291.607
OP 30	Lignin	28.149	-3.790	1.038	-4.828
OP 31	Lignin	253.338	-34.109	9.024	-43.133
OP 32	Lignin	210.825	-28.385	7.201	-35.586
OP 33	Lignin	1897.425	-255.469	62.417	-317.886
OP 34	Glucose	0.092	0.000	0.005	-0.005
OP 35	Glucose	1.654	Non Defined	0.043	Non Defined
OP 36	Glucose	0.054	Non Defined	0.001	Non Defined
OP 37	Glucose	17.466	Non Defined	0.436	Non Defined
OP 38	Glucose	8.865	0.000	0.475	-0.475
OP 39	Glucose	159.330	Non Defined	3.975	Non Defined
OP 40	Glucose	5.202	Non Defined	0.130	Non Defined
OP 41	Glucose	0.017	0.000	0.001	-0.001
OP 42	Glucose	0.300	Non Defined	0.008	Non Defined
OP 43	Glucose	0.010	Non Defined	0.000	Non Defined
OP 44	Glucose	3.173	Non Defined	0.086	Non Defined
OP 45	Glucose	1.610	0.000	0.090	-0.090
OP 46	Glucose	28.942	Non Defined	0.782	Non Defined

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 47	Glucose	0.945	Non Defined	0.026	Non Defined
OP 48	Glucose	0.154	0.000	0.008	-0.008
OP 49	Glucose	2.765	Non Defined	0.072	Non Defined
OP 5	Glucose	0.090	Non Defined	0.002	Non Defined
OP 51	Glucose	29.196	Non Defined	0.727	Non Defined
OP 52	Glucose	14.819	0.000	0.794	-0.794
OP 53	Glucose	266.333	Non Defined	6.634	Non Defined
OP 54	Glucose	8.695	Non Defined	0.217	Non Defined
OP 55	Glucose	3.142	0.000	0.094	-0.094
OP 56	Glucose	56.476	Non Defined	0.074	Non Defined
OP 57	Glucose	1.844	Non Defined	0.002	Non Defined
OP 58	Glucose	596.386	Non Defined	0.104	Non Defined
OP 59	Glucose	302.700	0.000	8.730	-8.730
OP 60	Glucose	5440.320	Non Defined	0.952	Non Defined
OP 61	Glucose	177.619	Non Defined	0.031	Non Defined
OP 62	Xylose	8.527	0.000	0.457	-0.457
OP 63	Xylose	53.950	Non Defined	1.408	Non Defined
OP 64	Xylose	1.932	Non Defined	0.050	Non Defined
OP 65	Xylose	297.272	Non Defined	7.417	Non Defined
OP 66	Xylose	430.949	0.000	22.624	-22.624
OP 67	Xylose	2726.535	Non Defined	68.024	Non Defined
OP 68	Xylose	97.654	Non Defined	2.436	Non Defined
OP 69	Xylose	0.454	0.000	0.025	-0.025
OP 70	Xylose	2.870	Non Defined	0.081	Non Defined
OP 71	Xylose	0.103	Non Defined	0.003	Non Defined
OP 72	Xylose	15.816	Non Defined	0.427	Non Defined
OP 73	Xylose	22.927	0.000	1.251	-1.251
OP 74	Xylose	145.058	Non Defined	3.921	Non Defined
OP 75	Xylose	5.195	Non Defined	0.140	Non Defined
OP 76	Xylose	6.279	0.000	0.337	-0.337
OP 77	Xylose	39.724	Non Defined	1.035	Non Defined
OP 78	Xylose	1.423	Non Defined	0.037	Non Defined
OP 79	Xylose	218.884	Non Defined	5.452	Non Defined
OP 80	Xylose	317.312	0.000	16.645	-16.645
OP 81	Xylose	2007.575	Non Defined	50.003	Non Defined
OP 82	Xylose	71.904	Non Defined	1.791	Non Defined
OP 83	Cellobiose	1.830	Non Defined	0.025	Non Defined
OP 84	Cellobiose	16.473	Non Defined	0.216	Non Defined
OP 85	Cellobiose	0.332	Non Defined	0.005	Non Defined
OP 86	Cellobiose	2.992	Non Defined	0.043	Non Defined
OP 87	Cellobiose	3.059	Non Defined	0.042	Non Defined
OP 88	Cellobiose	27.535	Non Defined	0.361	Non Defined
OP 89	Cellobiose	3.041	Non Defined	0.002	Non Defined
OP 90	Cellobiose	27.367	Non Defined	0.003	Non Defined
OP 91	Ethanol	44.468	0.000	0.000	0.000
OP 92	Ethanol	43.119	0.000	0.000	0.000
OP 93	Ethanol	421.744	3328.854	11.718	3317.136
OP 94	Ethanol	2.119	0.000	0.054	-0.054

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 95	Ethanol	30.926	0.000	13.145	-13.145
OP 96	Ethanol	49.017	0.000	2.533	-2.533
OP 97	Ethanol	1.516	0.000	0.004	-0.004
OP 98	Ethanol	462.387	0.000	0.000	0.000
OP 99	Ethanol	4522.599	35697.203	125.654	35571.548
OP 100	Ethanol	22.727	0.000	0.574	-0.574
OP 101	Ethanol	331.632	0.000	140.960	-140.960
OP 102	Ethanol	525.641	0.000	27.160	-27.160
OP 103	Ethanol	16.257	0.000	0.046	-0.046
OP 104	H2O	109.484	-0.867	1.406	-2.273
OP 105	H2O	0.011	0.000	0.000	0.000
OP 106	H2O	0.389	-0.003	0.008	-0.011
OP 107	H2O	0.059	0.000	0.002	-0.002
OP 108	H2O	0.693	-0.005	0.021	-0.026
OP 109	H2O	1.178	-0.009	1.419	-1.428
OP 110	H2O	19.521	-0.155	3.220	-3.375
OP 111	H2O	0.019	0.000	0.000	-0.001
OP 112	H2O	0.147	Non Defined	0.003	Non Defined
OP 113	H2O	3.501	-0.028	0.060	-0.088
OP 114	H2O	0.535	-0.004	0.016	-0.020
OP 115	H2O	6.239	-0.049	0.160	-0.209
OP 116	H2O	10.612	-0.084	12.733	-12.817
OP 117	H2O	175.773	-1.392	28.270	-29.662
OP 118	H2O	0.174	-0.001	0.004	-0.005
OP 119	H2O	1.324	Non Defined	0.019	Non Defined
OP 120	H2O	15.944	Non Defined	0.213	Non Defined
OP 121	H2O	39.776	Non Defined	0.511	Non Defined
OP 122	H2O	585.092	-4.634	7.511	-12.145
OP 123	H2O	0.059	0.000	0.001	-0.002
OP 124	H2O	2.078	-0.016	0.044	-0.061
OP 125	H2O	0.318	-0.003	0.011	-0.013
OP 126	H2O	3.703	-0.029	0.110	-0.139
OP 127	H2O	6.298	-0.050	7.583	-7.633
OP 128	H2O	104.320	-0.826	17.211	-18.037
OP 129	H2O	0.103	-0.001	0.003	-0.003
OP 130	H2O	0.785	Non Defined	0.014	Non Defined
OP 131	H2O	18.712	-0.148	0.321	-0.469
OP 132	H2O	2.860	-0.023	0.085	-0.107
OP 133	H2O	33.340	-0.264	0.853	-1.117
OP 134	H2O	56.709	-0.449	68.046	-68.496
OP 135	H2O	939.349	-7.440	151.076	-158.516
OP 136	H2O	0.930	-0.007	0.019	-0.027
OP 137	H2O	7.073	Non Defined	0.099	Non Defined
OP 138	H2O	85.206	Non Defined	1.139	Non Defined
OP 139	H2O	212.566	Non Defined	2.729	Non Defined
OP 140	H2O	422.977	-3.350	5.430	-8.780
OP 141	H2O	0.043	0.000	0.001	-0.001
OP 142	H2O	1.502	-0.012	0.032	-0.044

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 143	H2O	0.230	-0.002	0.008	-0.010
OP 144	H2O	2.677	-0.021	0.080	-0.101
OP 145	H2O	4.553	-0.036	5.482	-5.518
OP 146	H2O	75.415	-0.597	12.442	-13.039
OP 147	H2O	0.075	-0.001	0.002	-0.002
OP 148	H2O	0.568	Non Defined	0.010	Non Defined
OP 149	H2O	13.527	-0.107	0.232	-0.339
OP 150	H2O	2.067	-0.016	0.061	-0.078
OP 151	H2O	24.102	-0.191	0.616	-0.807
OP 152	H2O	40.997	-0.325	- 49.192	-49.517
OP 153	H2O	679.079	-5.378	109.217	-114.595
OP 154	H2O	0.672	-0.005	0.014	-0.019
OP 155	H2O	5.113	Non Defined	0.072	Non Defined
OP 156	H2O	61.598	Non Defined	0.824	Non Defined
OP 157	H2O	153.669	Non Defined	1.973	Non Defined
OP 158	H2O	2.231	-0.018	0.007	-0.025
OP 159	H2O	0.341	-0.003	0.005	-0.008
OP 160	H2O	3.974	-0.031	0.046	-0.077
OP 161	H2O	6.760	-0.054	8.017	-8.070
OP 162	H2O	111.976	-0.887	16.441	-17.328
OP 163	H2O	0.111	-0.001	0.001	-0.002
OP 164	H2O	0.843	Non Defined	0.000	Non Defined
OP 165	H2O	0.214	-0.002	0.001	-0.003
OP 166	H2O	7.576	-0.060	0.064	-0.124
OP 167	H2O	1.158	-0.009	0.024	-0.033
OP 168	H2O	13.498	-0.107	0.228	-0.335
OP 169	H2O	22.959	-0.182	27.350	-27.532
OP 170	H2O	380.305	-3.012	57.860	-60.872
OP 171	H2O	0.376	-0.003	0.005	-0.008
OP 172	H2O	2.864	Non Defined	0.015	Non Defined
OP 173	H2O	68.216	-0.540	0.295	-0.836
OP 174	H2O	10.426	-0.083	0.175	-0.258
OP 175	H2O	121.544	-0.963	1.548	-2.511
OP 176	H2O	206.738	-1.637	245.414	-247.051
OP 177	H2O	3424.457	-27.122	506.796	-533.918
OP 178	H2O	3.390	-0.027	0.027	-0.054
OP 179	H2O	25.785	Non Defined	0.030	Non Defined
OP 180	H2O	310.625	Non Defined	0.166	Non Defined
OP 181	H2O	10.862	-0.086	0.151	-0.237
OP 182	H2O	0.039	0.000	0.001	-0.001
OP 183	H2O	0.006	0.000	0.000	0.000
OP 184	H2O	0.069	-0.001	0.002	-0.003
OP 185	H2O	0.117	-0.001	0.141	-0.142
OP 186	H2O	1.937	-0.015	0.322	-0.337
OP 187	H2O	0.015	Non Defined	0.000	Non Defined
OP 188	H2O	0.347	-0.003	0.006	-0.009
OP 189	H2O	0.053	0.000	0.002	-0.002
OP 190	H2O	0.619	-0.005	0.017	-0.021

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 191	H2O	1.053	-0.008	1.264	-1.273
OP 192	H2O	17.439	-0.138	2.824	-2.962
OP 193	H2O	0.017	0.000	0.000	-0.001
OP 194	H2O	0.131	Non Defined	0.002	Non Defined
OP 195	H2O	1.582	Non Defined	0.023	Non Defined
OP 196	H2O	2.345	Non Defined	0.033	Non Defined
OP 197	H2O	58.678	-0.465	0.817	-1.282
OP 198	H2O	0.006	0.000	0.000	0.000
OP 199	H2O	0.208	-0.002	0.005	-0.006
OP 200	H2O	0.032	0.000	0.001	-0.001
OP 201	H2O	0.371	-0.003	0.011	-0.014
OP 202	H2O	0.632	-0.005	0.761	-0.766
OP 203	H2O	10.462	-0.083	1.737	-1.820
OP 204	H2O	0.010	0.000	0.000	0.000
OP 205	H2O	0.079	Non Defined	0.002	Non Defined
OP 206	H2O	1.877	-0.015	0.034	-0.049
OP 207	H2O	0.287	-0.002	0.009	-0.011
OP 208	H2O	3.344	-0.026	0.089	-0.116
OP 209	H2O	5.687	-0.045	6.830	-6.875
OP 210	H2O	94.206	-0.746	15.253	-15.999
OP 211	H2O	0.093	-0.001	0.002	-0.003
OP 212	H2O	0.709	Non Defined	0.011	Non Defined
OP 213	H2O	8.545	Non Defined	0.124	Non Defined
OP 214	H2O	12.669	Non Defined	0.176	Non Defined
OP 215	H2O	42.540	-0.337	0.592	-0.929
OP 216	H2O	0.151	-0.001	0.003	-0.005
OP 217	H2O	0.023	0.000	0.001	-0.001
OP 218	H2O	0.269	-0.002	0.008	-0.010
OP 219	H2O	0.458	-0.004	0.552	-0.555
OP 220	H2O	7.585	-0.060	1.260	-1.320
OP 221	H2O	0.008	0.000	0.000	0.000
OP 222	H2O	0.057	Non Defined	0.001	Non Defined
OP 223	H2O	1.360	-0.011	0.025	-0.036
OP 224	H2O	0.208	-0.002	0.006	-0.008
OP 225	H2O	2.424	-0.019	0.065	-0.084
OP 226	H2O	4.123	-0.033	4.952	-4.985
OP 227	H2O	68.297	-0.541	11.058	-11.599
OP 228	H2O	0.068	-0.001	0.001	-0.002
OP 229	H2O	0.514	Non Defined	0.008	Non Defined
OP 230	H2O	6.195	Non Defined	0.090	Non Defined
OP 231	H2O	9.185	Non Defined	0.128	Non Defined
OP 232	H2O	133.595	-1.058	1.712	-2.770
OP 233	H2O	0.013	0.000	0.000	0.000
OP 234	H2O	0.474	-0.004	0.010	-0.014
OP 235	H2O	0.073	-0.001	0.002	-0.003
OP 236	H2O	0.845	-0.007	0.025	-0.032
OP 237	H2O	1.438	-0.011	1.731	-1.743
OP 238	H2O	23.819	-0.189	3.929	-4.118

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 239	H2O	0.024	0.000	0.001	-0.001
OP 240	H2O	0.179	Non Defined	0.003	Non Defined
OP 241	H2O	4.273	-0.034	0.073	-0.107
OP 242	H2O	0.653	-0.005	0.019	-0.025
OP 243	H2O	7.613	-0.060	0.195	-0.255
OP 244	H2O	12.949	-0.103	15.537	-15.639
OP 245	H2O	214.483	-1.699	34.491	-36.190
OP 246	H2O	0.212	-0.002	0.004	-0.006
OP 247	H2O	1.615	Non Defined	0.023	Non Defined
OP 248	H2O	19.455	Non Defined	0.260	Non Defined
OP 249	H2O	36.436	Non Defined	0.467	Non Defined
OP 250	H2O	609.989	-4.831	7.818	-12.649
OP 251	H2O	0.061	0.000	0.001	-0.002
OP 252	H2O	2.166	-0.017	0.046	-0.063
OP 253	H2O	0.331	-0.003	0.011	-0.014
OP 254	H2O	3.860	-0.031	0.115	-0.145
OP 255	H2O	6.566	-0.052	7.906	-7.958
OP 256	H2O	108.759	-0.861	17.941	-18.802
OP 257	H2O	0.108	-0.001	0.003	-0.004
OP 258	H2O	0.819	Non Defined	0.015	Non Defined
OP 259	H2O	19.508	-0.155	0.334	-0.489
OP 260	H2O	2.981	-0.024	0.088	-0.112
OP 261	H2O	34.759	-0.275	0.888	-1.164
OP 262	H2O	59.123	-0.468	70.941	-71.409
OP 263	H2O	979.320	-7.756	157.484	-165.240
OP 264	H2O	0.969	-0.008	0.020	-0.028
OP 265	H2O	7.374	Non Defined	0.103	Non Defined
OP 266	H2O	88.832	Non Defined	1.186	Non Defined
OP 267	H2O	166.366	Non Defined	2.132	Non Defined
OP 268	H2O	421.901	-3.341	5.407	-8.749
OP 269	H2O	0.042	0.000	0.001	-0.001
OP 270	H2O	1.498	-0.012	0.032	-0.044
OP 271	H2O	0.229	-0.002	0.008	-0.010
OP 272	H2O	2.670	-0.021	0.079	-0.100
OP 273	H2O	4.541	-0.036	5.468	-5.504
OP 274	H2O	75.224	-0.596	12.409	-13.004
OP 275	H2O	0.074	-0.001	0.002	-0.002
OP 276	H2O	0.566	Non Defined	0.010	Non Defined
OP 277	H2O	13.493	-0.107	0.231	-0.338
OP 278	H2O	2.062	-0.016	0.061	-0.077
OP 279	H2O	24.041	-0.190	0.614	-0.805
OP 280	H2O	40.892	-0.324	49.066	-49.390
OP 281	H2O	677.350	-5.365	108.924	-114.289
OP 282	H2O	0.671	-0.005	0.014	-0.019
OP 283	H2O	5.100	Non Defined	0.071	Non Defined
OP 284	H2O	61.441	Non Defined	0.820	Non Defined
OP 285	H2O	115.067	Non Defined	1.475	Non Defined
OP 286	H2O	0.020	0.000	0.000	0.000

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 287	H2O	0.035	0.000	0.001	-0.001
OP 288	H2O	0.060	0.000	0.071	-0.071
OP 289	H2O	0.987	-0.008	0.149	-0.157
OP 290	H2O	0.007	Non Defined	0.000	Non Defined
OP 291	Sulfuric Acid	43.362	Non Defined	1.504	Non Defined
OP 292	Sulfuric Acid	4.158	Non Defined	0.156	Non Defined
OP 293	Sulfuric Acid	43.966	Non Defined	1.522	Non Defined
OP 294	Furfural	63.103	0.000	2.634	-2.634
OP 295	Furfural	0.151	0.000	0.007	-0.007
OP 296	Furfural	0.103	0.000	0.038	-0.038
OP 297	Furfural	6.257	0.000	0.527	-0.527
OP 298	Furfural	0.038	0.000	0.002	-0.002
OP 299	Furfural	1.362	0.000	0.059	-0.059
OP 300	Furfural	0.926	0.000	0.339	-0.339
OP 301	Furfural	56.317	0.000	4.647	-4.647
OP 302	Furfural	0.342	0.000	0.015	-0.015
OP 303	Furfural	3.357	0.000	0.152	-0.152
OP 304	Furfural	0.008	0.000	0.000	0.000
OP 305	Furfural	0.005	0.000	0.002	-0.002
OP 306	Furfural	0.333	0.000	0.029	-0.029
OP 307	Furfural	0.072	0.000	0.003	-0.003
OP 308	Furfural	0.049	0.000	0.018	-0.018
OP 309	Furfural	2.996	0.000	0.258	-0.258
OP 310	Furfural	0.018	0.000	0.001	-0.001
OP 311	Furfural	46.463	0.000	1.936	-1.936
OP 312	Furfural	0.111	0.000	0.005	-0.005
OP 313	Furfural	0.076	0.000	0.028	-0.028
OP 314	Furfural	4.607	0.000	0.388	-0.388
OP 315	Furfural	0.028	0.000	0.001	-0.001
OP 316	Furfural	1.003	0.000	0.044	-0.044
OP 317	Furfural	0.682	0.000	0.249	-0.249
OP 318	Furfural	41.467	0.000	3.419	-3.419
OP 319	Furfural	0.252	0.000	0.011	-0.011
OP 320	Ammonia	31.765	Non Defined	0.000	Non Defined
OP 321	Oxygen	1.412	-0.092	0.002	-0.094
OP 322	Oxygen	7.680	-0.501	0.010	-0.510
OP 323	Oxygen	0.054	-0.003	0.000	-0.004
OP 324	Carbon Dioxide	537.403	0.000	0.950	-0.950
OP 325	Carbon Dioxide	26.438	0.000	0.082	-0.082
OP 326	Carbon Dioxide	1.846	0.000	0.009	-0.009
OP 327	Carbon Dioxide	5247.408	0.000	7.066	-7.066
OP 328	Carbon Dioxide	366.409	0.000	1.043	-1.043
OP 329	Glycerol	0.661	-0.001	0.043	-0.044
OP 330	Glycerol	3.993	-0.005	0.252	-0.257
OP 331	Succinic Acid	1.931	0.000	0.074	-0.074
OP 332	Succinic Acid	12.183	0.000	0.442	-0.442
OP 333	Lactic Acid	0.364	0.000	0.019	-0.019
OP 334	Lactic Acid	2.240	0.000	0.109	-0.109

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 335	Lactic Acid	372.666	0.000	19.906	-19.906
OP 336	Xylitol	5.776	-0.004	0.499	-0.504
OP 337	Xylitol	39.409	-0.031	3.244	-3.274
OP 338	Acetic Acid	0.038	0.000	0.000	0.000
OP 339	Acetic Acid	0.010	0.000	0.003	-0.003
OP 340	Acetic Acid	2.607	0.000	0.089	-0.089
OP 341	Acetic Acid	0.232	0.000	0.000	0.000
OP 342	Acetic Acid	0.063	0.000	0.016	-0.016
OP 343	Acetic Acid	15.945	0.000	0.512	-0.512
OP 344	Acetic Acid	0.006	0.000	0.000	0.000
OP 345	CornSteep Liquor	0.106	-0.671	0.001	-0.671
OP 346	CornSteep Liquor	0.021	-0.130	0.025	-0.155
OP 347	CornSteep Liquor	13.030	-82.561	1.967	-84.528
OP 348	CornSteep Liquor	0.011	-0.071	0.000	-0.071
OP 349	CornSteep Liquor	0.402	Non Defined	0.002	Non Defined
OP 350	CornSteep Liquor	0.804	Non Defined	0.000	Non Defined
OP 351	CornSteep Liquor	0.510	-3.229	0.002	-3.230
OP 352	CornSteep Liquor	0.099	-0.627	0.120	-0.747
OP 353	CornSteep Liquor	62.748	-397.574	9.213	-406.787
OP 354	CornSteep Liquor	0.054	-0.343	0.000	-0.343
OP 355	CornSteep Liquor	1.938	Non Defined	0.000	Non Defined
OP 356	ZM	6.585	0.000	0.018	-0.018
OP 357	ZM	19.168	0.000	0.023	-0.023
OP 358	Cellulase	11.481	-454.660	0.014	-454.673
OP 359	Cellulase	4.312	-170.768	0.012	-170.779
OP 360	Ash	32.940	-4.435	6.179	-10.614
OP 361	Ash	296.458	-39.915	53.598	-93.513
OP 362	Ash	17.606	-2.371	3.298	-5.668
OP 363	Ash	158.457	-21.335	28.602	-49.936
OP 364	DAMPHOS	1.722	-4.091	0.004	-4.096
OP 365	DAMPHOS	0.025	Non Defined	0.000	Non Defined
OP 366	DAMPHOS	0.106	Non Defined	0.000	Non Defined
OP 367	DAMPHOS	19.391	-46.072	0.021	-46.093
OP 368	DAMPHOS	0.283	Non Defined	0.000	Non Defined
OP 369	AMSULFAT	12.326	-20.150	0.036	-20.186
OP 370	AMSULFAT	110.931	-181.346	0.168	-181.514

Table E3 Sustainability Results of alternative F case

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 1	Cellulose	18.132	-0.268	0.086	-0.354
OP 2	Cellulose	17.891	Non Defined	0.767	Non Defined
OP 3	Cellulose	163.189	-2.409	0.755	-3.164
OP 4	Cellulose	2085.164	Non Defined	6.702	Non Defined
OP 5	Cellulose	190.737	Non Defined	85.144	Non Defined
OP 6	Cellulose	0.361	Non Defined	7.749	Non Defined
OP 7	Cellulose	3.294	-0.049	0.017	-0.065

OP 8	Cellulose	3.250	Non Defined	0.148	Non Defined
OP 9	Cellulose	29.643	-0.438	0.146	-0.584
OP 10	Cellulose	378.762	Non Defined	1.299	Non Defined
OP 11	Cellulose	34.647	Non Defined	16.506	Non Defined
OP 12	Cellulose	3.318	Non Defined	1.503	Non Defined
OP 13	Cellulose	30.263	-0.447	0.144	-0.591
OP 14	Cellulose	29.860	Non Defined	1.279	Non Defined
OP 15	Cellulose	272.366	-4.020	1.259	-5.279
OP 16	Cellulose	3480.172	Non Defined	11.174	Non Defined
OP 17	Cellulose	318.343	Non Defined	141.963	Non Defined
OP 18	Hemicellulose	17.682	Non Defined	12.920	Non Defined
OP 19	Hemicellulose	159.141	137.663	0.767	136.896
OP 20	Hemicellulose	3359.645	1238.971	6.709	1232.261
OP 21	Hemicellulose	0.941	Non Defined	136.343	Non Defined
OP 22	Hemicellulose	8.467	7.324	0.043	7.281
OP 23	Hemicellulose	178.741	65.916	0.380	65.536
OP 24	Hemicellulose	13.000	Non Defined	7.744	Non Defined
OP 25	Hemicellulose	116.998	101.208	0.564	100.644
OP 26	Hemicellulose	2469.955	910.870	4.928	905.943
OP 27	Lignin	193.335	Non Defined	100.136	Non Defined
OP 28	Lignin	1740.012	-26.031	6.841	-32.872
OP 29	Lignin	28.149	-234.275	59.360	-293.635
OP 30	Lignin	253.338	-3.790	1.058	-4.848
OP 31	Lignin	210.502	-34.109	9.199	-43.308
OP 32	Lignin	1894.521	-28.342	7.442	-35.784
OP 33	Glucose	0.088	-255.078	64.568	-319.647
OP 34	Glucose	1.654	0.000	0.007	-0.007
OP 35	Glucose	0.054	Non Defined	0.044	Non Defined
OP 36	Glucose	17.466	Non Defined	0.001	Non Defined
OP 37	Glucose	8.511	Non Defined	0.448	Non Defined
OP 38	Glucose	159.330	0.000	0.639	-0.639
OP 39	Glucose	5.202	Non Defined	4.095	Non Defined
OP 40	Glucose	0.016	Non Defined	0.134	Non Defined
OP 41	Glucose	0.300	0.000	0.001	-0.001
OP 42	Glucose	0.010	Non Defined	0.009	Non Defined
OP 43	Glucose	3.173	Non Defined	0.000	Non Defined
OP 44	Glucose	1.546	Non Defined	0.087	Non Defined
OP 45	Glucose	28.942	0.000	0.119	-0.119
OP 46	Glucose	0.945	Non Defined	0.793	Non Defined
OP 47	Glucose	0.147	Non Defined	0.026	Non Defined
OP 48	Glucose	2.761	0.000	0.011	-0.011
OP 49	Glucose	0.090	Non Defined	0.074	Non Defined
OP 50	Glucose	29.152	Non Defined	0.002	Non Defined
OP 51	Glucose	14.204	Non Defined	0.747	Non Defined
OP 52	Glucose	265.925	0.000	1.066	-1.066
OP 53	Glucose	8.682	Non Defined	6.827	Non Defined
OP 54	Glucose	3.014	Non Defined	0.223	Non Defined
OP 55	Glucose	56.426	0.000	0.153	-0.153
OP 56	Glucose	1.842	Non Defined	0.077	Non Defined

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 57	Glucose	595.852	Non Defined	0.003	Non Defined
OP 58	Glucose	290.332	Non Defined	0.108	Non Defined
OP 59	Glucose	5435.441	0.000	14.397	-14.397
OP 60	Glucose	177.460	Non Defined	1.186	Non Defined
OP 61	Xylose	8.101	Non Defined	0.039	Non Defined
OP 62	Xylose	53.950	153.982	0.571	153.411
OP 63	Xylose	1.932	Non Defined	1.449	Non Defined
OP 64	Xylose	297.272	Non Defined	0.052	Non Defined
OP 65	Xylose	409.402	Non Defined	7.629	Non Defined
OP 66	Xylose	2726.535	7781.908	28.362	7753.546
OP 67	Xylose	97.654	Non Defined	70.071	Non Defined
OP 68	Xylose	0.431	Non Defined	2.510	Non Defined
OP 69	Xylose	2.870	8.192	0.031	8.161
OP 70	Xylose	0.103	Non Defined	0.082	Non Defined
OP 71	Xylose	15.816	Non Defined	0.003	Non Defined
OP 72	Xylose	21.781	Non Defined	0.433	Non Defined
OP 73	Xylose	145.058	414.015	1.546	412.469
OP 74	Xylose	5.195	Non Defined	3.976	Non Defined
OP 75	Xylose	5.956	Non Defined	0.142	Non Defined
OP 76	Xylose	39.663	113.205	0.419	112.786
OP 77	Xylose	1.421	Non Defined	1.064	Non Defined
OP 78	Xylose	218.549	Non Defined	0.038	Non Defined
OP 79	Xylose	300.985	Non Defined	5.603	Non Defined
OP 80	Xylose	2004.502	5721.127	20.843	5700.284
OP 81	Xylose	71.794	Non Defined	51.463	Non Defined
OP 82	Cellobiose	1.830	Non Defined	1.843	Non Defined
OP 83	Cellobiose	16.473	Non Defined	0.026	Non Defined
OP 84	Cellobiose	0.332	Non Defined	0.223	Non Defined
OP 85	Cellobiose	2.992	Non Defined	0.005	Non Defined
OP 86	Cellobiose	3.055	Non Defined	0.043	Non Defined
OP 87	Cellobiose	27.493	Non Defined	0.043	Non Defined
OP 88	Cellobiose	3.038	Non Defined	0.372	Non Defined
OP 89	Cellobiose	27.343	Non Defined	0.002	Non Defined
OP 90	Ethanol	44.434	Non Defined	0.003	Non Defined
OP 91	Ethanol	42.965	0.000	0.000	0.000
OP 92	Ethanol	421.517	0.000	0.000	0.000
OP 93	Ethanol	2.118	3327.062	12.319	3314.743
OP 94	Ethanol	15.454	0.000	0.057	-0.057
OP 95	Ethanol	24.495	0.000	7.371	-7.371
OP 96	Ethanol	1.515	0.000	1.792	-1.792
OP 97	Ethanol	460.741	0.000	0.006	-0.006
OP 98	Ethanol	4520.140	0.000	0.000	0.000
OP 99	Ethanol	22.714	35677.790	132.105	35545.685
OP 100	Ethanol	165.726	0.000	0.606	-0.606
OP 101	Ethanol	262.671	0.000	79.040	-79.040
OP 102	Ethanol	16.248	0.000	19.212	-19.212
OP 103	H2O	163.119	0.000	0.063	-0.063
OP 104	H2O	5.198	-1.292	2.152	-3.444

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 105	H2O	0.808	-0.041	0.096	-0.137
OP 106	H2O	9.418	-0.006	0.026	-0.033
OP 107	H2O	58.802	-0.075	0.268	-0.343
OP 108	H2O	0.260	-0.466	13.125	-13.590
OP 109	H2O	1.964	-0.002	0.006	-0.008
OP 110	H2O	21.620	Non Defined	0.029	Non Defined
OP 111	H2O	59.189	Non Defined	0.299	Non Defined
OP 112	H2O	68.024	Non Defined	0.781	Non Defined
OP 113	H2O	2.168	-0.539	0.897	-1.436
OP 114	H2O	0.337	-0.017	0.040	-0.057
OP 115	H2O	3.927	-0.003	0.011	-0.014
OP 116	H2O	24.522	-0.031	0.112	-0.143
OP 117	H2O	0.108	-0.194	5.473	-5.667
OP 118	H2O	0.819	-0.001	0.003	-0.003
OP 119	H2O	9.016	Non Defined	0.012	Non Defined
OP 120	H2O	24.683	Non Defined	0.125	Non Defined
OP 121	H2O	-630.190	Non Defined	0.326	Non Defined
OP 122	H2O	20.081	-4.991	8.313	-13.304
OP 123	H2O	3.121	-0.159	0.371	-0.530
OP 124	H2O	36.385	-0.025	0.102	-0.126
OP 125	H2O	227.175	-0.288	1.036	-1.324
OP 126	H2O	1.005	-1.799	50.706	-52.505
OP 127	H2O	7.588	-0.008	0.024	-0.032
OP 128	H2O	83.527	Non Defined	0.111	Non Defined
OP 129	H2O	228.668	Non Defined	1.156	Non Defined
OP 130	H2O	4.635	Non Defined	3.016	Non Defined
OP 131	H2O	0.720	-0.037	0.018	-0.055
OP 132	H2O	8.397	-0.006	0.013	-0.019
OP 133	H2O	52.430	-0.067	0.116	-0.183
OP 134	H2O	0.232	-0.415	10.935	-11.351
OP 135	H2O	1.751	-0.002	0.002	-0.004
OP 136	H2O	56.663	Non Defined	0.000	Non Defined
OP 137	H2O	8.806	-0.449	0.300	-0.749
OP 138	H2O	102.668	-0.070	0.171	-0.241
OP 139	H2O	641.023	-0.813	1.568	-2.382
OP 140	H2O	2.835	-5.077	134.621	-139.698
OP 141	H2O	21.412	-0.022	0.029	-0.052
OP 142	H2O	235.691	Non Defined	0.031	Non Defined
OP 143	H2O	16.053	Non Defined	0.152	Non Defined
OP 144	H2O	0.512	-0.127	0.226	-0.353
OP 145	H2O	0.079	-0.004	0.010	-0.014
OP 146	H2O	0.927	-0.001	0.003	-0.003
OP 147	H2O	5.787	-0.007	0.027	-0.035
OP 148	H2O	0.026	-0.046	1.297	-1.343
OP 149	H2O	0.193	0.000	0.001	-0.001
OP 150	H2O	2.128	Non Defined	0.003	Non Defined
OP 151	H2O	4.534	Non Defined	0.031	Non Defined
OP 152	H2O	6.766	Non Defined	0.064	Non Defined

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 153	H2O	0.216	-0.054	0.095	-0.149
OP 154	H2O	0.034	-0.002	0.004	-0.006
OP 155	H2O	0.391	0.000	0.001	-0.001
OP 156	H2O	2.439	-0.003	0.011	-0.015
OP 157	H2O	0.011	-0.019	0.547	-0.566
OP 158	H2O	0.081	0.000	0.000	0.000
OP 159	H2O	0.897	Non Defined	0.001	Non Defined
OP 160	H2O	1.911	Non Defined	0.013	Non Defined
OP 161	H2O	62.866	Non Defined	0.027	Non Defined
OP 162	H2O	2.003	-0.498	0.885	-1.383
OP 163	H2O	0.311	-0.016	0.039	-0.055
OP 164	H2O	3.630	-0.002	0.010	-0.013
OP 165	H2O	22.662	-0.029	0.107	-0.135
OP 166	H2O	0.100	-0.179	5.078	-5.258
OP 167	H2O	0.757	-0.001	0.002	-0.003
OP 168	H2O	8.332	Non Defined	0.012	Non Defined
OP 169	H2O	17.755	Non Defined	0.123	Non Defined
OP 170	H2O	793.567	Non Defined	0.250	Non Defined
OP 171	H2O	25.287	-6.285	10.457	-16.742
OP 172	H2O	3.930	-0.200	0.467	-0.668
OP 173	H2O	45.818	-0.031	0.128	-0.159
OP 174	H2O	286.070	-0.363	1.304	-1.667
OP 175	H2O	1.265	-2.266	63.847	-66.113
OP 176	H2O	9.555	-0.010	0.030	-0.040
OP 177	H2O	105.182	Non Defined	0.140	Non Defined
OP 178	H2O	209.562	Non Defined	1.454	Non Defined
OP 179	H2O	72.856	Non Defined	2.761	Non Defined
OP 180	H2O	2.322	-0.577	0.960	-1.537
OP 181	H2O	0.361	-0.018	0.043	-0.061
OP 182	H2O	4.206	-0.003	0.012	-0.015
OP 183	H2O	26.264	-0.033	0.120	-0.153
OP 184	H2O	0.116	-0.208	5.862	-6.070
OP 185	H2O	0.877	-0.001	0.003	-0.004
OP 186	H2O	9.657	Non Defined	0.013	Non Defined
OP 187	H2O	19.239	Non Defined	0.133	Non Defined
OP 188	H2O	59.396	Non Defined	0.254	Non Defined
OP 189	H2O	1.893	-0.470	0.783	-1.253
OP 190	H2O	0.294	-0.015	0.035	-0.050
OP 191	H2O	3.429	-0.002	0.010	-0.012
OP 192	H2O	21.412	-0.027	0.098	-0.125
OP 193	H2O	0.095	-0.170	4.779	-4.948
OP 194	H2O	0.715	-0.001	0.002	-0.003
OP 195	H2O	7.873	Non Defined	0.010	Non Defined
OP 196	H2O	15.685	Non Defined	0.109	Non Defined
OP 197	H2O	0.008	Non Defined	0.207	Non Defined
OP 198	H2O	0.041	0.000	0.000	0.000
OP 199	H2O	0.006	0.000	0.000	-0.001
OP 200	H2O	0.074	0.000	0.000	0.000

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 201	H2O	0.459	-0.001	0.001	-0.002
OP 202	H2O	0.015	-0.004	0.098	-0.101
OP 203	Sulfuric Acid	43.362	Non Defined	0.000	Non Defined
OP 204	Sulfuric Acid	4.158	Non Defined	1.545	Non Defined
OP 205	Sulfuric Acid	44.704	Non Defined	0.158	Non Defined
OP 206	Furfural	63.246	Non Defined	1.591	Non Defined
OP 207	Furfural	0.151	0.000	2.713	-2.713
OP 208	Furfural	0.073	0.000	0.007	-0.007
OP 209	Furfural	4.370	0.000	0.030	-0.030
OP 210	Furfural	0.038	0.000	0.449	-0.449
OP 211	Furfural	1.357	0.000	0.002	-0.002
OP 212	Furfural	0.653	0.000	0.061	-0.061
OP 213	Furfural	39.331	0.000	0.266	-0.266
OP 214	Furfural	0.342	0.000	3.976	-3.976
OP 215	Furfural	3.365	0.000	0.016	-0.016
OP 216	Furfural	0.008	0.000	0.154	-0.154
OP 217	Furfural	0.232	0.000	0.000	0.000
OP 218	Furfural	0.072	0.000	0.025	-0.025
OP 219	Furfural	0.035	0.000	0.003	-0.003
OP 220	Furfural	2.092	0.000	0.014	-0.014
OP 221	Furfural	0.018	0.000	0.218	-0.218
OP 222	Furfural	46.497	0.000	0.001	-0.001
OP 223	Furfural	0.111	0.000	1.992	-1.992
OP 224	Furfural	0.053	0.000	0.005	-0.005
OP 225	Furfural	3.213	0.000	0.022	-0.022
OP 226	Furfural	0.028	0.000	0.330	-0.330
OP 227	Furfural	0.998	0.000	0.001	-0.001
OP 228	Furfural	0.480	0.000	0.045	-0.045
OP 229	Furfural	28.915	0.000	0.195	-0.195
OP 230	Furfural	0.251	0.000	2.922	-2.922
OP 231	Ammonia	31.765	0.000	0.012	-0.012
OP 232	Oxygen	1.411	Non Defined	0.000	Non Defined
OP 233	Oxygen	7.675	-0.092	0.002	-0.094
OP 234	Oxygen	0.054	-0.500	0.012	-0.512
OP 235	Carbon Dioxide	536.985	-0.004	0.000	-0.004
OP 236	Carbon Dioxide	26.409	0.000	0.989	-0.989
OP 237	Carbon Dioxide	1.854	0.000	0.092	-0.092
OP 238	Carbon Dioxide	5241.489	0.000	0.010	-0.010
OP 239	Carbon Dioxide	367.931	0.000	8.626	-8.626
OP 240	Glycerol	0.627	0.000	1.358	-1.358
OP 241	Glycerol	3.791	-0.001	0.058	-0.059
OP 242	Succinic Acid	1.833	-0.004	0.342	-0.346
OP 243	Succinic Acid	11.566	0.000	0.100	-0.100
OP 244	Lactic Acid	0.346	0.000	0.603	-0.603
OP 245	Lactic Acid	2.127	0.000	0.025	-0.025
OP 246	Lactic Acid	353.760	0.000	0.149	-0.149
OP 247	Xylitol	5.484	0.000	26.321	-26.321
OP 248	Xylitol	37.415	-0.004	0.724	-0.728

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 249	Acetic Acid	0.038	-0.029	4.775	-4.804
OP 250	Acetic Acid	0.010	0.000	0.000	0.000
OP 251	Acetic Acid	2.475	0.000	0.003	-0.003
OP 252	Acetic Acid	0.231	0.000	0.120	-0.120
OP 253	Acetic Acid	0.059	0.000	0.000	0.000
OP 254	Acetic Acid	15.138	0.000	0.017	-0.017
OP 255	Acetic Acid	0.006	0.000	0.698	-0.698
OP 256	CornSteep Liquor	0.105	0.000	0.000	0.000
OP 257	CornSteep Liquor	0.020	-0.668	0.001	-0.669
OP 258	CornSteep Liquor	12.400	-0.124	0.027	-0.150
OP 259	CornSteep Liquor	0.011	-78.569	2.640	-81.209
OP 260	CornSteep Liquor	0.402	-0.071	0.000	-0.071
OP 261	CornSteep Liquor	0.803	Non Defined	0.002	Non Defined
OP 262	CornSteep Liquor	0.508	Non Defined	0.000	Non Defined
OP 263	CornSteep Liquor	0.094	-3.217	0.002	-3.219
OP 264	CornSteep Liquor	59.709	-0.595	0.128	-0.723
OP 265	CornSteep Liquor	0.054	-378.313	12.454	-390.767
OP 266	CornSteep Liquor	1.937	-0.343	0.000	-0.344
OP 267	ZM	6.580	Non Defined	0.000	Non Defined
OP 268	ZM	19.155	0.000	0.020	-0.020
OP 269	Cellulase	11.471	0.000	0.028	-0.028
OP 270	Cellulase	4.319	-454.254	0.017	-454.271
OP 271	Ash	32.940	-171.022	0.013	-171.035
OP 272	Ash	296.458	-4.435	6.391	-10.826
OP 273	Ash	17.579	-39.915	55.486	-95.401
OP 274	Ash	158.215	-2.367	3.408	-5.775
OP 275	DAMPHOS	1.725	-21.302	29.583	-50.885
OP 276	DAMPHOS	0.025	-4.098	0.005	-4.103
OP 277	DAMPHOS	0.106	Non Defined	0.000	Non Defined
OP 278	DAMPHOS	19.421	Non Defined	0.000	Non Defined
OP 279	DAMPHOS	0.283	-46.144	0.026	-46.170
OP 280	AMSULFAT	12.425	Non Defined	0.000	Non Defined
OP 281	AMSULFAT	111.827	-20.312	0.041	-20.353
OP 282	Cellulose	18.132	-182.809	0.207	-183.017

Table E4 Sustainability Results of alternative G case

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 1	Cellulose	0.398	-1.628	0.016	-1.644
OP 2	Cellulose	1.590	Non Defined	0.064	Non Defined
OP 3	Cellulose	18.132	Non Defined	0.713	Non Defined
OP 4	Cellulose	3.578	-14.651	0.140	-14.792
OP 5	Cellulose	14.313	Non Defined	0.562	Non Defined
OP 6	Cellulose	163.189	Non Defined	6.233	Non Defined
OP 7	Cellulose	2085.164	Non Defined	79.191	Non Defined
OP 8	Cellulose	190.737	Non Defined	7.206	Non Defined
OP 9	Cellulose	0.072	-0.296	0.003	-0.299

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 10	Cellulose	0.289	Non Defined	0.014	Non Defined
OP 11	Cellulose	3.294	Non Defined	0.154	Non Defined
OP 12	Cellulose	0.650	-2.661	0.030	-2.692
OP 13	Cellulose	2.600	Non Defined	0.122	Non Defined
OP 14	Cellulose	29.643	Non Defined	1.356	Non Defined
OP 15	Cellulose	378.762	Non Defined	17.238	Non Defined
OP 16	Cellulose	34.647	Non Defined	1.570	Non Defined
OP 17	Cellulose	0.664	-2.718	0.028	-2.746
OP 18	Cellulose	2.655	Non Defined	0.112	Non Defined
OP 19	Cellulose	30.276	Non Defined	1.250	Non Defined
OP 20	Cellulose	5.975	-24.464	0.246	-24.710
OP 21	Cellulose	23.899	Non Defined	0.984	Non Defined
OP 22	Cellulose	272.488	Non Defined	10.941	Non Defined
OP 23	Cellulose	3481.734	Non Defined	139.037	Non Defined
OP 24	Cellulose	318.486	Non Defined	12.655	Non Defined
OP 25	Hemicellulose	3.536	-28.485	0.143	-28.628
OP 26	Hemicellulose	14.146	Non Defined	0.570	Non Defined
OP 27	Hemicellulose	31.828	-256.365	1.247	-257.612
OP 28	Hemicellulose	127.313	Non Defined	4.990	Non Defined
OP 29	Hemicellulose	3359.645	Non Defined	126.793	Non Defined
OP 30	Hemicellulose	0.188	-1.515	0.009	-1.524
OP 31	Hemicellulose	0.753	Non Defined	0.036	Non Defined
OP 32	Hemicellulose	1.693	-13.639	0.079	-13.718
OP 33	Hemicellulose	6.773	Non Defined	0.316	Non Defined
OP 34	Hemicellulose	178.741	Non Defined	8.091	Non Defined
OP 35	Hemicellulose	2.601	-20.951	0.110	-21.061
OP 36	Hemicellulose	10.404	Non Defined	0.440	Non Defined
OP 37	Hemicellulose	23.410	-188.560	0.963	-189.523
OP 38	Hemicellulose	93.640	Non Defined	3.853	Non Defined
OP 39	Hemicellulose	2471.063	Non Defined	98.083	Non Defined
OP 40	Lignin	38.667	-311.448	1.271	-312.719
OP 41	Lignin	154.668	Non Defined	5.083	Non Defined
OP 42	Lignin	348.002	-2803.034	11.035	-2814.069
OP 43	Lignin	1392.010	Non Defined	44.141	Non Defined
OP 44	Lignin	5.630	-45.345	0.219	-45.564
OP 45	Lignin	22.519	Non Defined	0.876	Non Defined
OP 46	Lignin	50.668	-408.109	1.912	-410.021
OP 47	Lignin	202.670	Non Defined	7.648	Non Defined
OP 48	Lignin	42.119	-339.256	1.450	-340.707
OP 49	Lignin	168.477	Non Defined	5.801	Non Defined
OP 50	Lignin	379.074	-3053.308	12.613	-3065.921
OP 51	Lignin	1516.297	Non Defined	50.453	Non Defined
OP 52	Glucose	0.088	1.399	0.007	1.393
OP 53	Glucose	1.654	Non Defined	0.041	Non Defined
OP 54	Glucose	0.054	Non Defined	0.001	Non Defined
OP 55	Glucose	17.466	Non Defined	0.417	Non Defined
OP 56	Glucose	8.511	134.807	0.639	134.169
OP 57	Glucose	159.330	Non Defined	3.809	Non Defined

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 58	Glucose	5.202	Non Defined	0.124	Non Defined
OP 59	Glucose	0.016	0.254	0.001	0.253
OP 60	Glucose	0.300	Non Defined	0.009	Non Defined
OP 61	Glucose	0.010	Non Defined	0.000	Non Defined
OP 62	Glucose	3.173	Non Defined	0.091	Non Defined
OP 63	Glucose	1.546	24.487	0.123	24.364
OP 64	Glucose	28.942	Non Defined	0.828	Non Defined
OP 65	Glucose	0.945	Non Defined	0.027	Non Defined
OP 66	Glucose	0.148	2.337	0.011	2.325
OP 67	Glucose	2.762	Non Defined	0.072	Non Defined
OP 68	Glucose	0.090	Non Defined	0.002	Non Defined
OP 69	Glucose	29.165	Non Defined	0.732	Non Defined
OP 70	Glucose	14.211	225.097	1.084	224.013
OP 71	Glucose	266.044	Non Defined	6.684	Non Defined
OP 72	Glucose	8.686	Non Defined	0.218	Non Defined
OP 73	Glucose	3.015	47.753	0.158	47.596
OP 74	Glucose	56.440	Non Defined	0.071	Non Defined
OP 75	Glucose	1.843	Non Defined	0.002	Non Defined
OP 76	Glucose	596.008	Non Defined	0.102	Non Defined
OP 77	Glucose	290.408	4600.062	14.909	4585.153
OP 78	Glucose	5436.870	Non Defined	1.114	Non Defined
OP 79	Glucose	177.507	Non Defined	0.036	Non Defined
OP 80	Xylose	8.101	0.000	0.569	-0.569
OP 81	Xylose	53.950	Non Defined	1.346	Non Defined
OP 82	Xylose	1.932	Non Defined	0.048	Non Defined
OP 83	Xylose	297.272	Non Defined	7.097	Non Defined
OP 84	Xylose	409.402	0.000	28.334	-28.334
OP 85	Xylose	2726.535	Non Defined	65.181	Non Defined
OP 86	Xylose	97.654	Non Defined	2.335	Non Defined
OP 87	Xylose	0.431	0.000	0.032	-0.032
OP 88	Xylose	2.870	Non Defined	0.085	Non Defined
OP 89	Xylose	0.103	Non Defined	0.003	Non Defined
OP 90	Xylose	15.816	Non Defined	0.452	Non Defined
OP 91	Xylose	21.781	0.000	1.610	-1.610
OP 92	Xylose	145.058	Non Defined	4.148	Non Defined
OP 93	Xylose	5.195	Non Defined	0.149	Non Defined
OP 94	Xylose	5.958	0.000	0.426	-0.426
OP 95	Xylose	39.681	Non Defined	1.039	Non Defined
OP 96	Xylose	1.421	Non Defined	0.037	Non Defined
OP 97	Xylose	218.648	Non Defined	5.486	Non Defined
OP 98	Xylose	301.120	0.000	21.207	-21.207
OP 99	Xylose	2005.402	Non Defined	50.383	Non Defined
OP 100	Xylose	71.826	Non Defined	1.805	Non Defined
OP 101	Cellobiose	1.830	Non Defined	0.024	Non Defined
OP 102	Cellobiose	16.473	Non Defined	0.207	Non Defined
OP 103	Cellobiose	0.332	Non Defined	0.005	Non Defined
OP 104	Cellobiose	2.992	Non Defined	0.045	Non Defined
OP 105	Cellobiose	3.056	Non Defined	0.042	Non Defined

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 106	Cellobiose	27.505	Non Defined	0.364	Non Defined
OP 107	Cellobiose	3.039	Non Defined	0.002	Non Defined
OP 108	Cellobiose	27.350	Non Defined	0.003	Non Defined
OP 109	Ethanol	44.444	0.000	0.000	0.000
OP 110	Ethanol	43.090	0.000	0.000	0.000
OP 111	Ethanol	421.517	3327.067	11.920	3315.146
OP 112	Ethanol	2.118	0.000	0.055	-0.055
OP 113	Ethanol	15.454	0.000	7.092	-7.092
OP 114	Ethanol	24.495	0.000	1.879	-1.879
OP 115	Ethanol	1.515	0.000	0.005	-0.005
OP 116	Ethanol	462.073	0.000	0.000	0.000
OP 117	Ethanol	4520.154	35677.900	127.829	35550.071
OP 118	Ethanol	22.714	0.000	0.585	-0.585
OP 119	Ethanol	165.726	0.000	76.052	-76.052
OP 120	Ethanol	262.672	0.000	20.146	-20.146
OP 121	Ethanol	16.248	0.000	0.054	-0.054
OP 122	H2O	68.616	-408.983	0.842	-409.824
OP 123	H2O	2.158	-12.861	0.037	-12.898
OP 124	H2O	0.335	-1.997	0.010	-2.008
OP 125	H2O	3.907	-23.287	0.104	-23.391
OP 126	H2O	24.244	-144.509	5.640	-150.149
OP 127	H2O	0.107	-0.639	0.002	-0.642
OP 128	H2O	0.816	Non Defined	0.011	Non Defined
OP 129	H2O	8.978	Non Defined	0.116	Non Defined
OP 130	H2O	24.675	Non Defined	0.303	Non Defined
OP 131	H2O	4.658	-27.762	0.016	-27.779
OP 132	H2O	0.723	-4.312	0.012	-4.324
OP 133	H2O	8.434	-50.270	0.143	-50.413
OP 134	H2O	52.336	-311.950	11.729	-323.679
OP 135	H2O	0.232	-1.380	0.051	-1.431
OP 136	H2O	1.760	-10.493	0.016	-10.509
OP 137	H2O	56.893	Non Defined	0.278	Non Defined
OP 138	H2O	8.836	Non Defined	0.162	Non Defined
OP 139	H2O	103.018	Non Defined	1.466	Non Defined
OP 140	H2O	639.277	-339.111	140.865	-479.976
OP 141	H2O	2.828	-52.670	0.026	-52.696
OP 142	H2O	21.503	-614.036	0.139	-614.176
OP 143	H2O	236.733	-3810.405	51.156	-3861.561
OP 144	H2O	6.825	-16.857	0.129	-16.986
OP 145	H2O	0.215	Non Defined	0.004	Non Defined
OP 146	H2O	0.033	-128.171	0.001	-128.172
OP 147	H2O	0.389	-1411.048	0.011	-1411.059
OP 148	H2O	2.411	-40.678	0.567	-41.245
OP 149	H2O	0.011	-1.279	0.000	-1.279
OP 150	H2O	0.081	-0.199	0.002	-0.200
OP 151	H2O	0.893	Non Defined	0.014	Non Defined
OP 152	H2O	1.910	Non Defined	0.029	Non Defined
OP 153	H2O	73.244	-2.316	0.945	-3.261

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 154	H2O	2.303	-14.373	0.041	-14.414
OP 155	H2O	0.358	-0.064	0.011	-0.075
OP 156	H2O	4.170	-0.483	0.113	-0.597
OP 157	H2O	25.880	-436.572	6.037	-442.609
OP 158	H2O	0.114	-13.728	0.003	-13.731
OP 159	H2O	0.871	Non Defined	0.012	Non Defined
OP 160	H2O	9.584	Non Defined	0.130	Non Defined
OP 161	H2O	19.719	Non Defined	0.254	Non Defined
OP 162	H2O	3226.860	-2.132	1.885	-4.018
OP 163	H2O	758.394	-24.858	4.144	-29.002
OP 164	H2O	0.008	-154.257	0.000	-154.258
OP 165	H2O	0.041	-0.682	0.001	-0.683
OP 166	H2O	0.006	-19233.681	0.001	-19233.683
OP 167	H2O	0.074	-4520.402	0.001	-4520.403
OP 168	H2O	0.458	Non Defined	0.102	Non Defined
OP 169	H2O	0.015	Non Defined	0.000	Non Defined
OP 170	H2O	3696.408	Non Defined	0.000	Non Defined
OP 171	Sulfuric Acid	43.362	Non Defined	1.437	Non Defined
OP 172	Sulfuric Acid	4.158	-0.048	0.165	-0.214
OP 173	Sulfuric Acid	43.982	-0.243	2.057	-2.300
OP 174	Furfural	63.112	-0.038	3.738	-3.775
OP 175	Furfural	0.151	-0.440	0.015	-0.456
OP 176	Furfural	0.072	-2.732	0.028	-2.761
OP 177	Furfural	4.379	Non Defined	0.447	Non Defined
OP 178	Furfural	0.038	Non Defined	0.002	Non Defined
OP 179	Furfural	1.361	Non Defined	0.057	Non Defined
OP 180	Furfural	0.649	-22032.421	0.253	-22032.674
OP 181	Furfural	39.415	-1.153	3.967	-5.119
OP 182	Furfural	0.342	-12.192	0.020	-12.212
OP 183	Furfural	3.358	0.000	0.226	-0.226
OP 184	Furfural	0.008	0.000	0.001	-0.001
OP 185	Furfural	0.233	0.000	0.026	-0.026
OP 186	Furfural	0.072	Non Defined	0.004	Non Defined
OP 187	Furfural	0.035	Non Defined	0.014	Non Defined
OP 188	Furfural	2.097	Non Defined	0.228	Non Defined
OP 189	Furfural	0.018	0.000	0.001	-0.001
OP 190	Furfural	46.420	0.000	1.947	-1.947
OP 191	Furfural	0.111	0.000	0.005	-0.005
OP 192	Furfural	0.053	0.000	0.021	-0.021
OP 193	Furfural	3.221	0.000	0.336	-0.336
OP 194	Furfural	0.028	0.000	0.001	-0.001
OP 195	Furfural	1.001	0.000	0.044	-0.044
OP 196	Furfural	0.477	Non Defined	0.187	Non Defined
OP 197	Furfural	28.990	0.000	2.977	-2.977
OP 198	Furfural	0.252	Non Defined	0.012	Non Defined
OP 199	Ammonia	31.735	Non Defined	0.000	Non Defined
OP 200	Oxygen	2381.435	Non Defined	10.933	Non Defined
OP 201	Oxygen	9507.272	Non Defined	43.647	Non Defined

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 202	Oxygen	1.411	0.000	0.004	-0.004
OP 203	Oxygen	7.677	0.000	0.040	-0.040
OP 204	Oxygen	0.054	0.000	0.000	0.000
OP 205	Carbon Dioxide	537.107	0.000	2.640	-2.640
OP 206	Carbon Dioxide	26.423	0.000	0.084	-0.084
OP 207	Carbon Dioxide	1.845	0.000	0.010	-0.010
OP 208	Carbon Dioxide	5244.422	0.000	19.698	-19.698
OP 209	Carbon Dioxide	366.286	0.000	1.188	-1.188
OP 210	Carbon Dioxide	9561.276	0.000	0.000	0.000
OP 211	Glycerol	0.628	0.000	0.061	-0.061
OP 212	Glycerol	3.791	0.000	0.366	-0.366
OP 213	Succinic Acid	1.833	0.000	0.103	-0.103
OP 214	Succinic Acid	11.568	0.000	4.046	-4.046
OP 215	Lactic Acid	0.346	0.000	0.026	-0.026
OP 216	Lactic Acid	2.127	0.000	0.155	-0.155
OP 217	Lactic Acid	353.840	0.000	27.419	-27.419
OP 218	Xylitol	5.485	0.000	0.748	-0.748
OP 219	Xylitol	37.422	0.000	29.714	-29.714
OP 220	Acetic Acid	0.038	0.000	0.002	-0.002
OP 221	Acetic Acid	0.010	0.000	0.003	-0.003
OP 222	Acetic Acid	2.475	0.000	0.123	-0.123
OP 223	Acetic Acid	0.232	0.000	0.063	-0.063
OP 224	Acetic Acid	0.059	0.000	0.019	-0.019
OP 225	Acetic Acid	15.140	-0.001	0.722	-0.723
OP 226	Acetic Acid	0.006	Non Defined	0.000	Non Defined
OP 227	CornSteep Liquor	0.106	-0.004	0.001	-0.005
OP 228	CornSteep Liquor	0.020	Non Defined	0.026	Non Defined
OP 229	CornSteep Liquor	12.374	0.000	2.758	-2.758
OP 230	CornSteep Liquor	0.011	0.000	0.000	0.000
OP 231	CornSteep Liquor	0.402	0.000	0.002	-0.002
OP 232	CornSteep Liquor	0.804	0.000	0.000	0.000
OP 233	CornSteep Liquor	0.509	0.000	0.002	-0.002
OP 234	CornSteep Liquor	0.094	-0.004	0.123	-0.127
OP 235	CornSteep Liquor	59.587	-0.029	13.049	-13.078
OP 236	CornSteep Liquor	0.054	0.000	0.000	0.000
OP 237	CornSteep Liquor	1.937	Non Defined	0.000	Non Defined
OP 238	ZM	6.582	0.000	0.021	-0.021
OP 239	ZM	19.159	0.000	0.034	-0.034
OP 240	Cellulase	11.475	0.000	0.020	-0.020
OP 241	Cellulase	4.311	0.000	0.012	-0.012
OP 242	Ash	32.940	0.000	5.936	-5.936
OP 243	Ash	296.458	0.000	51.575	-51.575
OP 244	Ash	17.587	-0.670	3.320	-3.991
OP 245	Ash	158.286	-0.124	28.896	-29.020
OP 246	DAMPHOS	1.721	-78.401	0.004	-78.405
OP 247	DAMPHOS	0.025	-0.160	0.000	-0.160
OP 248	DAMPHOS	0.106	-5.734	0.000	-5.734
OP 249	DAMPHOS	19.383	-5.091	0.031	-5.122

Open Path	Component	Flow-rate (kg/h)	MVA	EWC	TVA
OP 250	DAMPHOS	0.283	-3.227	0.000	-3.227
OP 251	AMSULFAT	12.328	-0.596	0.037	-0.633
OP 252	AMSULFAT	110.951	-377.542	0.189	-377.731
OP 253	N2	39153.968	-0.771	157.250	-158.021
OP 254	CornSteep Liquor	0.106	0.000	0.001	-0.001
OP 255	CornSteep Liquor	0.020	0.000	0.026	-0.026
OP 256	CornSteep Liquor	12.374	-454.397	2.758	-457.155
OP 257	CornSteep Liquor	0.011	-170.697	0.000	-170.697
OP 258	CornSteep Liquor	0.402	Non Defined	0.002	Non Defined
OP 259	CornSteep Liquor	0.804	Non Defined	0.000	Non Defined
OP 260	CornSteep Liquor	0.509	-4.435	0.002	-4.437
OP 261	CornSteep Liquor	0.094	-39.915	0.123	-40.038
OP 262	CornSteep Liquor	59.587	-2.368	13.049	-15.417
OP 263	CornSteep Liquor	0.054	-21.312	0.000	-21.312
OP 264	CornSteep Liquor	1.937	Non Defined	0.000	Non Defined
OP 265	ZM	6.582	-17.723	0.018	-17.741
OP 266	ZM	19.159	-0.060	0.025	-0.085
OP 267	Cellulase	11.475	-0.252	0.015	-0.267
OP 268	Cellulase	4.311	-46.053	0.012	-46.065
OP 269	Ash	32.940	-0.673	5.936	-6.609
OP 270	Ash	296.458	-20.153	51.575	-71.728
OP 271	Ash	17.587	-181.377	3.320	-184.697
OP 272	Ash	158.286	0.000	28.896	-28.896
OP 273	DAMPHOS	1.721	-0.670	0.004	-0.674
OP 274	DAMPHOS	0.025	Non Defined	0.000	Non Defined
OP 275	DAMPHOS	0.106	Non Defined	0.000	Non Defined
OP 276	DAMPHOS	19.383	-0.124	0.023	-0.147
OP 277	DAMPHOS	0.283	Non Defined	0.000	Non Defined
OP 278	AMSULFAT	12.328	-78.401	0.037	-78.438
OP 279	AMSULFAT	110.951	-0.160	0.189	-0.350
OP 280	N2	39153.968	-3.227	157.250	-160.477

Appendix F Results of Life Cycle Inventory of Bioethanol Production

Table F1 Life Cycle Inventory of alternative D case

Table F1.1 Results of the inventory analysis of cassava cultivation per one kilogram ethanol 99.5% wt. production (Khongsiri, S. 2009)

Inventory of cassava cultivation					
Input			**Output**		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Raw material			**Products**		
Cassava stems	1.7844	piece	Cassava root	5.1722	kg
Cassava peel	5.5653	kg	Cassava Leaves	1.2053	kg
Chicken manure	13.3442	kg	Cassava Rhizome	1.6655	kg
N-fertilizer	0.0065	kg	Cassava stems	4.5101	piece
P-fertilizer	0.0036	kg			
K-fertilizer	0.0069	kg	**Air emissions**		
Alachlor	0.0005	kg	Carbon dioxide	0.0430	kg
Paraquat	0.0008	kg	Nitrogen oxide	0.0009	kg
Glyphosate	0.0015	kg	Sulfur dioxide	0.0001	kg
Zinc	0.0004	kg	Nitrous oxide	0.0002	kg
			Ammonia	0.0014	kg
Fuel			Volatile organic compound	0.0003	kg
Diesel	0.0128	kg			

Table F1.2 Results of the inventory analysis of sugarcane cultivation per one kilogram ethanol 99.5% wt. production (MTEC, 2012)

Inventory of sugarcane cultivation					
Input			**Output**		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Chemical			**Product**		
Fertilizer (N)	1.12E-02	kg	Sugarcane	6.2676	kg
Fertilizer (P)	5.20E-03	kg			
Fertilizer (K)	4.63E-03	kg	**Co-product**		
Paraquat	8.09E-05	kg	Cane trash - 0% burning	1.247252	kg
Atrazine	2.82E-04	kg			
Ametryne	2.01E-04	kg	**Air emissions**		
2,4-D	8.09E-05	kg	Carbon monoxide	5.54E-06	kg
			Nitrogen oxide	6.52E-06	kg
Fuel/Electricity			PM10	1.08E-06	kg
Diesel	7.58E-03	kg	sulfur dioxide	2.12E-06	kg
			Methane	2.7E-08	kg
			Nitrogen dioxide	1.2E-07	kg
			Carbon dioxide	0.02482	kg

Table F1.3 Results of the inventory analysis of sugar milling per one kilogram ethanol 99.5% wt. production (MTEC, 2012)

Inventory of sugar milling					
Input			**Output**		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Raw material			**Product**		
Sugarcane plant	6.2676	kg	Raw sugar	0.6867	kg
Energy			**Co-product**		
Steam	2.8204	kg	Molasses	0.2274	kg
Electricity	0.1089	kWh	Bagasse	1.8176	kg
Chemical					
Lime	0.01322	kg			
Sodium chloride	0.00489	kg			
Hydrochloric acid	0.00000	kg			
SiO_2	0.00001	kg			
Biocide	0.00002	kg			
Aluminium sulfate	0.00002	kg			
Caustic soda flake	0.00001	kg			
Flocculants	0.00024	kg			
Miscellaneous	0.00004	kg			

Table F1.4 Results of the inventory analysis of corn cultivation per one kilogram ethanol 99.5% wt. production (MTEC, 2012)

Inventory of corn cultivation					
Input			**Output**		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Raw material			**Product**		
Corn seed	0.0009	kg	Corn	0.25708	kg
Urea	0.0124	kg			
Phosphorus pentoxide	0.0194	kg	**Co-product**		
Potassium oxide	0.0047	kg	Corn cob	0.00015	kg
Atrazine	0.0001	kg	Corn stover	0.18510	kg
Fuel			**Air emissions**		
Diesel	0.0063	kg	Ammonia	0.00070	kg
			Nitrogen oxide	0.00001	kg
			Dinitrogen monoxide	0.00005	kg

Table F1.5 Results of the inventory data of feedstocks transportation for 1 ton-kilometer (tkm) for 10-wheel truck at full load 16 tons (MTEC, 2012)

Inventory of feedstocks transportation					
Input			Output		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Fuel			**Emission to Air**		
Diesel	1.51E-02	kg	Carbon dioxide	47.37	g
			Carbon monoxide	1.62E-01	g
			Nitrogen oxides	4.88E-01	g
			Particulate matter	3.66E-02	g
			Hydrocarbons	4.24E-02	g
			Methane	1.00E-03	g
			Benzene	8.05E-04	g
			Toluene	3.39E-04	g
			Xylene	3.39E-04	g
			Non – methane volatile organic compounds	8.09E-02	g
			Sulfur oxides	1.02E-02	g
			Nitrous Oxide	1.80E-03	g
			Cadmium	1.46E-07	g
			Copper	2.48E-05	g
			Chromium	7.29E-07	g
			Nickel	1.02E-06	g
			Selenium	1.46E-07	g
			Zinc	1.46E-05	g
			Lead	1.60E-09	g
			Mercury	2.91E-10	g

Table F1.6 Results of the inventory analysis of pretreatment section per one kilogram ethanol 99.5% wt. production

Inventory of pretreatment					
Input			**Output**		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Raw material			**Products**		
Cassava Rhizome	1.6655	kg	Pretreated Output	4.8537	kg
Corn Stover	0.1851				
Sugarcane Bagasse	1.8176				
Sulfuric acid	0.0184	kg			
Water	0.8752	kg			
			Air emissions		
			Water	0.4820	kg
Electricity/Heat			Furfural	0.0227	kg
Steam	0.8024	kg			

Table F1.7 Results of the inventory analysis of detoxification section per one kilogram ethanol 99.5% wt. production

Inventory of detoxification					
Input			**Output**		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Raw material			**Products**		
Pretreated Output	4.8537	kg	Detoxificated Output	5.7784	kg
Ammonia	0.0063	kg			
Water	0.9183	kg			
Make up cooling water	0.5377	kg			
Electricity/Heat					
Electricity	0.0004	kWh			

Table F1.8 Results of the inventory analysis of SSCF fermentation section per one kilogram ethanol 99.5% wt. production

Inventory of SSCF fermentation					
Input			**Output**		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Raw material	-		**Products**		
Detoxificated Output	5.7784	kg	SSCF Fermented Output	3.4267	kg
Cellulase	0.0032	kg			
DAP	0.0043	kg	**Wastes**		
CSL	0.0160	kg	Solid waste	1.08	kg
Water	0.0254	kg			
Make up cooling water	29.7589	kg	**Air emissions**		
			Water	0.0329	kg
			Ethanol	0.1109	kg
Electricity/Heat			Carbon dioxide	1.1699	kg
Electricity	0.0198	kWh	Oxygen	0.0018	kg
Steam	0.237	kg	Acetic acid	0.0001	kg
			Furfural	0.0005	kg
			Lactic acid	0.0000	kg
			CSL	0.0001	kg
			Emissions to soil		
			Biowaste	0.9452	kg
			Ash	0.1017	kg

Table F1.9 Results of the inventory analysis of distillation section per one kilogram ethanol 99.5% wt. production

Inventory of distillation					
Input			**Output**		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Raw material			**Products**		
SSCF Fermented Output	3.4267	kg	Distillated Output	1.0631	kg
Make up cooling water	72.8046	kg			
			Wastes		
			Waste water	2.2844	kg
			Air emissions		
			Water	0.0016	kg
Electricity/Heat			Ethanol	0.0036	kg
Electricity	0.0493	kWh	Carbon dioxide	0.0739	kg
Steam	3.6760	kg	Oxygen	0.0000	kg
			Fufural	0.0001	kg
			Water emissions		
			Water	1.7405	kg
			Ethanol	0.1886	kg
			Fufural	0.0229	kg
			Glycerol	0.0009	kg
			Succinic acid	0.0028	kg
			Lactic acid	0.0755	kg
			Xylitol	0.0091	kg
			Acetic acid	0.0037	kg
			CSL	0.0153	kg
			Biowaste	0.2250	kg

Table F1.10 Results of the inventory analysis of dehydration section per one kilogram ethanol 99.5% wt. production

Inventory of dehydration					
Input			**Output**		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Raw material			**Products**		
Distillated Output	1.0631	kg	Ethanol 99.5% wt.	1.00000	kg
Make up cooling water	11.7233	kg			
Electricity/Heat			**Air emissions**		
Electricity	0.0078	kWh	Water	0.06314	kg
Steam	0.015	kg			

Table F2 Life Cycle Inventory of alternative E case

Table F2.1 Results of the inventory analysis of pretreatment section per one kilogram ethanol 99.5% wt. production

Inventory of pretreatment					
Input			**Output**		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Raw material			**Products**		
Cassava Rhizome	1.6655	kg	Pretreated Output	4.8642	kg
Corn Stover	0.1851				
Sugarcane Bagasse	1.8162				
Sulfuric acid	0.0186	kg			
Water	0.8839	kg			
			Air emissions		
			Water	0.4845	kg
Electricity/Heat			Furfural	0.0228	kg
Steam	0.8024	kg			

Table F2.2 Results of the inventory analysis of detoxification section per one kilogram ethanol 99.5% wt. production

Inventory of detoxification					
Input			**Output**		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Raw material			**Products**		
Pretreated Output	4.8642	kg	Detoxificated Output	5.7964	kg
Ammonia	0.0064	kg			
Water	0.9257	kg			
Make up cooling water	0.4039	kg			
Electricity/Heat					
Electricity	0.0004	kWh			

Table F2.3 Results of the inventory analysis of SSCF fermentation section per one kilogram ethanol 99.5% wt. production

Inventory of SSCF fermentation					
Input			**Output**		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Raw material			**Products**		
Detoxificated Output	5.7964	kg	SSCF Fermented Output	3.4351	kg
Cellulase	0.0032	kg			
DAP	0.0043	kg	**Wastes**		
CSL	0.0161	kg	Solid waste	1.08	kg
Water	0.0254	kg			
Make up cooling water	23.8598	kg	**Air emissions**		
			Water	3.29E-02	kg
			Ethanol	1.10E-01	kg
Electricity/Heat			Carbon dioxide	1.17E+00	kg
Electricity	0.0262	kWh	Oxygen	1.83E-03	kg
Steam	0.0000	kg	Acetic acid	5.41E-05	kg
			Furfural	5.43E-04	kg
			Lactic acid	3.47E-07	kg
			CSL	1.23E-04	kg
			Emission to soil		
			Biowaste	0.9449	kg
			Ash	0.1017	kg

Table F2.4 Results of the inventory analysis of distillation section per one kilogram ethanol 99.5% wt. production

Inventory of distillation					
Input			**Output**		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Raw material			**Products**		
SSCF Fermented Output	3.4351	kg	Distillated Output	1.0632	kg
Make up cooling water	40.6998	kg			
			Waste		
			Waste water	2.3033	kg
			Air emissions		
			Water	1.64E-03	kg
Electricity/Heat			Ethanol	3.58E-03	kg
Electricity	0.0454	kWh	Carbon dioxide	7.44E-02	kg
Steam	2.1132	kg	Oxygen	1.08E-05	kg
			Fufural	1.37E-04	kg
			Water emissions		
			Water	1.76E+00	kg
			Ethanol	1.89E-01	kg
			Fufural	2.29E-02	kg
			Glycerol	9.36E-04	kg
			Succinic acid	2.84E-03	kg
			Lactic acid	7.55E-02	kg
			Xylitol	9.09E-03	kg
			Acetic acid	3.75E-03	kg
			CSL	1.53E-02	kg
			Biowaste	2.25E-01	kg

Table F2.5 Results of the inventory analysis of dehydration section per one kilogram ethanol 99.5% wt. production

Inventory of dehydration					
Input			**Output**		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Raw material			**Products**		
Distillated Output	1.0632	kg	Ethanol 99.5% wt.	1.0000	kg
Make up cooling water	4.7832	kg			
Electricity/Heat			**Air emissions**		
Electricity	0.0052	kWh	Water	0.0632	kg
Steam	0.0098	kg			

Table F3 Life Cycle Inventory of alternative F case

Table F3.1 Results of the inventory analysis of pretreatment section per one kilogram ethanol 99.5% wt. production

Inventory of pretreatment					
Input			**Output**		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Raw material			**Products**		
Cassava Rhizome	1.6653	kg	Pretreated Output	4.8636	kg
Corn Stover	0.1850				
Sugarcane Bagasse	1.8139				
Sulfuric acid	0.0186	kg			
Water	-	kg			
			Air emissions		
			Water	0.4842	kg
Electricity/Heat			Furfural	0.0228	kg
Steam	0.8019	kg			

Table F3.2 Results of the inventory analysis of detoxification section per one kilogram ethanol 99.5% wt. production

Inventory of detoxification					
Input			**Output**		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Raw material			**Products**		
Pretreated Output	4.8636	kg	Detoxificated Output	5.7931	kg
Ammonia	0.0064	kg			
Water	0.3096	kg			
Make up cooling water	0.4149	kg			
Electricity/Heat					
Electricity	0.0004	kWh			

Table F3.3 Results of the inventory analysis of SSCF fermentation section per one kilogram ethanol 99.5% wt. production

Inventory of SSCF fermentation					
Input			**Output**		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Raw material			**Products**		
Detoxificated Output	5.7931	kg	SSCF Fermented Output	3.4448	kg
Cellulase	0.0032	kg			
DAP	0.0043	kg	**Wastes**		
CSL	0.0161	kg	Solid waste	1.08	kg
Water	0.0254	kg			
Make up cooling water	23.8521	kg	**Air emissions**		
			Water	3.29E-02	kg
			Ethanol	1.10E-01	kg
Electricity/Heat			Carbon dioxide	1.17E+00	kg
Electricity	0.0247	kWh	Oxygen	1.83E-03	kg
Steam	0.0000	kg	Acetic acid	5.41E-05	kg
			Furfural	5.43E-04	kg
			Lactic acid	3.47E-07	kg
			CSL	1.23E-04	kg
			Wastes		
			Biowaste	0.9447	kg
			Ash	0.1017	kg

Table F3.4 Results of the inventory analysis of distillation section per one kilogram ethanol 99.5% wt. production

Inventory of distillation					
Input			**Output**		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Raw material			**Products**		
SSCF Fermented Output	3.4448	kg	Distillated Output	1.0714	kg
Make up cooling water	40.6674	kg	-		
			Co-products		
			Waste water	2.2936	kg
			Air emissions	-	
			Water	1.64E-03	kg
Electricity/Heat			Ethanol	3.57E-03	kg
Electricity	- 0.0430	kWh	Carbon dioxide	7.44E-02	kg
Steam	2.1158	kg	Oxygen	1.08E-05	kg
			Fufural	1.37E-04	kg

Table F3.5 Results of the inventory analysis of dehydration section per one kilogram ethanol 99.5% wt. production

Inventory of dehydration					
Input			**Output**		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Raw material			**Products**		
Distillated Output	1.0714	kg	Ethanol 99.5% wt.	1.0000	kg
Make up cooling water	4.8008	kg			
Electricity/Heat			**Air emissions**		
Electricity	0.0050	kWh	Water	0.0714	kg
Steam	0.0099	kg			

Table F3.6 Results of the inventory analysis of membrane treatment section per one kilogram ethanol 99.5% wt. production

Inventory of membrane					
Input			**Output**		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Raw material			**Products**		
Waste water	2.2936	kg	Water recycle	1.4997	kg
Make up cooling water	3.9594	kg			
			Wastes		
Electricity/Heat			Waste water	0.7939	kg
Electricity	0.0077	kWh			
			Water emissions		
			Water	3.68E-01	kg
			Ethanol	9.42E-02	kg
			Fufural	1.60E-02	kg
			Glycerol	8.89E-04	kg
			Succinic acid	2.70E-03	kg
			Lactic acid	7.17E-02	kg
			Xylitol	8.63E-03	kg
			Acetic acid	3.56E-03	kg
			CSL	1.45E-02	kg
			Biowaste	2.14E-01	kg

Table F4 Life Cycle Inventory of alternative G case

Table F4.1 Results of the inventory analysis of pretreatment section per one kilogram ethanol 99.5% wt. production

Inventory of pretreatment					
Input			**Output**		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Raw material			**Products**		
Cassava Rhizome	1.6653	kg	Pretreated Output	4.8509	kg
Corn Stover	0.1850	kg			
Sugarcane Bagasse	1.8147	kg			
Sulfuric acid	0.0184	kg			
Water	-	kg			
			Air emissions		
			Water	0.4819	kg
Electricity/Heat			Furfural	0.0227	kg
Steam	0.0245	kg			

Table F4.2 Results of the inventory analysis of detoxificationsection per one kilogram ethanol 99.5% wt. production

Inventory of detoxification					
Input			**Output**		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Raw material			**Products**		
Pretreated Output	4.8509	kg	Detoxificated Output	5.7819	kg
Ammonia	0.0064	kg			
Water	0.3180	kg			
Make up cooling water	0.4063	kg			
Electricity/Heat					
Electricity	0.0004	kWh			

Table F4.3 Results of the inventory analysis of SSCF fermentation section per one kilogram ethanol 99.5% wt. production

Inventory of SSCF fermentation					
Input			**Output**		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Raw material			**Products**		
Detoxificated Output	5.7819	kg	SSCF Fermented Output	3.4327	kg
Cellulase	0.0032	kg			
DAP	0.0043	kg	**By-Products**		
CSL	0.0160	kg	Solid waste	1.08	kg
Water	0.0254	kg			
Make up cooling water	23.8417	kg	**Air emissions**		
			Water	3.29E-02	kg
			Ethanol	1.11E-01	kg
Electricity/Heat			Carbon dioxide	1.17E+00	kg
Electricity	0.0248	kWh	Oxygen	1.83E-03	kg
Steam	0.0000	kg	Acetic acid	5.42E-05	kg
			Furfural	5.44E-04	kg
			Lactic acid	3.49E-07	kg
			CSL	1.24E-04	kg

Table F4.4 Results of the inventory analysis of distillation section per one kilogram ethanol 99.5% wt. production

Inventory of distillation					
Input			**Output**		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Raw material			**Products**		
SSCF Fermented Output	3.4327	kg	Distillated Output	1.0714	kg
Make up cooling water	40.6600	kg	-		
	-		**Co-products**		
			Waste water	2.2819	kg
			Air emissions		
			Water	1.63E-03	kg
Electricity/Heat			Ethanol	3.57E-03	kg
Electricity	0.0428	kWh	Carbon dioxide	7.41E-02	kg
Steam	2.1141	kg	Oxygen	1.08E-05	kg
			Fufural	1.37E-04	kg

Table F4.5 Results of the inventory analysis of dehydration section per one kilogram ethanol 99.5% wt. production

Inventory of dehydration					
Input			**Output**		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Raw material			**Products**		
Distillated Output	1.0714	kg	Ethanol 99.5% wt.	1.0000	kg
Make up cooling water	4.8005	kg			
Electricity/Heat			**Air emissions**		
Electricity	0.0050	kWh	Water	0.0714	kg
Steam	0.0099	kg			

Table F4.6 Results of the inventory analysis of membrane treatment section per one kilogram ethanol 99.5% wt. production

Inventory of membrane					
Input			**Output**		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Raw material			**Products**		
Waste water	2.2819	kg	Water recycle	1.4904	kg
Make up cooling water	3.9337	kg			
			Wastes		
Electricity/Heat			Waste water	0.7915	kg
Electricity	0.0076	kWh			
			Water emissions		
			Water	3.65E-01	kg
			Ethanol	9.42E-02	kg
			Fufural	1.60E-02	kg
			Glycerol	8.89E-04	kg
			Succinic acid	2.70E-03	kg
			Lactic acid	7.17E-02	kg
			Xylitol	8.63E-03	kg
			Acetic acid	3.56E-03	kg
			CSL	1.45E-02	kg
			Biowaste	2.14E-01	kg

Table F4.7 Results of the inventory analysis of solid combustion treatment section per one kilogram ethanol 99.5% wt. production

Inventory of solid combustion					
Input			**Output**		
Type	**Quantity**	**Unit**	**Type**	**Quantity**	**Unit**
Raw material			**Products**		
Solid waste	1.0835	kg	Steam	0.80187	kg
			Air emissions		
Electricity/Heat			Water	0.74375	kg
Electricity	0.0952	kWh	Carbon dioxide	1.92381	kg
			Oxygen	0.47917	kg
			Nitrogen	7.87811	kg
			Waste		
			Biowaste	0.18889	kg

CURRICULUM VITAE

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