

Electronic Supplementary Information (ESI)

Techno-economic assessment of biodiesel-derived crude glycerol purification processes

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1. Economic Analysis

1.1. Capital and operating costs

Table S1. Types of capital costs and calculation method used.

Economics Parameters	Calculation Method
Total Installed Cost	Σ Installation factor \times Equipment Cost
Battery Limits Investment (BLI) contingency	$0.25 \times$ Total Installed Cost
Battery Limits Investment (BLI)	Total Equipment Cost + Total Installed Cost + BLI Contingency
Offsite Costs +General Services Facilities	$0.35 \times$ BLI
Contingency Offsite Cost (20%)	$0.20 \times$ (Offsite Costs +General Services Facilities)
Total Offsite Cost (TOC)	Offsite Costs +General Services Facilities+ Contingency Offsite Cost
Total Fix Capital (TFC)	TOC + BLI
Total Working Capital (TWC)	$0.25 \times$ TFC
Total Capital Investment (TCI)	TFC + TWC

Table S2. Types of operating costs and calculation method used.

Economics Parameters	Calculation Method
Variable Cost	Total Raw Material Cost + Total Utility Cost
Number of Shifts	3
Operating Labor Cost	(6 Plant Operators per annum + 3 Plant Managers per annum) \times Number of shifts/7920/Product rate
Maintenance Labor Cost	$0.016 \times$ Battery Limits Investment
Control Lab Labor Cost	$0.15 \times$ Operating Labor Cost
Labor Costs	Operating Labor Cost+ Maintenance Labor + Control Lab labor
Maintenance Materials Cost	$0.024 \times$ Battery Limits Investment
Operating Supplies Cost	$0.1 \times$ Operating Labor Cost
Total Direct Cost (TDC)	Variable Cost + Labor Cost + Maintenance Materials Cost + Operating Supplies Cost
Plant Overhead Cost	$0.6 \times$ Labor Cost
Taxes and Insurance	$0.02 \times$ TFC
Plant Cash Costs	TDC + Plant Overhead + Taxes and Insurance
Depreciation	$0.1 \times$ TFC
Plant Gate Costs	Plant Cash Costs+ Depreciation
G&A Sales Research	$0.065 \times$ Plant Gates Costs
Net Production Costs	Plant Gate Costs + G&A Sales Research
Return on Investment (ROI) before taxes	$0.15 \times$ TFC
Production cost	Net Production cost+ ROI before taxes+CO ₂ Separation Cost
Profit	Acrylic acid selling price-Production cost

Table S3. Breakdown of capital costs of the four acrylic acid production routes.

Type of costs (in MUSD)	Process		
	MBP	VDP	IEP
Total Equipment Cost	0.74	0.56	0.75
Total Installed Cost	2.79	2.05	2.81
BLI Contingency	0.70	0.51	0.70
Battery Limits Investment	4.22	3.13	4.25
Offsite Costs + General Services Facilities	1.48	1.09	1.49
Contingency Offsite Cost, 20%	0.30	0.22	0.30
Total Offsite Cost	1.77	1.31	1.79
Total Fix Capital (TFC)	6.00	4.44	6.04
Total Working Capital (TWC)	1.50	1.11	1.51
Total Capital Cost	7.50	5.55	7.55

Table S4. Breakdown of production costs of the four acrylic acid production routes.

Type of costs (in USD/tonne)	Process		
	MBP	VDP	IEP
Raw Materials	-85.61	-404.02	3094.96
Utilities	476.26	294.01	125.89
Variable Costs (Raw Materials + Utilities)	390.65	-110.01	3220.84
Operating Labor	391.85	391.85	391.85
Maintenance Labor, 1.6% of BLI	0.07	0.05	0.07
Control Lab labour, 15% of operating labour	58.78	58.78	58.78
Labor Costs	450.70	450.68	450.70
Maintenance Materials, 2.4% of BLI	34.87	24.16	32.15
Operating Supplies, 10% of operating labour	39.19	39.19	39.19
Total Direct Cost	915.40	404.01	3742.88
Plant Overhead, 60% of Labor Cost	270.42	270.41	270.42
Taxes and insurance, 2% of TFC	41.26	28.59	38.05
Plant Cash Costs	1227.08	703.00	4051.34
Depreciation, 10% of TFC	206.30	142.94	190.24
Plant Gate Costs	1433.38	845.94	4241.58
G&A sales research	93.17	54.99	275.70
Net Production Cost	1526.55	900.93	4517.28
ROI before taxes, 15% of TFC	309.46	214.41	285.36
Methanol Sales (380 USD/tonne)		293.72	307.89
Product Value	1836.01	821.62	4494.75
Profit	-	78.38	-
Annual Profit (MUSD/year)	-2.72	0.24	-11.42
Payback period (years)	-	18.24	-
ROI (%)	-	5.48	-

1.2. Equipment and installation costs

Table S5. Equipment and installation costs for MBP process.

MBP						
Pumps		Values	Units	Equipment Cost (2024)	Installation Cost (2024)	Units
PUMP-1	Single Stage Centrifugal Flow	0.445	Litres/s	0.024	0.059	MUSD
Heat Exchangers		Values	Units	Equipment Cost (2024)	Installation Cost (2024)	Units
COOLER-3	Shell & Tube Heat Transfer	0.457	m ²	0.041	0.142	MUSD
HEATER-1	Shell & Tube Heat Transfer	0.581	m ²	0.041	0.142	MUSD
HEATER-2	Shell & Tube Heat Transfer	5.811	m ²	0.041	0.144	MUSD
COOLER-4	Shell & Tube Heat Transfer	3.665	m ²	0.041	0.143	MUSD
COOLER-1	Shell & Tube Heat Transfer	6.716	m ²	0.041	0.145	MUSD
HEATER-3	Shell & Tube Heat Transfer	11.520	m ²	0.042	0.147	MUSD
Column & Vessels		Values	Units	Equipment Cost (2024)	Installation Cost (2024)	Units
FLASH-1	Vertical, SS	84.397	kg	0.019	0.076	MUSD
FLASH-2	Vertical, SS	28.287	kg	0.018	0.071	MUSD
FLASH-3	Vertical, SS	45.633	kg	0.018	0.072	MUSD
LIQUID-LIQUID EXTRACTOR	Trays Diameter, 50	0.677	m	0.005	0.020	MUSD
LIQUID-LIQUID EXTRACTOR	Main Tower Shell Mass	738.750	kg	0.057	0.227	MUSD
Reactors		Values	Units	Equipment Cost (2024)	Installation Cost (2024)	Units
REACTOR-3	Reactor vessel	0.000	m ³	0.089	0.357	MUSD
REACTOR-1	Reactor vessel	0.001	m ³	0.089	0.357	MUSD
REACTOR-2	Reactor vessel	0.006	m ³	0.090	0.360	MUSD
Separators		Values	Units	Equipment Cost (2024)	Installation Cost (2024)	Units
ACTIVATED CARBON	Trays Diameter, 10	0.184	m	0.002	0.009	MUSD
ACTIVATED CARBON	Main Tower Shell Mass	28.777	kg	0.027	0.109	MUSD
OIL-SEPARATOR	Volume	1761.250	L	0.014	0.056	MUSD
MEMBRANE UNIT	Membrane	0.237	m ²	0.100	0.288	MUSD

Table S6. Equipment and installation costs for VDP process.

VDP						
Pumps		Values	Units	Equipment Cost (2024)	Installation Cost (2024)	Units
PUMP-1	Single Stage Centrifugal Flow	0.089	Litres/s	0.023	0.058	MUSD
Heat Exchangers and Reboilers		Values	Units	Equipment Cost (2024)	Installation Cost (2024)	Units
COOLER-1	Shell & Tube Heat Transfer	0.199	m ²	0.041	0.142	MUSD
HEATER-1	Shell & Tube Heat Transfer	0.724	m ²	0.041	0.142	MUSD
CONDENSER (DISTILLATION COLUMN-2)	Shell & Tube Heat Transfer	20.750	m ²	0.044	0.153	MUSD
CONDENSER (DISTILLATION COLUMN-1)	Shell & Tube Heat Transfer	59.590	m ²	0.051	0.179	MUSD
FLASH (Heat exchanger)	Shell & Tube Heat Transfer	8.787	m ²	0.042	0.146	MUSD
VACFLASH (Heat exchanger)	Shell & Tube Heat Transfer	11.640	m ²	0.042	0.147	MUSD
REBOILER (DISTILLATION COLUMN-2)	U-type Kettle Reboiler	1.731	m ²	0.043	0.151	MUSD
REBOILER (DISTILLATION COLUMN-1)	U-type Kettle Reboiler	0.414	m ²	0.042	0.148	MUSD
Column & Vessels		Values	Units	Equipment Cost (2024)	Installation Cost (2024)	Units
DISTILLATION COLUMN-2	Sieve Trays Diameter, Main Tower	0.851	m	0.005	0.021	MUSD
DISTILLATION COLUMN-2	Shell Mass	1330.466	kg	0.077	0.308	MUSD
DISTILLATION COLUMN-2	Horizontal, SS Sieve Trays	168.402	kg	0.018	0.073	MUSD
DISTILLATION COLUMN-1	Sieve Trays Diameter, Main Tower	0.313	m	0.002	0.009	MUSD
DISTILLATION COLUMN-1	Shell Mass	259.137	kg	0.038	0.153	MUSD
CONDENSER (DISTILLATION COLUMN-1)	Horizontal, SS	270.646	kg	0.020	0.080	MUSD
Flash drums		Values	Units	Equipment Cost (2024)	Installation Cost (2024)	Units
FLASH-1	Vertical, SS	26.578	kg	0.018	0.071	MUSD
FLASH-2	Vertical, SS	0.666	kg	0.017	0.067	MUSD

Table S7. Equipment and installation costs for VDP process.

IEP						
Pumps		Values	Units	Equipment Cost (2024)	Installation Cost (2024)	Units
PUMP-1	Single Stage Centrifugal Flow	0.283	Litres/s	0.023	0.059	MUSD
Heat Exchangers and Reboilers		Values	Units	Equipment Cost (2024)	Installation Cost (2024)	Units
COOLER-3	Shell & Tube Heat Transfer	0.802	m ²	0.041	0.142	MUSD
HEATER-1	Shell & Tube Heat Transfer	0.435	m ²	0.041	0.142	MUSD
Heater (REACTOR-1)	Shell & Tube Heat Transfer	0.655	m ²	0.000	0.000	MUSD
HEATER-2	Shell & Tube Heat Transfer	1.362	m ²	0.041	0.143	MUSD
Condenser (DISTILLATION COLUMN-1)	Shell & Tube Heat Transfer	1.031	m ²	0.041	0.142	MUSD
Heater (REACTOR-3)	Shell & Tube Heat Transfer	49.200	m ²	0.000	0.000	MUSD
COOLER-2	Shell & Tube Heat Transfer	1.415	m ²	0.041	0.143	MUSD
Reboiler (DISTILLATION COLUMN-1)	U-type Kettle Reboiler	1.188	m ²	0.043	0.150	MUSD
COOLER-1	Shell & Tube Heat Transfer	0.502	m ²	0.041	0.142	MUSD
Column & Vessels		Values	Units	Equipment Cost (2024)	Installation Cost (2024)	Units
DISTILLATION COLUMN-1	Sieve Trays Diameter,	0.222	m	0.002	0.007	MUSD
DISTILLATION COLUMN-1	Main Tower Shell Mass	228.747	kg	0.037	0.147	MUSD
Condenser (DISTILLATION COLUMN-1)	Horizontal, SS	42.100	kg	0.016	0.064	MUSD
Reactors		Values	Units	Equipment Cost (2024)	Installation Cost (2024)	Units
REACTOR-3	Reactor vessel	0.015	m ³	0.091	0.364	MUSD
REACTOR-1	Reactor vessel	0.000	m ³	0.089	0.357	MUSD
Separators		Values	Units	Equipment Cost (2024)	Installation Cost (2024)	Units
CENTRIFUGE	Throughput	1.021	m ³ /h	0.088	0.353	MUSD
ION-EXCHANGE COLUMN	Column Volume	27.834	m ³	0.113	0.452	MUSD

2. Mass balance

2.1. Mass balance for MBP process

Table S8. Mass balance results for MBP process.

MBP											
Stream Name	CRUDEGLY	EXTRACT	HCL	KOH	KOH-2	LIGHT	LIQ-WAST	LIQWAST2	METHANOL	PE-SOLV	PERMEATE
From		LIQUID-LIQUID EXTRACTOR				OIL-SEPARATOR	FLASH-1	FLASH-3			MEMBRANE
To	MIXER-2	FLASH-1	REACTOR-2	REACTOR-1	REACTOR-3				MIXER-1	MIXER-3	FLASH-2
Temperature (°C)	25.0	112.4	25.0	25.0	25.0	125.0	20.0	70.0	25.0	25.0	25.2
Pressure (bar)	1.0	1.0	1.0	1.0	1.0	1.0	0.7	1.0	1.0	1.0	4.5
Mole Flows (kmol/hr)	17.6	9.0	3.9	2.2	1.1	6.4	4.9	9.8	1.4	0.5	42.6
Mole Fractions											
GLYCEROL	0.2468	0.0445	0.0000	0.0000	0.0000	0.0225	0.0814	0.0055	0.0000	0.0000	0.0891
METHANOL	0.5320	0.4203	0.0000	0.0000	0.0000	0.1823	0.6593	0.6462	1.0000	0.0000	0.7215
M-OLEATE	0.0192	0.0000	0.0000	0.0000	0.0000	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000
OLE-ACID	0.0267	0.0000	0.0000	0.0000	0.0000	0.0727	0.0001	0.0000	0.0000	0.0000	0.0001
WATER	0.1577	0.0855	0.7751	0.7342	0.7342	0.6647	0.1502	0.3483	0.0000	0.0000	0.1891
PENTANE	0.0000	0.3325	0.0000	0.0000	0.0000	0.0000	0.0926	0.0000	0.0000	1.0000	0.0000
HEXANE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
HCL	0.0000	0.1114	0.2249	0.0000	0.0000	0.0017	0.0059	0.0000	0.0000	0.0000	0.0000
KCL	0.0000	0.0058	0.0000	0.0000	0.0000	0.0029	0.0106	0.0000	0.0000	0.0000	0.0002
KOH	0.0177	0.0000	0.0000	0.2658	0.2658	0.0009	0.0000	0.0000	0.0000	0.0000	0.0001
K-OLEATE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0518	0.0001	0.0000	0.0000	0.0000	0.0000

Table S8 continued...

Stream Name	PURE-GLY	REC-MEOH	RECOV-PE	RETENT	S1	S2	S3	S4	S5	S6	S7
From	ACTIVATED CARBON	COOLER-4	COOLER-2	MEMBRANE	MIXER- 1	MIXER-2	HEATER-1	REACTOR-1	REACTOR-2	HEATER-2	OIL- SEPARATOR
To		MIXER-1	MIXER-3		MIXER- 2	HEATER- 1	REACTOR-1	REACTOR-2	HEATER-2	OIL- SEPARATOR	COOLER-1
Temperature (°C)	25.0	25.0	100.0	25.2	25.0	24.7	60.0	60.0	60.0	125.0	125.0
Pressure (bar)	1.0	1.0	1.0	4.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Mole Flows (kmol/hr)	4.7	28.1	4.1	0.8	29.5	47.1	47.1	49.3	53.2	53.2	46.8
Mole Fractions											
GLYCEROL	0.8032	0.0000	0.0000	0.0000	0.0000	0.0923	0.0923	0.0881	0.0816	0.0816	0.0897
METHANOL	0.0653	0.8584	0.1319	0.0000	0.8649	0.7404	0.7404	0.7138	0.6611	0.6611	0.7264
M-OLEATE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0072	0.0072	0.0001	0.0001	0.0001	0.0000
OLE-ACID	0.0009	0.0000	0.0000	0.0000	0.0000	0.0100	0.0100	0.0095	0.0088	0.0088	0.0001
WATER	0.1290	0.1416	0.0074	0.0000	0.1351	0.1435	0.1435	0.1702	0.2254	0.2254	0.1655
PENTANE	0.0000	0.0000	0.6220	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
HEXANE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
HCL	0.0000	0.0000	0.2386	0.0000	0.0000	0.0000	0.0000	0.0000	0.0060	0.0060	0.0066
KCL	0.0012	0.0000	0.0000	0.9961	0.0000	0.0000	0.0000	0.0000	0.0106	0.0106	0.0116
KOH	0.0004	0.0000	0.0000	0.0000	0.0000	0.0066	0.0066	0.0116	0.0001	0.0001	0.0000
K-OLEATE	0.0000	0.0000	0.0000	0.0039	0.0000	0.0000	0.0000	0.0068	0.0063	0.0063	0.0001

Table S8 continued...

Stream Name	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19
From	COOLER-1	MIXER-3	FLASH-1	LIQUID-LIQUID EXTRACTOR	REACTOR-3	PUMP-1	VALVE-1	FLASH-2	FLASH-2	COOLER-3	ACTIVATED CARBON	FLASH-3
To	LIQUID-LIQUID EXTRACTOR	LIQUID-LIQUID EXTRACTOR	COOLER-2	REACTOR-3	PUMP-1	VALVE-1	MEMBRANE	COOLER-3	FLASH-3	ACTIVATED CARBON		COOLER-4
Temperature (°C)	25.0	64.9	20.0	25.0	25.0	25.2	25.2	130.0	130.0	25.0	25.0	70.0
Pressure (bar)	1.0	1.0	0.7	1.0	1.0	4.5	4.5	1.0	1.0	1.0	1.0	1.0
Mole Flows (kmol/hr)	46.8	4.5	4.1	42.3	43.4	43.4	43.4	4.7	37.9	4.7	0.1	28.1
Mole Fractions												
GLYCEROL	0.0897	0.0000	0.0000	0.0897	0.0875	0.0875	0.0875	0.7914	0.0014	0.7914	0.0000	0.0000
METHANOL	0.7264	0.1187	0.1319	0.7264	0.7087	0.7087	0.7087	0.0643	0.8035	0.0643	0.0000	0.8584
M-OLEATE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
OLE-ACID	0.0001	0.0000	0.0000	0.0001	0.0001	0.0001	0.0001	0.0009	0.0000	0.0009	0.0006	0.0000
WATER	0.1655	0.0067	0.0074	0.1655	0.1858	0.1858	0.1858	0.1412	0.1951	0.1412	0.9624	0.1416
PENTANE	0.0000	0.6601	0.6220	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
HEXANE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
HCL	0.0066	0.2146	0.2386	0.0066	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
KCL	0.0116	0.0000	0.0000	0.0116	0.0178	0.0178	0.0178	0.0016	0.0000	0.0016	0.0278	0.0000
KOH	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001	0.0005	0.0000	0.0005	0.0092	0.0000
K-OLEATE	0.0001	0.0000	0.0000	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000

2.2. Mass balance for VDP process

Table S9. Mass balance for VDP process.

VDP							
Stream Name	CRUDE-GL	HCL	LIQWAST1	LIQWAST2	PURE-GLY	REC-METH	S1
From			DISTILLATION COLUMN-1	DISTILLATION COLUMN-2	COOLER-1	DISTILLATION COLUMN-1	MIXER-1
To	MIXER-1	MIXER-1					HEATER-1
Temperature (°C)	25.0	25.0	103.8	229.0	25.0	62.4	32.7
Pressure (bar)	1.0	1.0	1.0	0.0	1.0	1.0	1.0
Mole Flows (kmol/hr)	17.9	2.2	4.3	0.8	4.6	9.6	19.8
Mole Fractions							
GLYCEROL	0.2425	0.0000	0.0394	0.0555	0.8898	0.0000	0.2197
METHANOL	0.5227	0.0000	0.0001	0.0000	0.0264	0.9583	0.4737
KOH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
M-OLEATE	0.0188	0.0000	0.0011	0.3897	0.0009	0.0000	0.0171
HCL	0.0000	0.0004	0.0000	0.0000	0.0001	0.0020	0.0082
WATER	0.1550	0.5505	0.8875	0.0000	0.0828	0.0397	0.2405
H3O+	0.0000	0.2246	0.0357	0.0000	0.0000	0.0000	0.0006
K+	0.0174	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
KCL(S)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0158
CL-	0.0000	0.2246	0.0357	0.0000	0.0000	0.0000	0.0007
OH-	0.0174	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
OLE-ACID	0.0262	0.0000	0.0004	0.5548	0.0000	0.0000	0.0237

Table S9 continued...

Stream Name	S2	S3	S4	S5	S6	S7	SALT
From	HEATER-1	FLASH-1	FLASH-1	FLASH-2	DISTILLATION COLUMN-2	PUMP-1	FLASH-2
To	FLASH	DISTILLATION COLUMN-1	FLASH-2	DISTILLATION COLUMN-2	PUMP-1	COOLER-1	
Temperature (°C)	75.0	180.0	180.0	208.0	47.2	47.3	208.0
Pressure (bar)	1.0	1.0	1.0	0.0	0.0	1.0	0.0
Mole Flows (kmol/hr)	19.8	14.0	5.8	5.5	4.6	4.6	0.3
Mole Fractions							
GLYCEROL	0.2197	0.0122	0.7204	0.7615	0.8898	0.8898	0.0000
METHANOL	0.4737	0.6613	0.0212	0.0224	0.0264	0.0264	0.0000
KOH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
M-OLEATE	0.0171	0.0003	0.0574	0.0607	0.0009	0.0009	0.0000
HCL	0.0088	0.0125	0.0001	0.0001	0.0001	0.0001	0.0000
WATER	0.2410	0.3136	0.0663	0.0700	0.0828	0.0828	0.0000
H3O+	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
K+	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
KCL(S)	0.0158	0.0000	0.0538	0.0000	0.0000	0.0000	1.0000
CL-	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
OH-	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
OLE-ACID	0.0237	0.0001	0.0807	0.0853	0.0000	0.0000	0.0000

2.3. Mass balance for IEP process

Table S10. Mass balance for IEP process.

IEP										
Stream Name	CRUDEGLY	HCL	HCL-2	KOH	KOH-2	OILS	OUTREGEN	OUTWASH	PURE-GLY	REC-METH
From						CENTRIFUGE	ION-EXCHANGE COLUMN	ION-EXCHANGE COLUMN	COOLER-3	COOLER-2
To	HEATER-1	REACTOR-3	ION-EXCHANGE COLUMN	REACTOR-1	ION-EXCHANGE COLUMN					
Stream Class	CONVEN	CONVEN	CONVEN	CONVEN	CONVEN	CONVEN	CONVEN	CONVEN	CONVEN	CONVEN
Temperature (°C)	25.0	25.0	25.0	25.0	25.0	60.3	25.5	25.5	25.0	25.0
Pressure (bar)	1.0	1.0	1.0	1.0	1.0	3.0	1.0	1.0	1.0	1.0
Mole Flows (kmol/hr)	17.6	2.2	863.1	2.2	885.0	0.8	887.2	867.7	4.4	10.1
Mole Fractions										
GLYCEROL	0.2468	0.0000	0.0000	0.0000	0.0000	0.0516	0.0000	0.0000	0.9861	0.0000
METHANOL	0.5320	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0070	0.9590
M-OLEATE	0.0192	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
OLE-ACID	0.0267	0.0000	0.0000	0.0000	0.0000	0.5517	0.0000	0.0000	0.0011	0.0000
WATER	0.1577	0.0000	0.9747	0.0000	0.9799	0.0000	0.9775	0.9753	0.0000	0.0000
HCL	0.0000	1.0000	0.0253	0.0000	0.0000	0.0000	0.0000	0.0247	0.0000	0.0410
KCL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0025	0.0000	0.0050	0.0000
KOH	0.0177	0.0000	0.0000	1.0000	0.0201	0.0000	0.0200	0.0000	0.0000	0.0000
K-OLEATE	0.0000	0.0000	0.0000	0.0000	0.0000	0.3967	0.0000	0.0000	0.0008	0.0000

Table S10 continued...

Stream Name	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
From	HEATER-1	REACTOR -1	REACTOR-3	PUMP	CENTRIFUGE	COOLER-1	ION-EXCHANGE COLUMN	HEATER-2	DISTIL-1	DISTIL-1
To	REACTOR-1	REACTOR -3	PUMP	CENTRIFUGE	COOLER-1	ION- EXCHANGE COLUMN	HEATER-2	DISTIL-1	COOLER-3	COOLER-2
Stream Class	CONVEN	CONVEN	CONVEN	CONVEN	CONVEN	CONVEN	CONVEN	CONVEN	CONVEN	CONVEN
Temperature (°C)	60.0	60.0	60.0	60.3	60.3	25.0	25.5	80.0	237.0	63.2
Pressure (bar)	1.0	1.0	1.0	3.0	3.0	1.0	1.0	1.0	1.0	1.0
Mole Flows (kmol/hr)	17.6	19.8	22.0	22.0	21.2	21.2	14.4	14.4	4.4	10.1
Mole Fractions										
GLYCEROL	0.2468	0.2191	0.1972	0.1972	0.2030	0.2030	0.2977	0.2977	0.9861	0.0000
METHANOL	0.5320	0.4893	0.4404	0.4404	0.4579	0.4579	0.6716	0.6716	0.0070	0.9590
M-OLEATE	0.0192	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
OLE-ACID	0.0267	0.0237	0.0213	0.0213	0.0002	0.0002	0.0003	0.0003	0.0011	0.0000
WATER	0.1577	0.1400	0.2259	0.2259	0.2349	0.2349	0.0000	0.0000	0.0000	0.0000
HCL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0287	0.0287	0.0000	0.0410
KCL	0.0000	0.0000	0.0999	0.0999	0.1038	0.1038	0.0015	0.0015	0.0050	0.0000
KOH	0.0177	0.1110	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
K-OLEATE	0.0000	0.0170	0.0153	0.0153	0.0002	0.0002	0.0002	0.0002	0.0008	0.0000