FAME-GLY Production from Used Cooking Oil (UCO)

CHE452: Capstone Design Project

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DESTINATION CODE

COMPONENTS

ASPEN PLUS

Source Databank: Aspen Properties

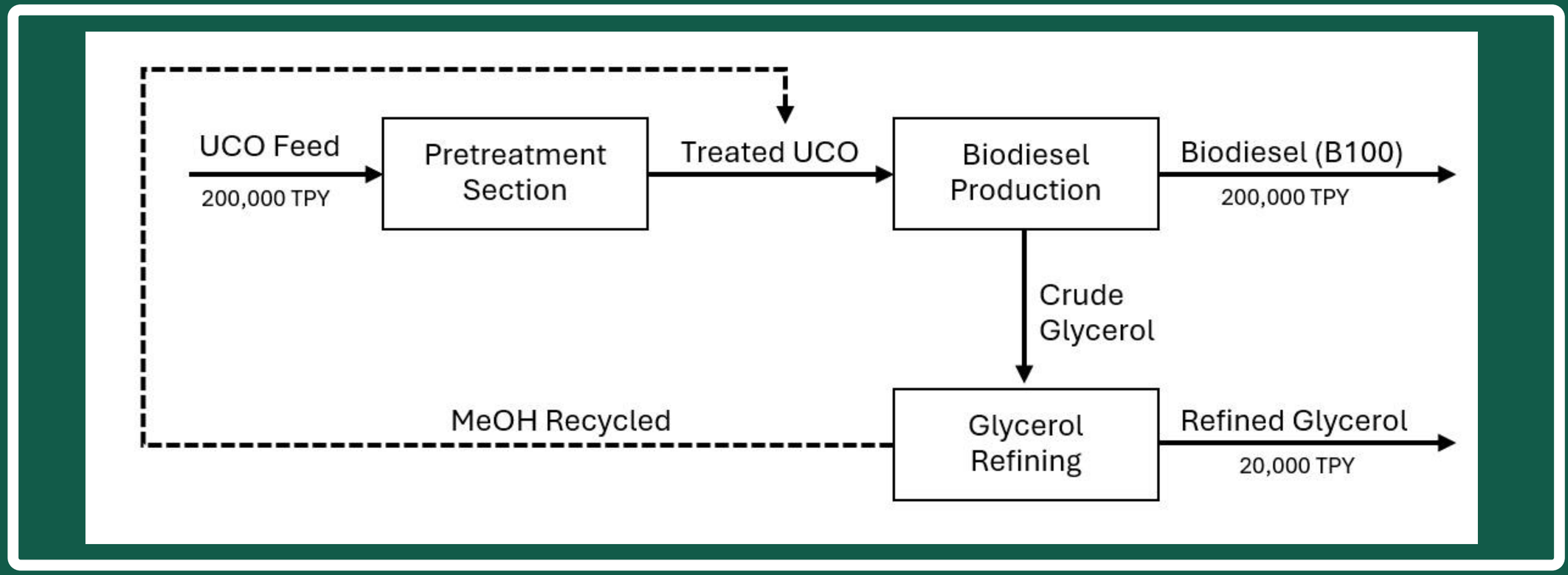
Component	Type	Group
Triolein	Pure Component	
Diolein	Pure Component	
Monoolein	Pure Component	
Methanol	Pure Component	
Methyl-Oleate	Pure Component	
Glycerol	Pure Component	
Potassium-Hydroxide	Pure Component	

ASPEN HYSYS

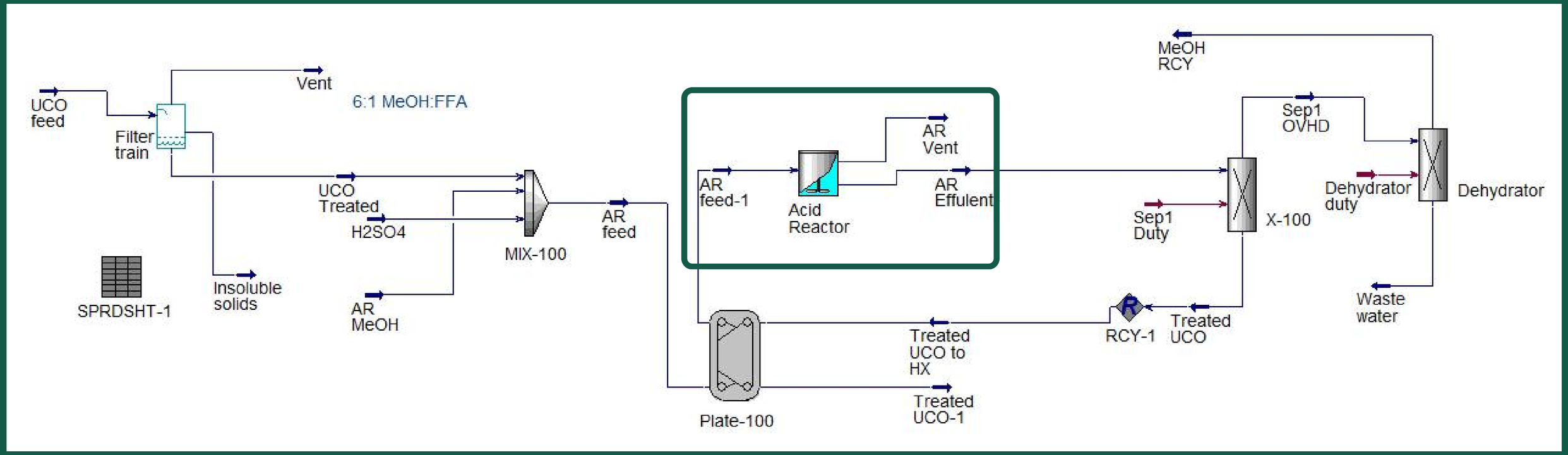
Source Databank: HYSYS

Component	Type	Group
Solid20000*	User Defined Hypothe...	HypoGroup1
Triolein	Pure Component	
OleicAcid	Pure Component	
Methanol	Pure Component	
NaOH	Pure Component	
H2SO4	Pure Component	
M-Oleate	Pure Component	
Glycerol	Pure Component	
H2O	Pure Component	
NACL	Pure Component	

PROCESS OVERVIEW

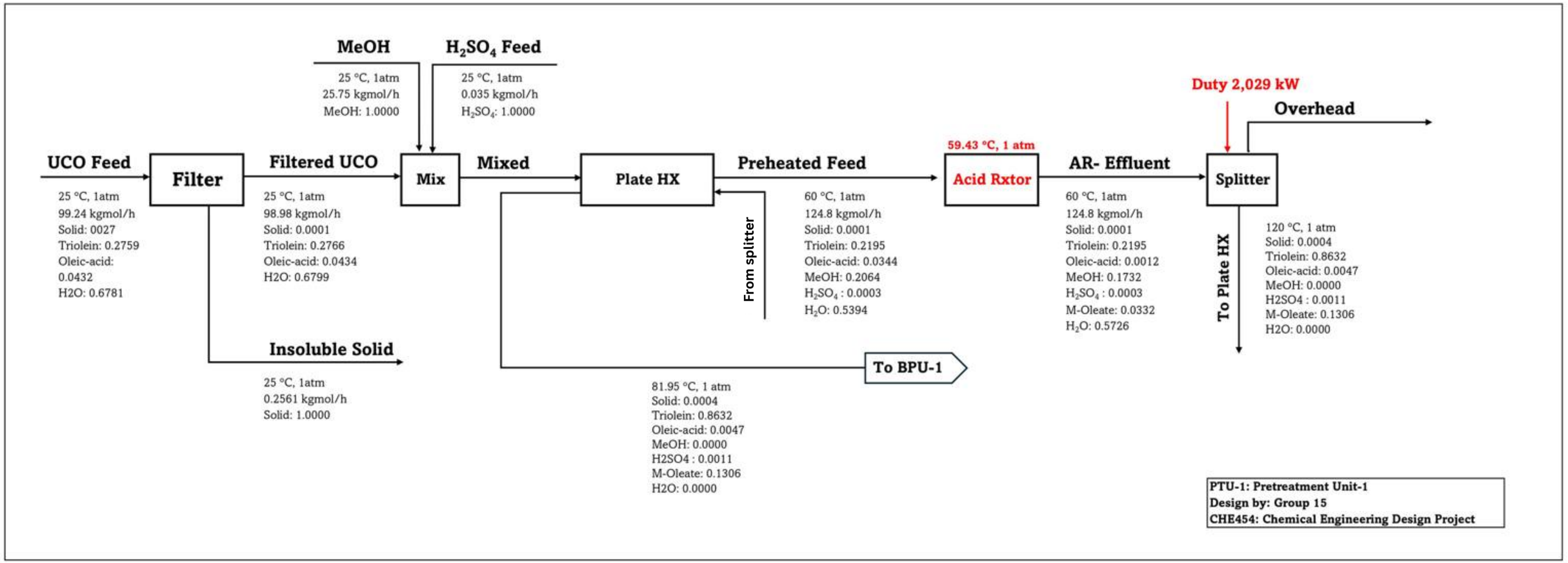


UCO Pretreatment



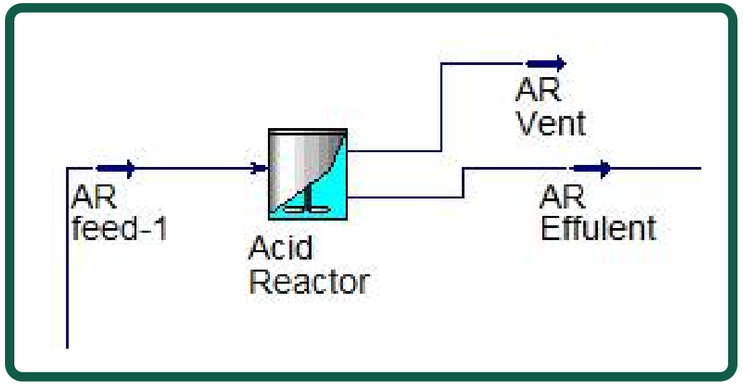
UCO Pretreatment

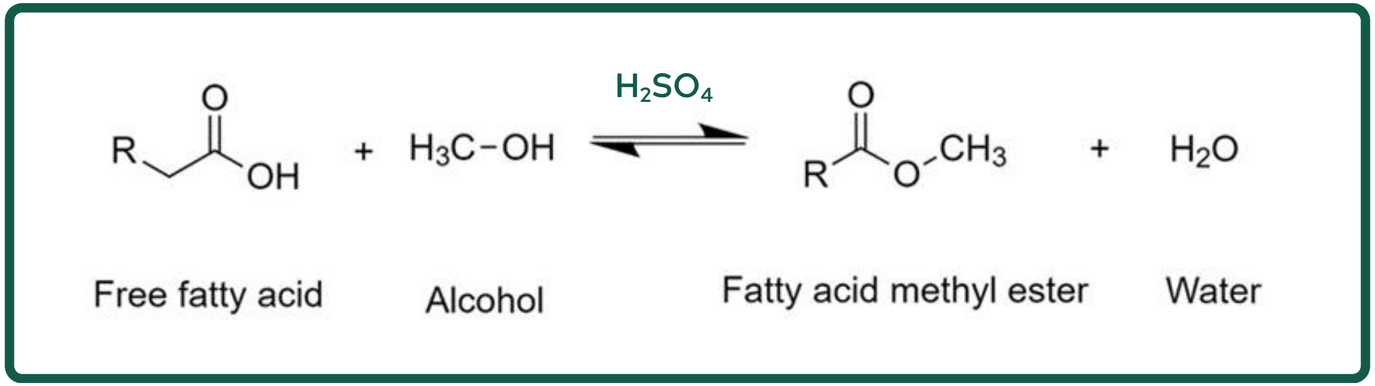
Mass Balance



UCO Pretreatment

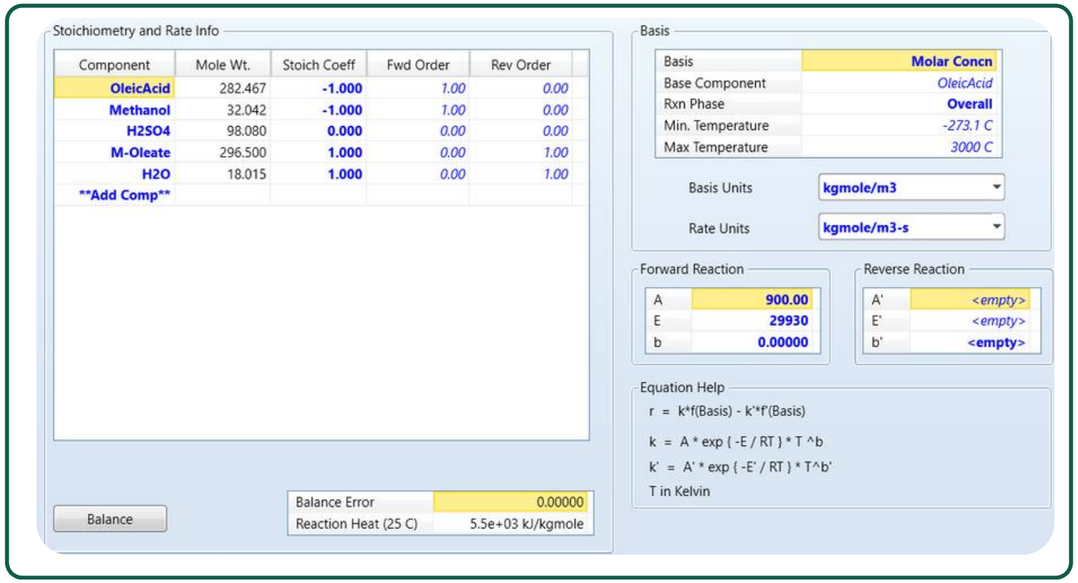
Chemical reaction in Acid Reactor





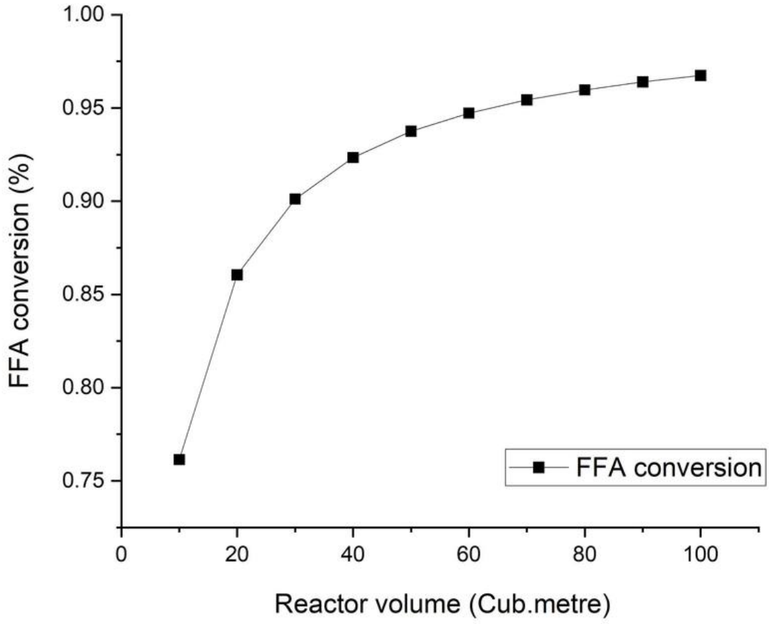
- FFA Conversion: Free fatty acids are converted to FAME via acid-catalyzed esterification.
- Equilibrium Shift: Excess methanol and water removal enhance ester formation efficiency.

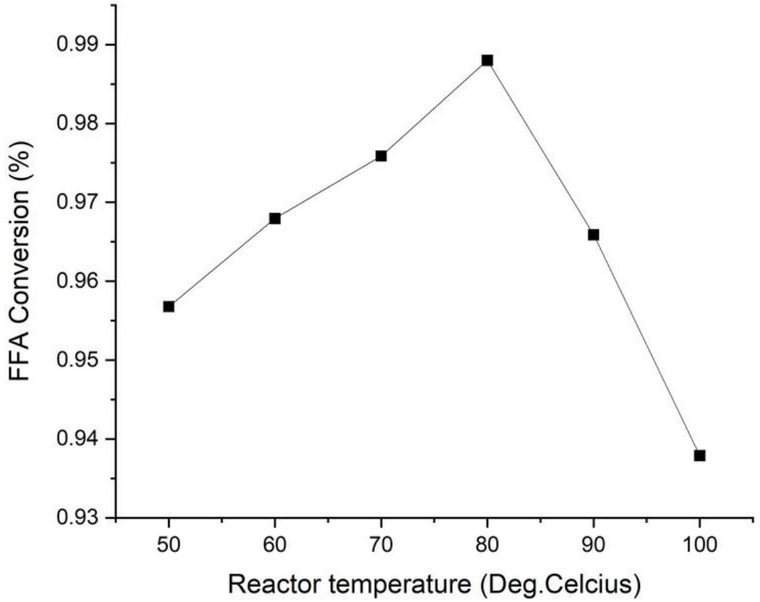
	BEFORE	AFTER
	Mass Fractions	Mass Fractions
Solid20000*	0.0100	0.0005
Triolein	0.9000	0.9496
OleicAcid	0.0450	0.0017
Methanol	0.0000	0.0000
NaOH	0.0000	0.0000
H2SO4	0.0000	0.0001
M-Oleate	0.0000	0.0481
Glycerol	0.0000	0.0000
H2O	0.0450	0.0000

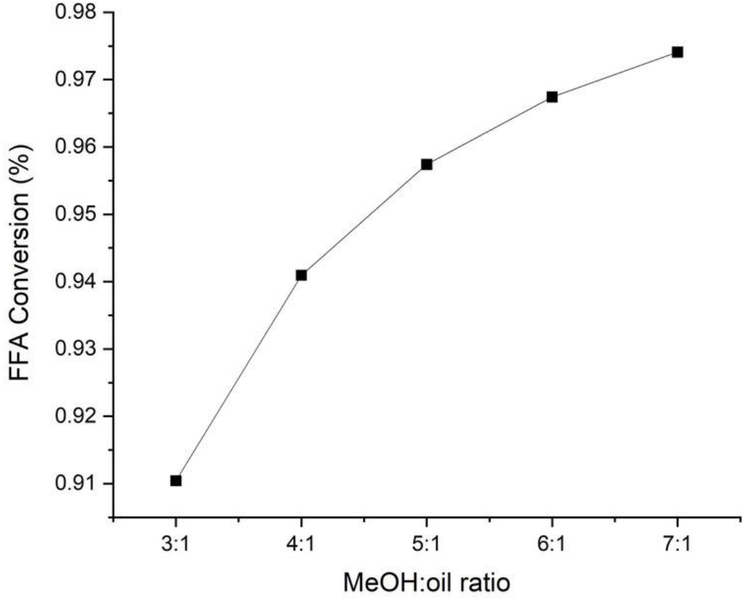


UCO Pretreatment

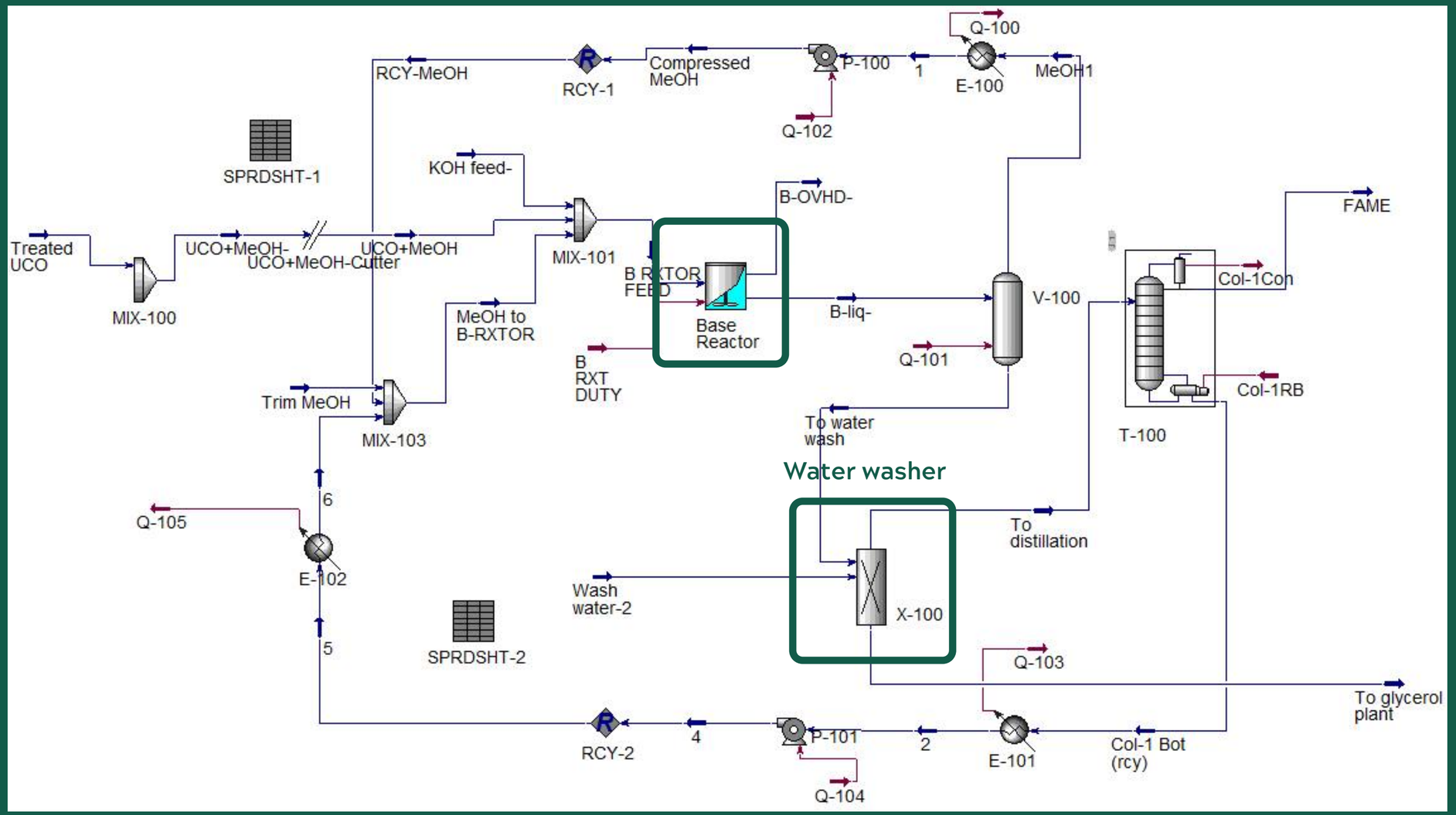
Chemical reaction in Acid Reactor

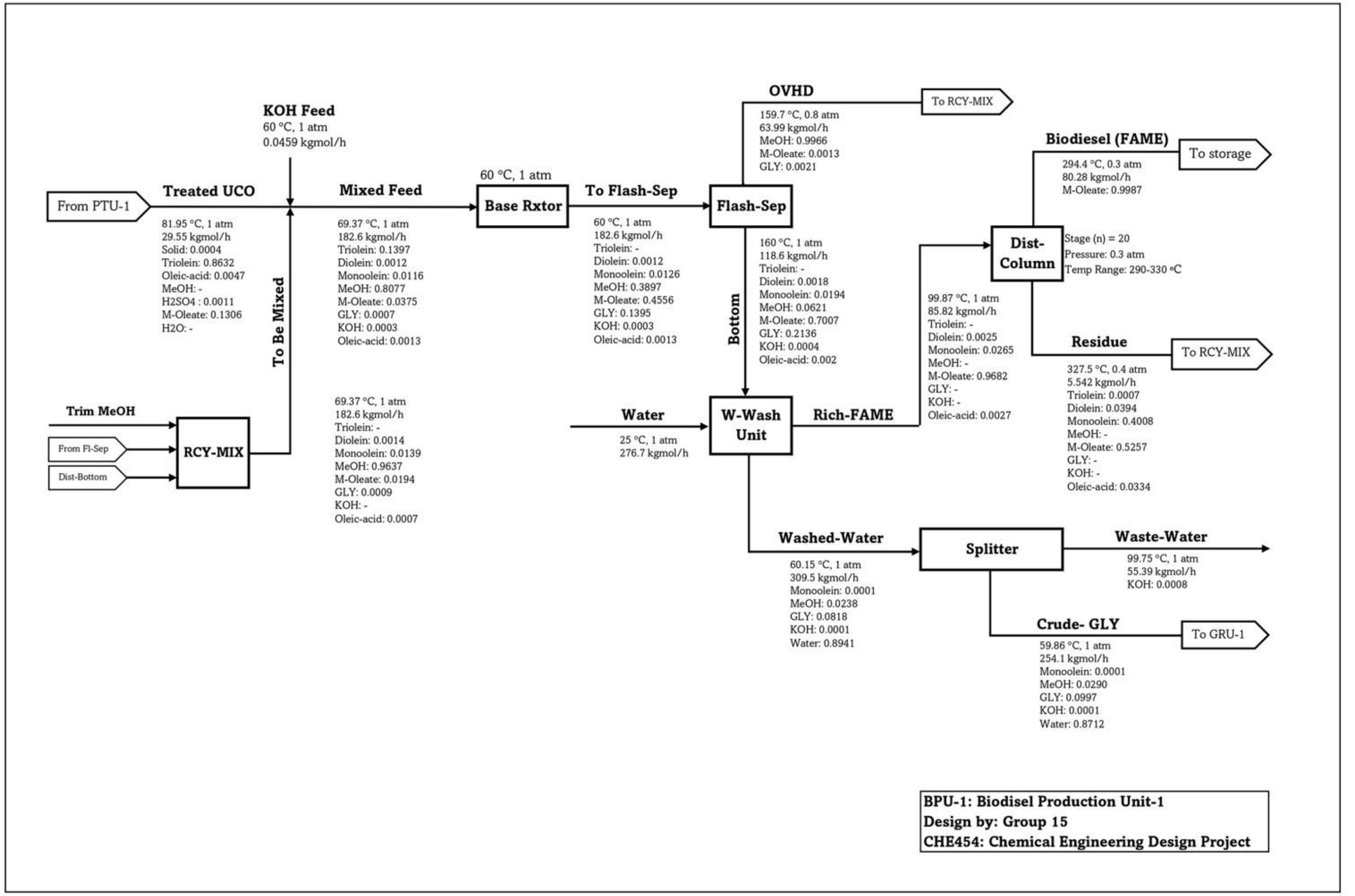






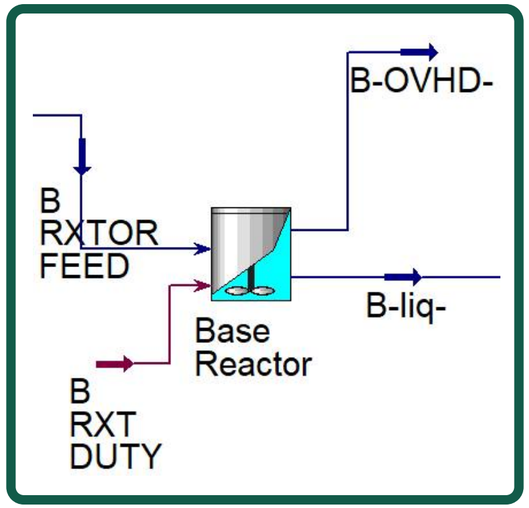
Biodiesel Plant

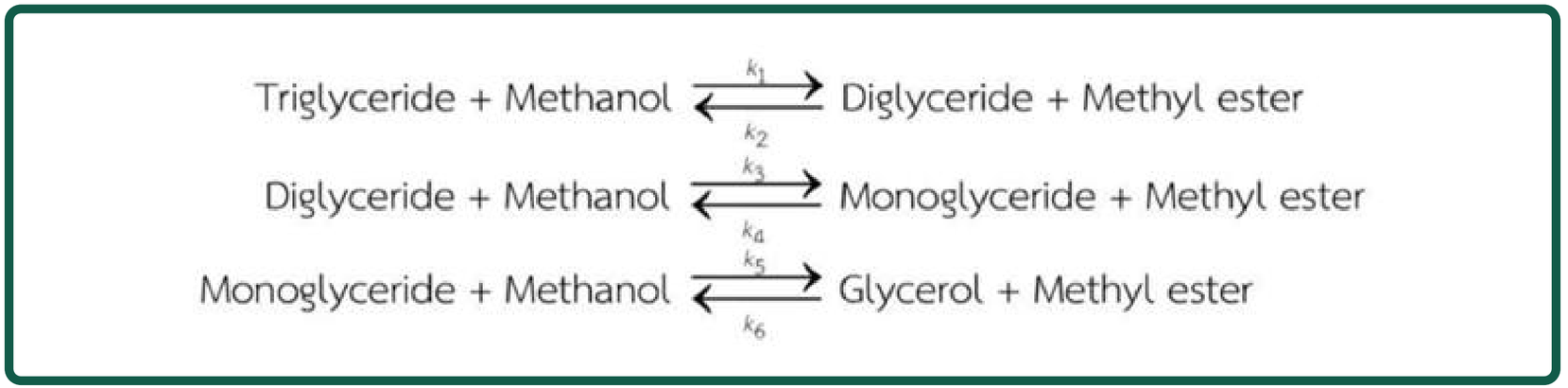



KOH Feed
60 °C, 1 atm
0.0459 kgmol/h
From PTU-1
Treated UCO
81.95 °C, 1 atm
29.55 kgmol/h
Solid: 0.0004
Triolein: 0.8632
Oleic-acid: 0.0047
MeOH: -
H2SO4 : 0.0011
M-Oleate: 0.1306
H2O: -
To Be Mixed
Mixed Feed
69.37 °C, 1 atm
182.6 kgmol/h
Triolein: 0.1397
Diolein: 0.0012
Monoolein: 0.0116
MeOH: 0.8077
M-Oleate: 0.0375
GLY: 0.0007
KOH: 0.0003
Oleic-acid: 0.0013
60 °C, 1 atm
Base Rxtor
To Flash-Sep
60 °C, 1 atm
182.6 kgmol/h
Triolein: -
Diolein: 0.0012
Monoolein: 0.0126
MeOH: 0.3897
M-Oleate: 0.4556
GLY: 0.1395
KOH: 0.0003
Oleic-acid: 0.0013
Flash-Sep
OVHD
159.7 °C, 0.8 atm
63.99 kgmol/h
MeOH: 0.9966
M-Oleate: 0.0013
GLY: 0.0021
To RCY-MIX
Bottom
160 °C, 1 atm
118.6 kgmol/h
Triolein: -
Diolein: 0.0018
Monoolein: 0.0194
MeOH: 0.0621
M-Oleate: 0.7007
GLY: 0.2136
KOH: 0.0004
Oleic-acid: 0.002
Trim MeOH
From Fl-Sep
Dist-Bottom
RCY-MIX
69.37 °C, 1 atm
182.6 kgmol/h
Triolein: -
Diolein: 0.0014
Monoolein: 0.0139
MeOH: 0.9637
M-Oleate: 0.0194
GLY: 0.0009
KOH: -
Oleic-acid: 0.0007
Water
25 °C, 1 atm
276.7 kgmol/h
W-Wash Unit
Rich-FAME
99.87 °C, 1 atm
85.82 kgmol/h
Triolein: -
Diolein: 0.0025
Monoolein: 0.0265
MeOH: -
M-Oleate: 0.9682
GLY: -
KOH: -
Oleic-acid: 0.0027
Dist-Column
Stage (n) = 20
Pressure: 0.3 atm
Temp Range: 290-330 °C
Biodiesel (FAME)
294.4 °C, 0.3 atm
80.28 kgmol/h
M-Oleate: 0.9987
To storage
Residue
327.5 °C, 0.4 atm
5.542 kgmol/h
Triolein: 0.0007
Diolein: 0.0394
Monoolein: 0.4008
MeOH: -
M-Oleate: 0.5257
GLY: -
KOH: -
Oleic-acid: 0.0334
To RCY-MIX
Washed-Water
60.15 °C, 1 atm
309.5 kgmol/h
Monoolein: 0.0001
MeOH: 0.0238
GLY: 0.0818
KOH: 0.0001
Water: 0.8941
Splitter
Waste-Water
99.75 °C, 1 atm
55.39 kgmol/h
KOH: 0.0008
Crude- GLY
59.86 °C, 1 atm
254.1 kgmol/h
Monoolein: 0.0001
MeOH: 0.0290
GLY: 0.0997
KOH: 0.0001
Water: 0.8712
To GRU-1
BPU-1: Biodisel Production Unit-1
Design by: Group 15
CHE454: Chemical Engineering Design Project

Biodiesel Plant

Chemical reaction in Base Reactor



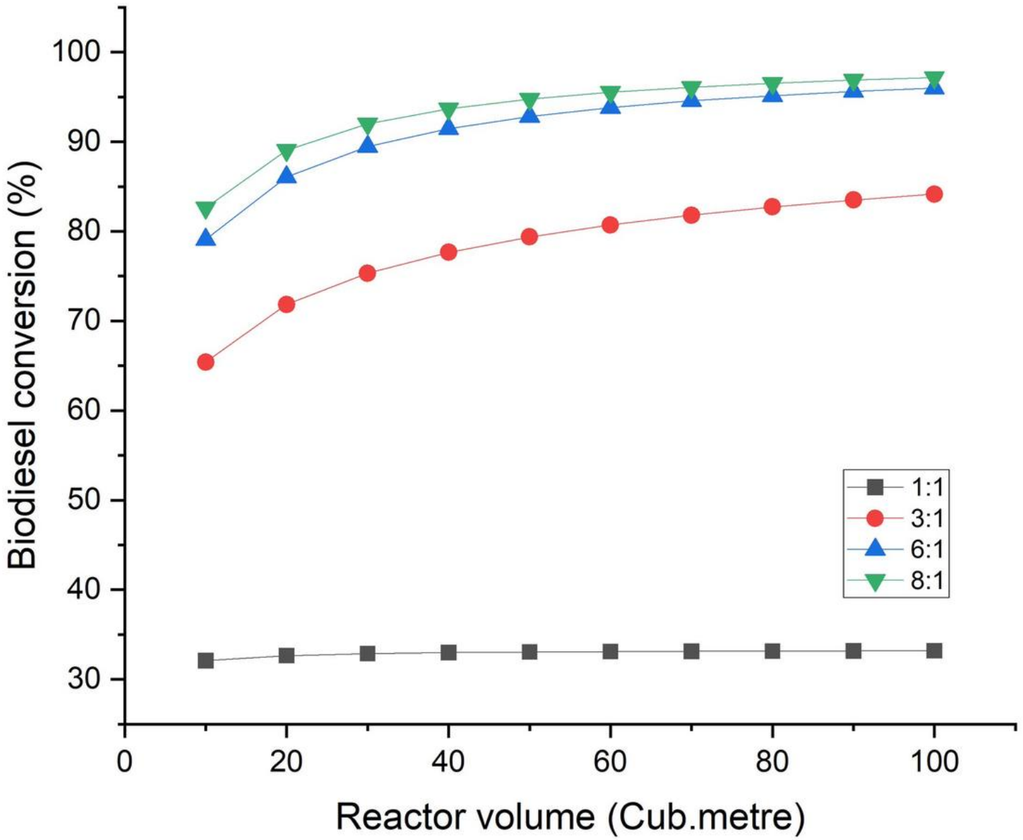


- Base-Catalyzed Transesterification: Triglycerides react with excess methanol KOH catalyst to produce biodiesel and glycerol.
- Reaction Progress: Triglycerides are fully converted maximizing biodiesel yield with glycerol as a by-product.

Assume $k_{rev} = 0$			
Cat: KOH 0.2% wt, MeOH/oil ratio: 6:1, T=60 C			
k_{fw}	**L/mol-min**	**L/mol-sec**	**Ea (J/mol)**
TG - DG	3.06	0.051	30566
DG - MG	2.86	0.047667	23311
MG - GLY	2.22	0.037	25691

Biodiesel Plant

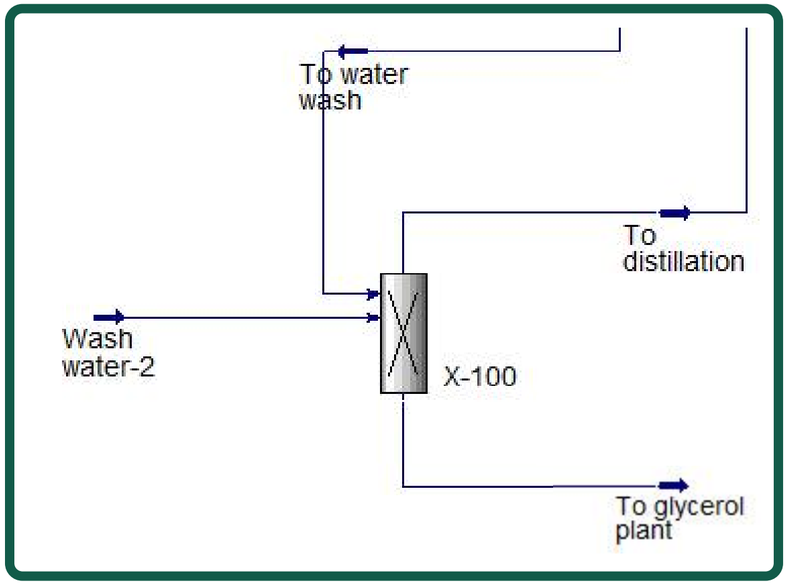
Chemical reaction in Base Reactor



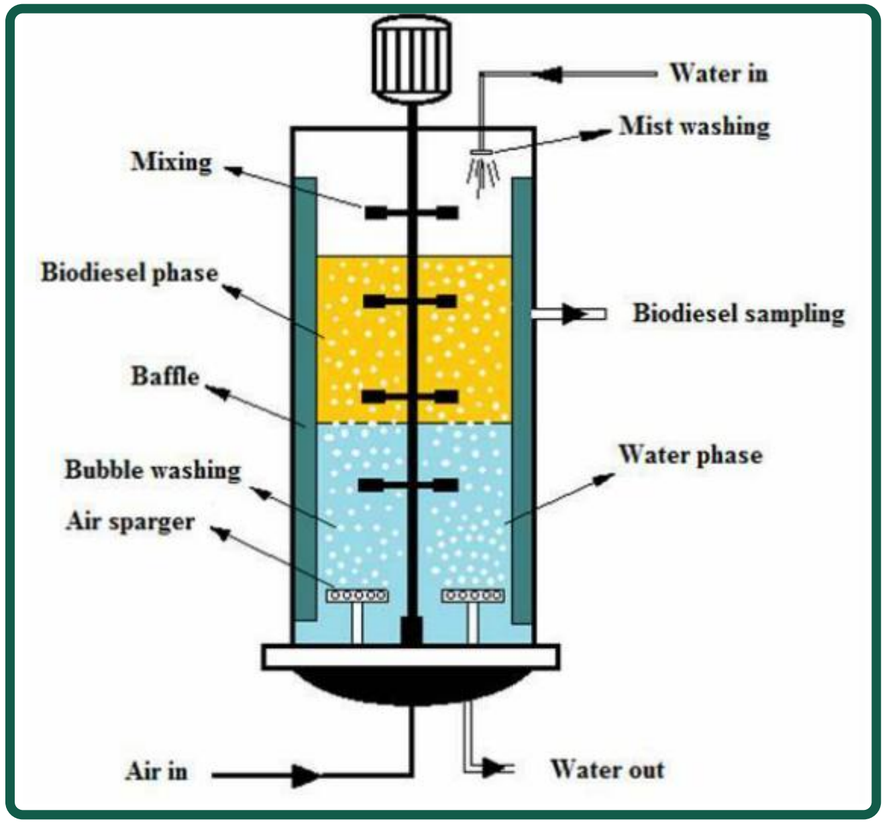
- Effect of Methanol to Oil Ratio: Increasing MeOH:TG ratio enhances equilibrium shift and accelerates conversion, leading to higher biodiesel yield.
- Conversion Behavior with Reactor Volume: Conversion rises rapidly at small reactor volume due to fast primary reaction, then gradually approaches equilibrium as secondary reactions become rate-limiting.

Biodiesel Plant

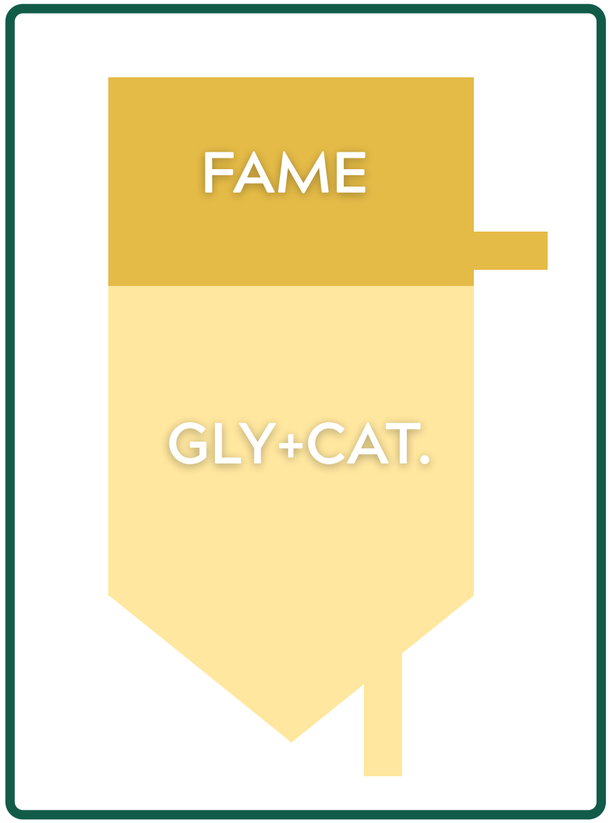
Wet washing of crude biodiesel



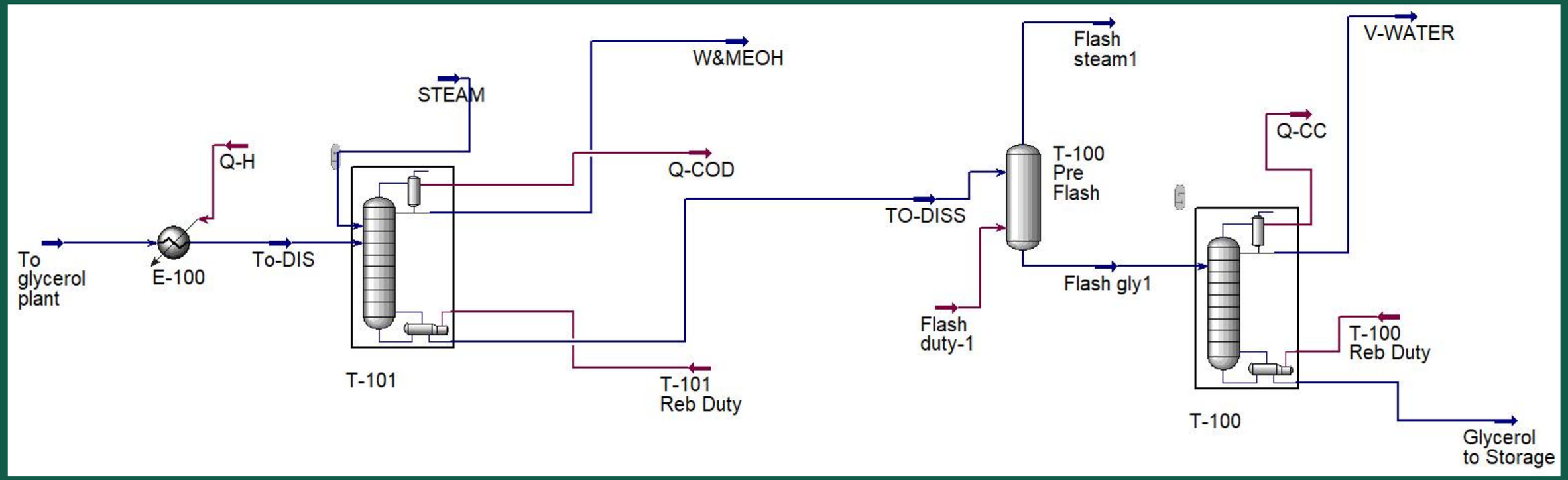
- Wet Washing Mechanism: Water contacts crude biodiesel to extract residual catalyst, soap, methanol, and polar impurities through phase separation.
- Process Performance: Higher washing temperature enhances impurity removal, while water ratio controls the trade-off between catalyst/soap reduction and final water residue.

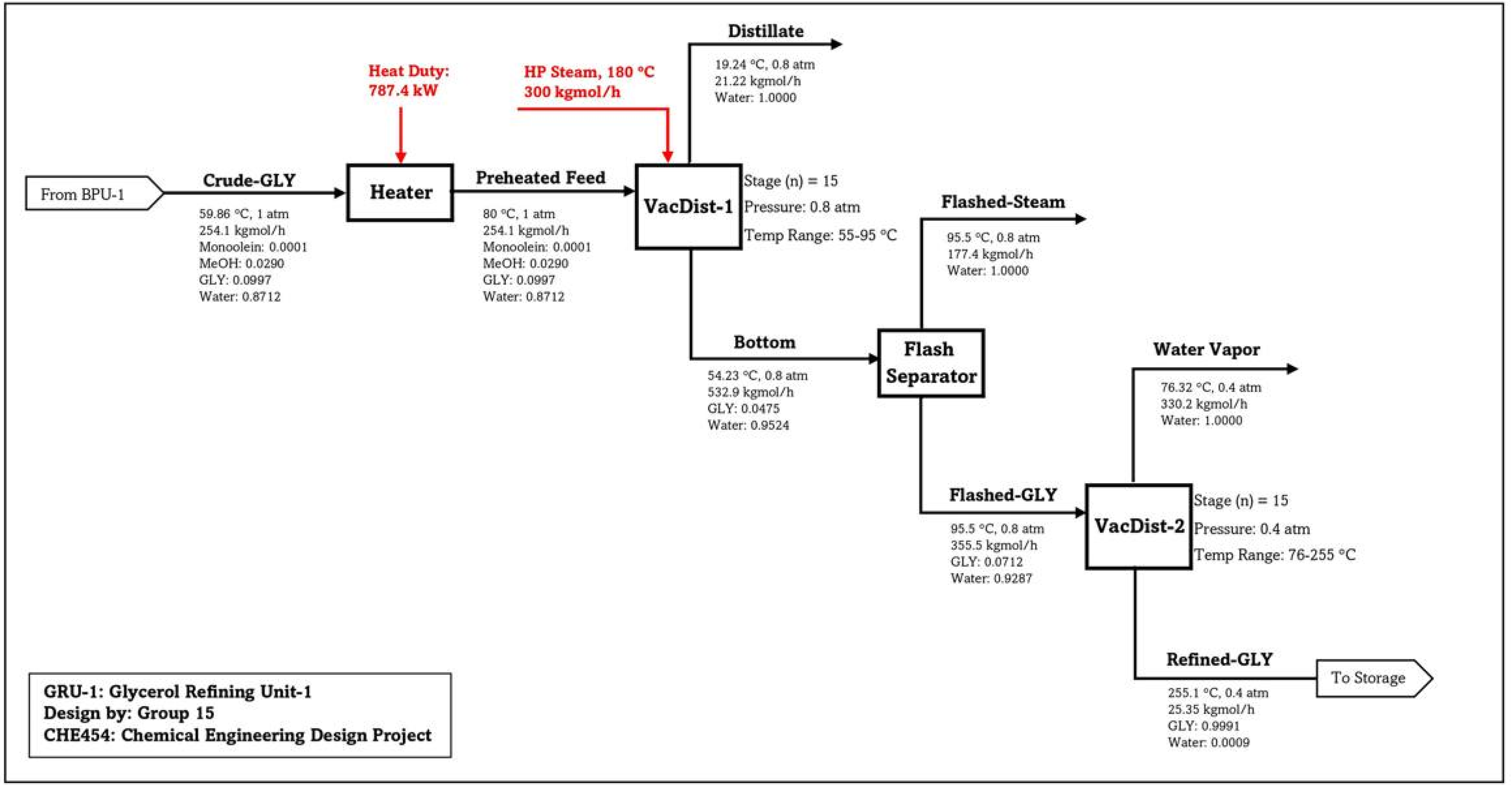


https://www.researchgate.net/figure/Schematic-diagram-of-the-setup-used-for-the-wet-washing-process-Biodiesel-soap-and_fig1_264232838

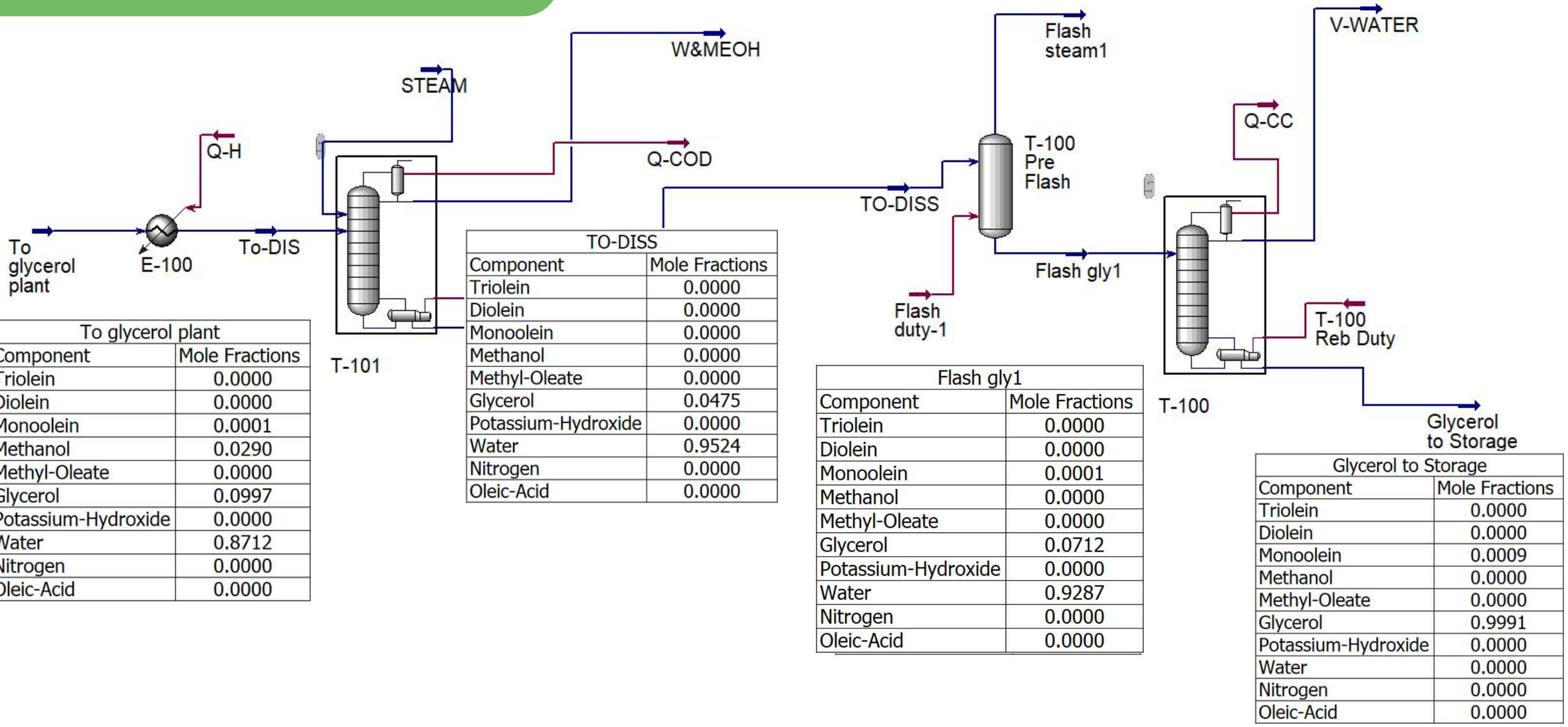


Glycerol Plant




Distillate
19.24 °C, 0.8 atm
21.22 kgmol/h
Water: 1.0000
Heat Duty:
787.4 kW
HP Steam, 180 °C
300 kgmol/h
From BPU-1
Crude-GLY
59.86 °C, 1 atm
254.1 kgmol/h
Monoolein: 0.0001
MeOH: 0.0290
GLY: 0.0997
Water: 0.8712
Heater
Preheated Feed
80 °C, 1 atm
254.1 kgmol/h
Monoolein: 0.0001
MeOH: 0.0290
GLY: 0.0997
Water: 0.8712
VacDist-1
Stage (n) = 15
Pressure: 0.8 atm
Temp Range: 55-95 °C
Flashed-Steam
95.5 °C, 0.8 atm
177.4 kgmol/h
Water: 1.0000
Bottom
54.23 °C, 0.8 atm
532.9 kgmol/h
GLY: 0.0475
Water: 0.9524
Flash Separator
Water Vapor
76.32 °C, 0.4 atm
330.2 kgmol/h
Water: 1.0000
Flashed-GLY
95.5 °C, 0.8 atm
355.5 kgmol/h
GLY: 0.0712
Water: 0.9287
VacDist-2
Stage (n) = 15
Pressure: 0.4 atm
Temp Range: 76-255 °C
Refined-GLY
255.1 °C, 0.4 atm
25.35 kgmol/h
GLY: 0.9991
Water: 0.0009
To Storage
GRU-1: Glycerol Refining Unit-1
Design by: Group 15
CHE454: Chemical Engineering Design Project

Glycerol Plant



To glycerol plant	
Component	Mole Fractions
Triolein	0.0000
Diolein	0.0000
Monoolein	0.0001
Methanol	0.0290
Methyl-Oleate	0.0000
Glycerol	0.0997
Potassium-Hydroxide	0.0000
Water	0.8712
Nitrogen	0.0000
Oleic-Acid	0.0000

TO-DISS	
Component	Mole Fractions
Triolein	0.0000
Diolein	0.0000
Monoolein	0.0000
Methanol	0.0000
Methyl-Oleate	0.0000
Glycerol	0.0475
Potassium-Hydroxide	0.0000
Water	0.9524
Nitrogen	0.0000
Oleic-Acid	0.0000

Flash gly1	
Component	Mole Fractions
Triolein	0.0000
Diolein	0.0000
Monoolein	0.0001
Methanol	0.0000
Methyl-Oleate	0.0000
Glycerol	0.0712
Potassium-Hydroxide	0.0000
Water	0.9287
Nitrogen	0.0000
Oleic-Acid	0.0000

Glycerol to Storage	
Component	Mole Fractions
Triolein	0.0000
Diolein	0.0000
Monoolein	0.0009
Methanol	0.0000
Methyl-Oleate	0.0000
Glycerol	0.9991
Potassium-Hydroxide	0.0000
Water	0.0000
Nitrogen	0.0000
Oleic-Acid	0.0000

Waste Management | Wastewater

Sources

1. From methanol recovery at T-100

   Specs:

   Flowrate = 10532.98 Tonne/year

   Composition (%Mass) = 99.71% Water, 0.29% MeOH

2. Flashed after water washing FAME

   Specs:

   Flowrate = 9448 Tonne/year

   Composition (%Mass) = 86.77% Water, 13.23% MeOH

3. Waste from glycerol distillation

   Specs:

   Flowrate = 5300 Tonne/year

   Composition (%Mass) = 85% Water, 15% MeOH

Wastewater treatment plant

Cost: 2 $/m3 , Annually: 50,563 $/year

Waste Management | Solid Waste

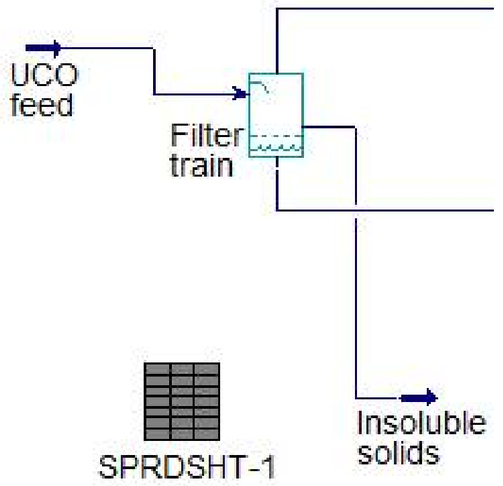
Sources

1. **Insoluble solid from raw-UCO filtration**

Specs:

Flowrate = 2198 Tonne/year

Composition (%Mass) = 50% Solids, 30% Moisture , and 20% Oil

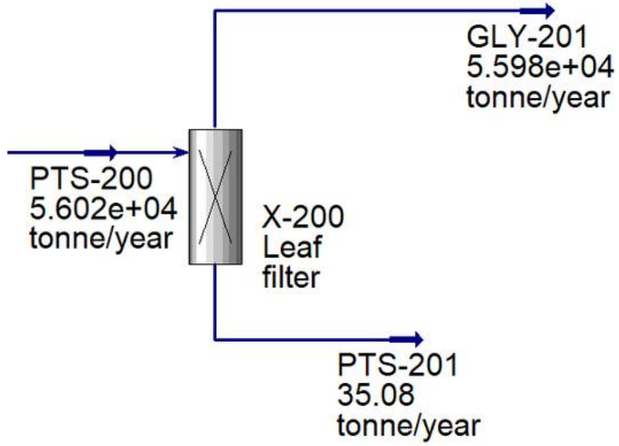


2. K_2SO_4 **salt from neutralization**

Specs:

Flowrate = 35.08 Tonne/year

Composition (%Mass) = 100% K_2SO_4



Waste Management | Solid Waste

Treatment/Valorization

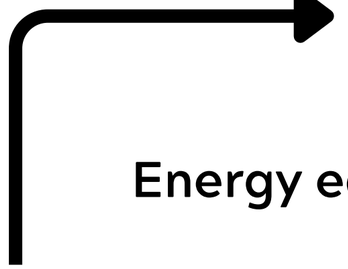
Insoluble solid from raw-UCO filtration

Flowrate = 2198 Tonne/year

Composition (%Mass)
50% Solids,
30% Moisture,
20% Oil

Anaerobic Digestion

~30 days retention time



Biogas

3,813 m3/day

Energy eqivalence : ~16 MJ/m3

Volume: 330.63 m3

Sludge

1,700 kg/day

Energy eqivalence : ~10 MJ/kg

Waste Management | Solid Waste

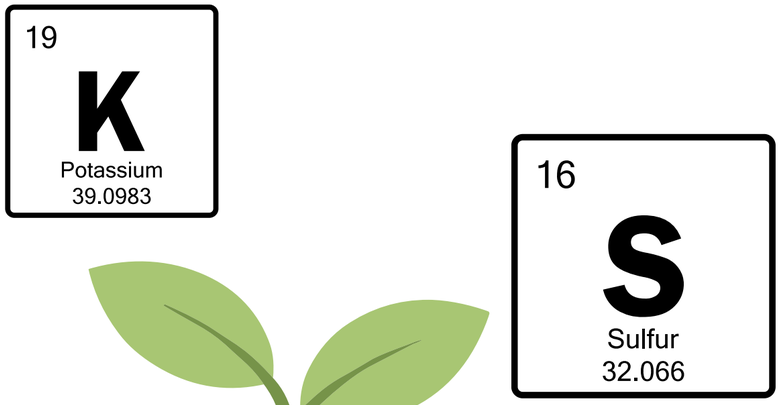
Treatment/Valorization

K_2SO_4 salt from neutralization

Flowrate = 35.08 Tonne/year

Composition (%Mass)
100 % Solid K_2SO_4

Sells as fertilizer



- Does not increase soil salinity
- Sulfur is essential for plant growth
- Potassium increase resistance to heat & drought

Current Results from Aspen Hysys Simulation Compared to TOR			
B100 (FAME)			
Parameter	**Spec**	**This work**	**Status**
Acid value	0.5 $mgKOH/g_{max}$	0.12 mgKOH/g	**on-spec**
Cloud Point	16 $°C_{max}$	12.91 °C	**on-spec**
MeOH	0.20 $\%wt_{max}$	0 %wt	**on-spec**
Phosphorus	0.001 $\%wt_{max}$	-	**N/A**
Monoglyceride	0.40 $\%wt_{max}$	0 %wt	**on-spec**
Diglyceride	0.20 $\%wt_{max}$	0 %wt	**on-spec**
Triglyceride	0.20 $\%wt_{max}$	0 %wt	**on-spec**
FAME	96.5 $\%wt_{min}$	99.94 %wt	**on-spec**
LinoA-FAME	12 $\%wt_{max}$	-	**N/A**
Refined Glycerin (R-GLY)			
Parameter	**Spec**	**This work**	**Status**
Purity	99.5 $\%wt_{min}$	99.65 %wt	**on-spec**
FattyA-Ester	1 $\%wt_{max}$	0 %wt	**on-spec**
Colour	10 $APHA_{max}$	-	**N/A**
Water	0.25 $\%wt_{max}$	0 %wt	**on-spec**
3-Methoxy	250 ppm_{max}	-	**N/A**
Heat Stability	70 Ax_{max}	-	**N/A**

Economic analysis

Estimated cost of each equipment in the process

Equipment in pretreatment process		Equipment Cost (USD)	Equipment Cost (THB)
Type	**Name**		
Separator	Dehydrator	$ 125,000.00	฿ 4,188,750.00
Separator	Filter train	$ 70,000.00	฿ 2,345,700.00
Reactor	Acid Reactor	$ 144,800.00	฿ 4,852,248.00
Heat exchanger	Plate-100	$ 14,400.00	฿ 482,544.00
Separator	X-100	$ 100,000.00	฿ 3,351,000.00

Equipment in glycerine plant		Equipment Cost (USD)	Equipment Cost (THB)
Type	**Name**		
Distillation column	Main Tower_@T-100	$ 250,000.00	฿ 8,377,500.00
Distillation column	Main Tower_@T-103	$ 58,800.00	฿ 1,970,388.00
Condenser	Condenser_@T-100	$ 53,800.00	฿ 9,553,701.00
Heat exchanger	E-100	$ 37,900.00	฿ 1,270,029.00
Reboiler	Reboiler_@T-100	$ 104,900.00	฿ 3,515,199.00
Condenser	Condenser_@T-101	$ 48,900.00	฿ 1,638,639.00
Distillation column	Main Tower_@T-101	$ 67,600.00	฿ 2,265,276.00
Reboiler	Reboiler_@T-101	$ 100,000.00	฿ 3,351,000.00
Flash drum	T-100 Pre Flash	$ 26,200.00	฿ 877,962.00
Separator	V-100	$ 41,400.00	฿ 1,387,314.00
	V-101	$ 45,400.00	฿ 1,521,354.00

Equipment in biodiesel plant		Equipment Cost (USD)	Equipment Cost (THB)
Type	**Name**		
Reactor	Base Reactor	$ 342,100.00	฿ 12,291,468.00
Condenser	Condenser_@T-100	$ 236,700.00	฿ 11,463,771.00
Heat exchanger	E-100	$ 185,100.00	฿ 6,202,701.00
Distillation column	Main Tower_@T-100	$ 3,261,600.00	฿ 109,296,216.00
Pump	P-100	$ 10,000.00	฿ 335,100.00
Pump	P-101	$ 8,200.00	฿ 274,782.00
Reboiler	Reboiler_@T-100	$ 80,000.00	฿ 2,680,800.00
Separator	V-100	$ 49,600.00	฿ 1,662,096.00
Separator	Water washing	$ 200,000.00	฿ 6,702,000.00

Overall plant	Equipment Cost (USD)	Equipment Cost (THB)
Total	$ 5,792,500.00	฿ 194,106,675.00

Economic analysis

Plant construction cost calculation.

Direct cost	Percentage (%)	Cost (USD)	Cost (THB)
Installation		$ 18,375,500.00	฿ 615,763,005.00
Instrumentation	5	$ 1,448,125.00	฿ 48,526,668.75
Piping	1	$ 289,625.00	฿ 9,705,333.75
Electrical	5	$ 1,448,125.00	฿ 48,526,668.75
Building	15	$ 4,344,375.00	฿ 145,580,006.25
Land	2	$ 2,023,982.78	฿ 67,823,663.00
Landscaping	4	$ 1,158,500.00	฿ 38,821,335.00
Utilities	12	$ 3,475,500.00	฿ 116,464,005.00
Total		$ 32,563,732.78	฿ 1,091,210,685.50
Indirect cost			
Engineering	1	$ 289,625.00	฿ 9,705,333.75
Construction	15	$ 4,344,375.00	฿ 145,580,006.25
Contractor's fee	5	$ 1,448,125.00	฿ 48,526,668.75
Contingency	10	$ 2,896,250.00	฿ 97,053,337.50
Total		$ 8,978,375.00	฿ 300,865,346.25
Total Capital Investment Cost		$ 41,542,107.78	฿ 1,392,076,031.75

https://davuniversity.org/images/files/study-material/PLANT%20DESIGN%20AND%20ECONOMICS%20FOR%20CHEMICAL%20ENGINEERS.pdf

Economic analysis

Total cost of production (Raw material + utilities)

Item	rate	unit	cost per rate	Value (USD)	Value (THB)
UCO	228100.00	Ton/yr	925	$ 210,992,500.00	฿ 7,408,223,250.00
Methanol	48700	Ton/yr	378	$ 18,408,600.00	฿ 564,558,384.60
KOH	23.44	Ton/yr	1096	$ 25,690.24	฿ 860,879.94
Utility					
Steam	53362.92	Ton	42.2	$ 2,251,915.22	฿ 33,250,250.59
Electricity	10136914.74	kWh	0.11	$ 1,115,060.62	฿ 37,353,079.61
Clarified water	2682360	m3	0.74	$ 1,984,946.40	฿ 30,207,919.91
Total production cost				$ 240,956,543.26	฿ 8,074,453,764.64

Economic analysis

Net profit from production calculation

Item	rate	unit	cost per rate	Value (USD)	Value (THB)
B100	216000	Ton/yr	1026	$ 221,616,000.00	฿ 7,426,352,160.00
Refined Glycerine	20400	Ton/yr	508	$ 10,342,880.00	฿ 346,589,908.80
Yellow Glycerine	0	Ton/yr	238	$ -	฿ -
Total				$ 231,958,880.00	฿ 7,772,942,068.80
Gross profit before tax				$ -8,997,663.26	-฿ 301,511,695.84
Net profit				$ -8,997,663.26	-฿ 301,511,695.84

Economic analysis

Production cost in of case changing UCO supplier to

UCO cost changed from 925 to 626.67 USD/ton

Item	rate	unit	cost per rate	Value (USD)	Value (THB)
UCO	239000.00	Ton/yr	626.67	$ 149,774,130.00	฿ 5,018,931,096.30
Methanol	44570	Ton/yr	378	$ 16,847,460.00	฿ 564,558,384.60
KOH	23.44	Ton/yr	1096	$ 25,690.24	฿ 860,879.94
Utility					
Steam	23513	Ton	42.2	$ 992,248.60	฿ 33,250,250.59
Electricity	10133496	kWh	0.11	$ 1,114,684.56	฿ 37,353,079.61
Clarified water	1218189	m3	0.74	$ 901,459.86	฿ 30,207,919.91
Operating labor	200	person/yr	300	$ 20,100,000.00	฿ 673,551,000.00
Total product cost				$ 169,655,673.26	฿ 5,685,161,610.94

Economic analysis

Profit in case of changing UCO supplier to Bangchak

Item	rate	unit	cost per rate	Value (USD)	Value (THB)
B100	2.16E+05	Ton/yr	1026	$ 221,616,000.00	฿ 7,426,352,160.00
Refined Glycerine	2.04E+04	Ton/yr	508	$ 10,342,880.00	฿ 346,589,908.80
Yellow Glycerine	0	Ton/yr	238	$ -	฿ -
Total				$ 231,958,880.00	฿ 7,772,942,068.80
Gross profit before tax				$ 42,203,206.74	฿ 1,414,229,457.86
Gross profit with depreciation				$ 42,203,206.74	฿ 1,414,229,457.86
Gross profit after tax	25	%		$ 31,652,405.06	฿ 1,060,672,093.39
Net profit				$ 31,652,405.06	฿ 1,060,672,093.39

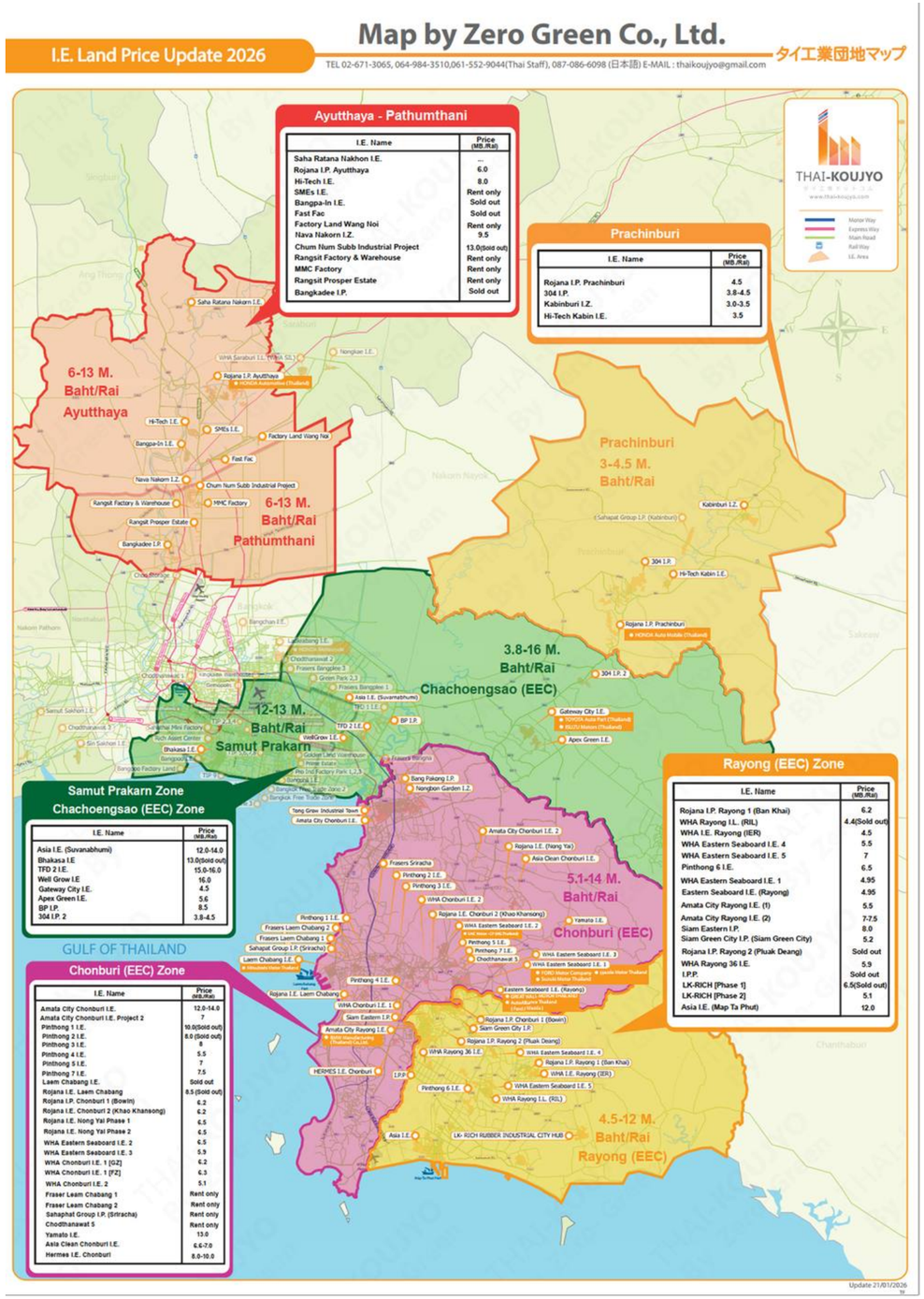
Economic analysis

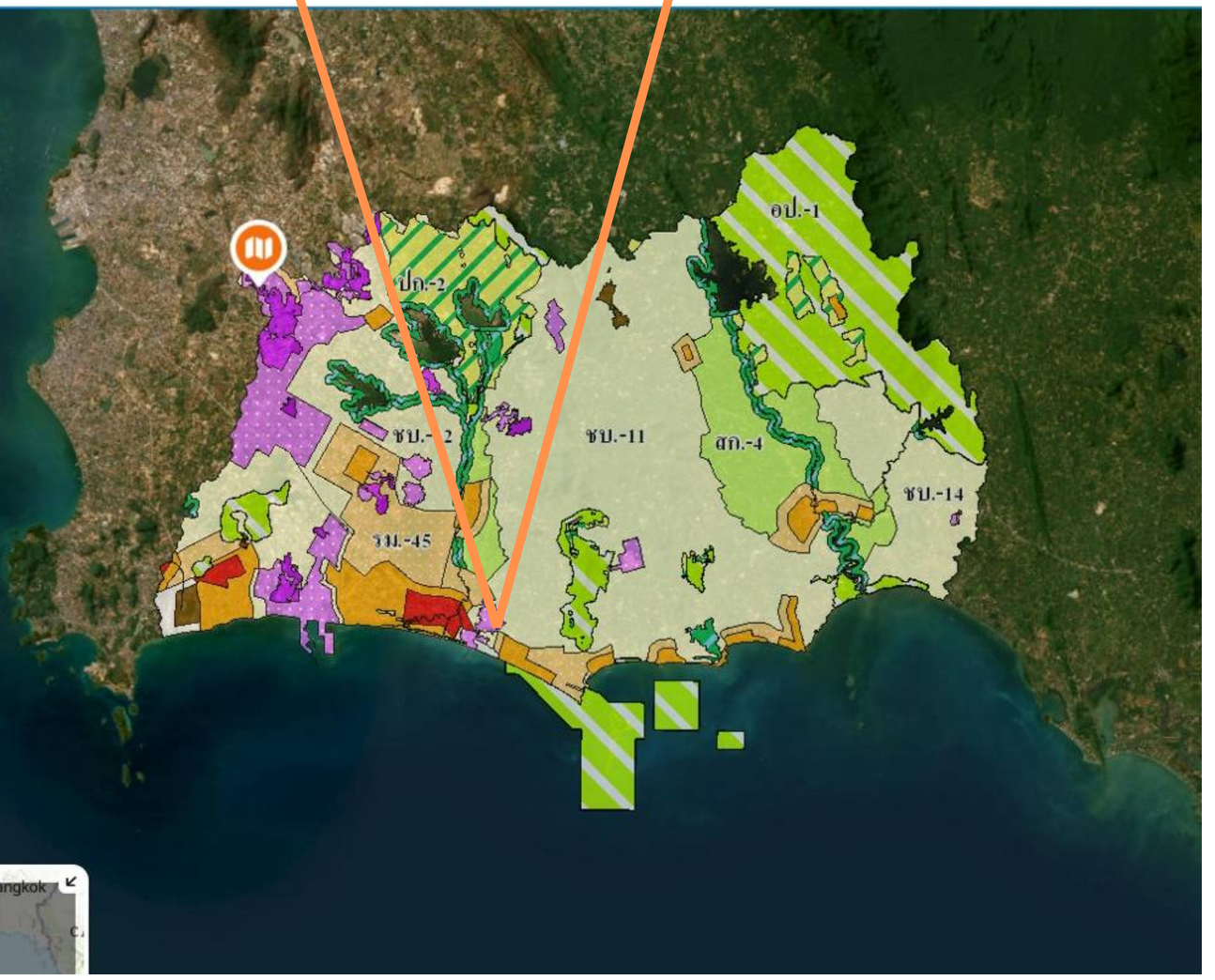
Profit in case of changing UCO supplier to Bangchak

Location

ตารางที่ 9 ข้อมูลจำนวนโรงงานอุตสาหกรรมประเภทพลังงานหมุนเวียน/ทดแทน

อุตสาหกรรมพลังงานหมุนเวียน/ทดแทน				
จังหวัด	จำนวนโรงงาน (โรงงาน)	แรงม้ารวม (แรงม้า)	เงินทุนรวม (ล้านบาท)	จำนวนแรงงาน (คน)
สมุทรปราการ	14	20,430,729	19,583	1,080
ชลบุรี	18	2,785,432	29,662	577
ระยอง	27	15,748,904	57,880	1,003
สมุทรสาคร	9	107,749	1,819	153
นครปฐม	18	382,219	12,327	423
อยุธยา	16	5,776,890	69,388	391





OSD1L0140 - ที่ดิน

Near Eastern Seaboard Industrial Estate (Rayong)

จังหวัด : ระยอง

ขนาดที่ดิน : 18.83475 ไร่

เข้าใช้ได้ : ตอนนี้

ราคา : 75,339,000 บาท

แก้ไขล่าสุด : 26 ก.พ. 2569

ดูรายละเอียดเพิ่มเติม คลิกที่นี่

DPT Landuse Plan

ค้นหาข้อมูลผังเมือง

สำนักงานศุลกากรเขตปลอดอากรนิคมอุตสาหกรรมอีสเทิร์นซีบอร์ด - พิกัด : 13.020070,101.161802

ผังเขตพัฒนาพิเศษภาคตะวันออกจังหวัดระยอง

ประกาศบังคับใช้: วันที่ 9 ธันวาคม 2562

ชื่อประเภทการใช้ประโยชน์	บริเวณ
เขตส่งเสริมเศรษฐกิจพิเศษสำหรับกิจการพิเศษ	ขก.-1 - ขก.-5
เขตส่งเสริมเศรษฐกิจพิเศษเพื่อกิจการอุตสหกรรม	ขอ.-1 - ขอ.-23
ชุมชนชนบท	ชบ.-1 - ชบ.-15
ที่พระราชกฤษฎีกากำหนดให้เป็นเขตปฏิรูปที่ดิน	ปก.-1 - ปก.-6
ศูนย์กลางพาณิชยกรรม	พ.-1 - พ.-7
ชุมชนเมือง	ม.-1 - ม.-53
รองรับการพัฒนาเมือง	รม.-1 - รม.-56
ที่โล่งเพื่อนันทนาการและการรักษาคุณภาพสิ่งแวดล้อมชายฝั่งทะเล	ล.-1 - ล.-32
ส่งเสริมเกษตรกรรม	สก.-1 - สก.-8
พัฒนาอุตสหกรรม	อ.-1 - อ.-67
อนุรักษ์ป่าไม้	อป.-1 - อป.-12

ชั้นข้อมูลที่เกี่ยวข้อง

ข้อควรทราบ: การเผยแพร่และบริการข้อมูลในเว็ปไซต์นี้เป็นไปเพื่อวัตถุประสงค์ให้ผู้ใช้

Location

OSD1L0140 - ที่ดิน

Near Eastern Seaboard Industrial Estate (Rayong)

จังหวัด : ระยอง
เข้าใช้ได้ : ตอนนี้
ขนาดที่ดิน : 18.83475 ไร่
ราคา : 75,339,000 บาท

ดูรายละเอียดเพิ่มเติม คลิกที่นี่

แก้ไขล่าสุด : 26 ก.พ. 2569

DPT Landuse Plan

ค้นหาข้อมูลผังเมือง

สำนักงานศุลกากรเขตปลอดอากรนิคมอุตสาหกรรมอีสเทิร์นซีบอร์ด - พิกัด : 13.020070,101.161802

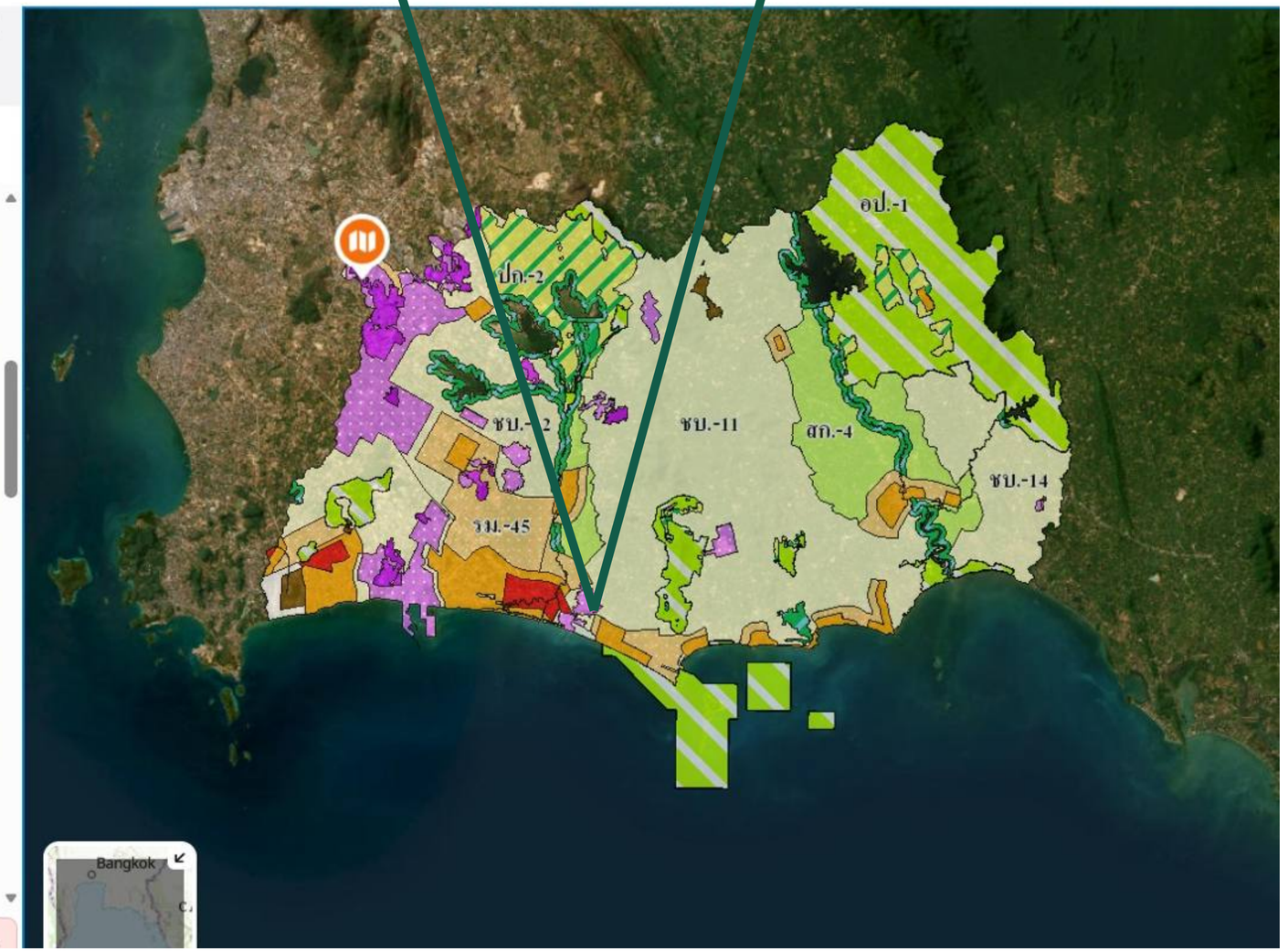
ผังเขตพัฒนาพิเศษภาคตะวันออกจังหวัดระยอง

ประกาศบังคับใช้: วันที่ 9 ธันวาคม 2562

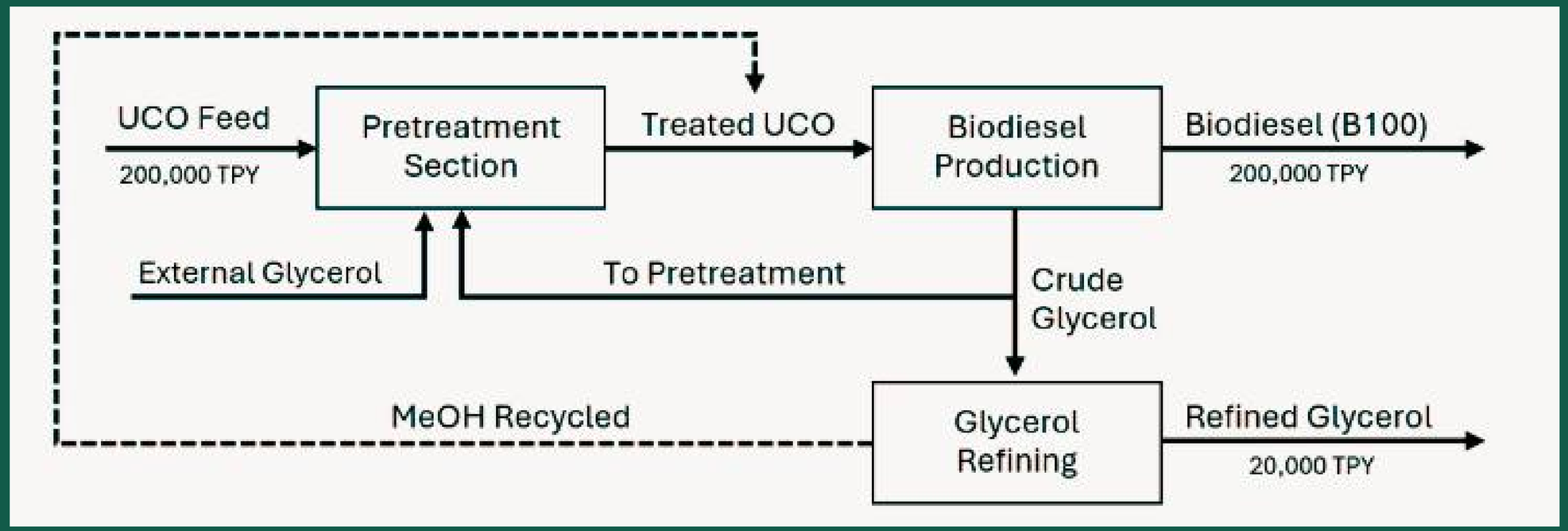
ชื่อประเภทการใช้ประโยชน์	บริเวณ
เขตส่งเสริมเศรษฐกิจพิเศษสำหรับกิจการพิเศษ	ขก.-1 - ขก.-5
เขตส่งเสริมเศรษฐกิจพิเศษเพื่อกิจการอุตสหกรรม	ขอ.-1 - ขอ.-23
ชุมชนชนบท	ชบ.-1 - ชบ.-15
ที่พระราชกฤษฎีกากำหนดให้เป็นเขตปฏิรูปที่ดิน	ปก.-1 - ปก.-6
ศูนย์กลางพาณิชยกรรม	พ.-1 - พ.-7
ชุมชนเมือง	ม.-1 - ม.-53
รองรับการพัฒนาเมือง	รม.-1 - รม.-56
ที่โล่งเพื่อนันทนาการและการรักษาคุณภาพสิ่งแวดล้อมชายฝั่งทะเล	ล.-1 - ล.-32
ส่งเสริมเกษตรกรรม	สก.-1 - สก.-8
พัฒนาอุตสหกรรม	อ.-1 - อ.-67
อนุรักษ์ป่าไม้	อป.-1 - อป.-12

ชั้นข้อมูลที่เกี่ยวข้อง

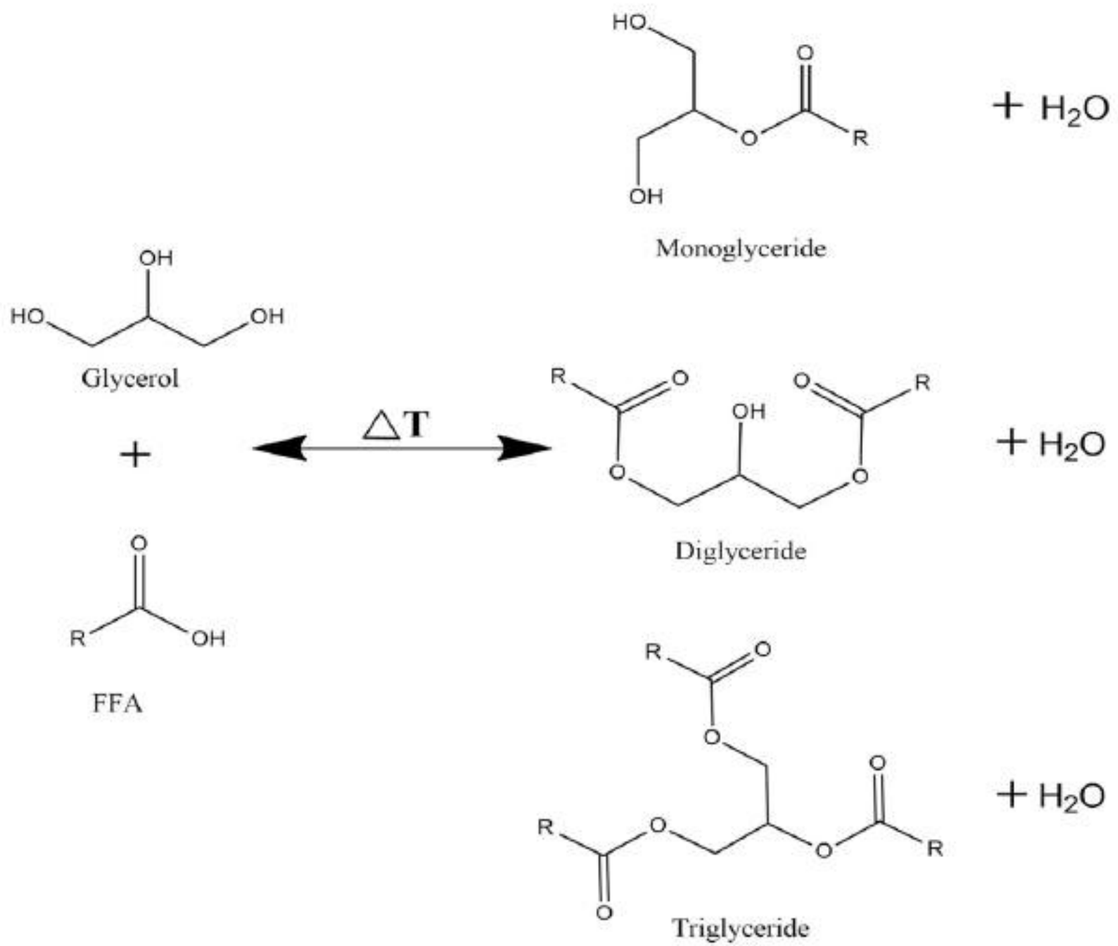
ข้อควรทราบ: การเผยแพร่และบริการข้อมูลในเว็ปไซต์นี้เป็นไปเพื่อวัตถุประสงค์ให้ผู้ใช้



GLYCEROLYSIS



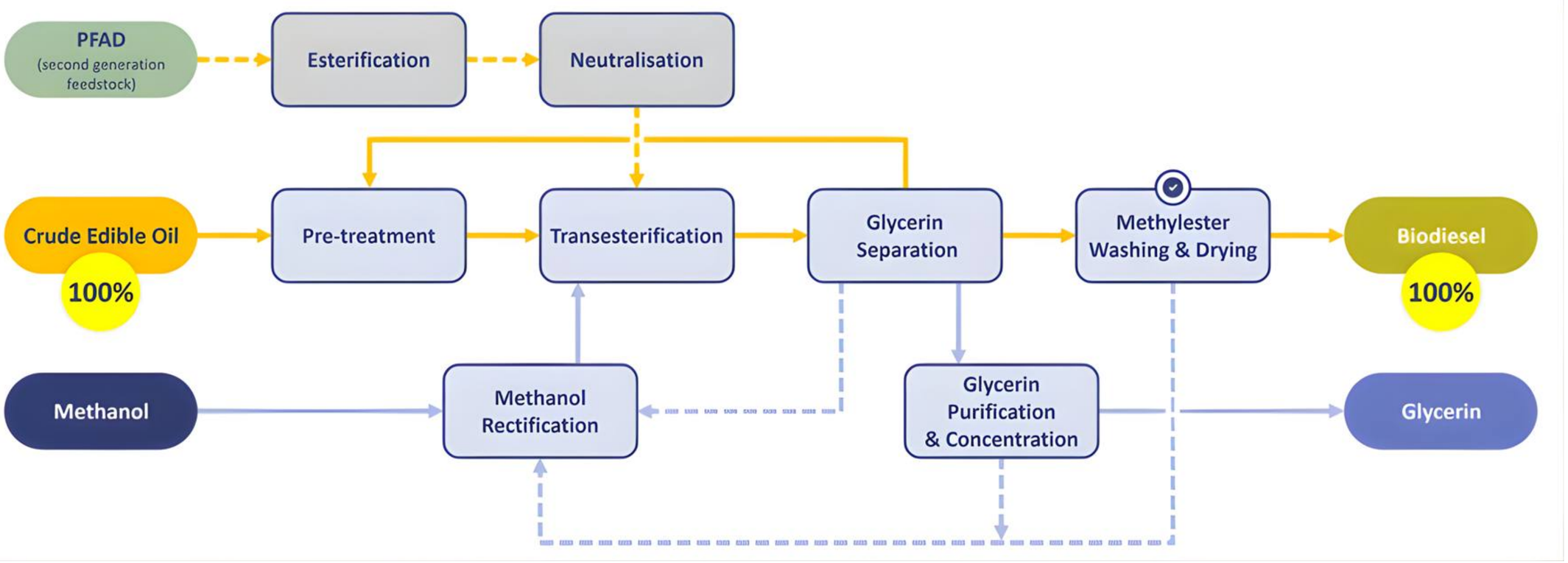
GLYCEROLYSIS



Experimental runs	k (L/mol.min)	Reaction condition
FFA/crude glycerol variation		
1:2	0.0068	T: 65°C, stirring: 250 rpm, catalyst: 0.75% w/w
1:3	0.0105	
1:4	0.0136	
1:5	0.0121	
Temperature variation		
55°C	0.0092	FFA/crude glycerol:1/4, stirring: 250 rpm, catalyst: 0.75% w/w
65°C	0.0136	
75°C	0.0212	
85°C	0.0131	
Stirring speed variation		
150 rpm	0.0094	FFA/crude glycerol:1/4, T: 75°C, catalyst: 0.75% w/w
200 rpm	0.0119	
250 rpm	0.0212	
Catalyst loading variation		
0 %	0.0013	FFA/crude glycerol:1/4, T: 75°C, stirring: 250 rpm
0.5 %	0.0098	
0.75 %	0.0212	
1.0 %	0.0090	

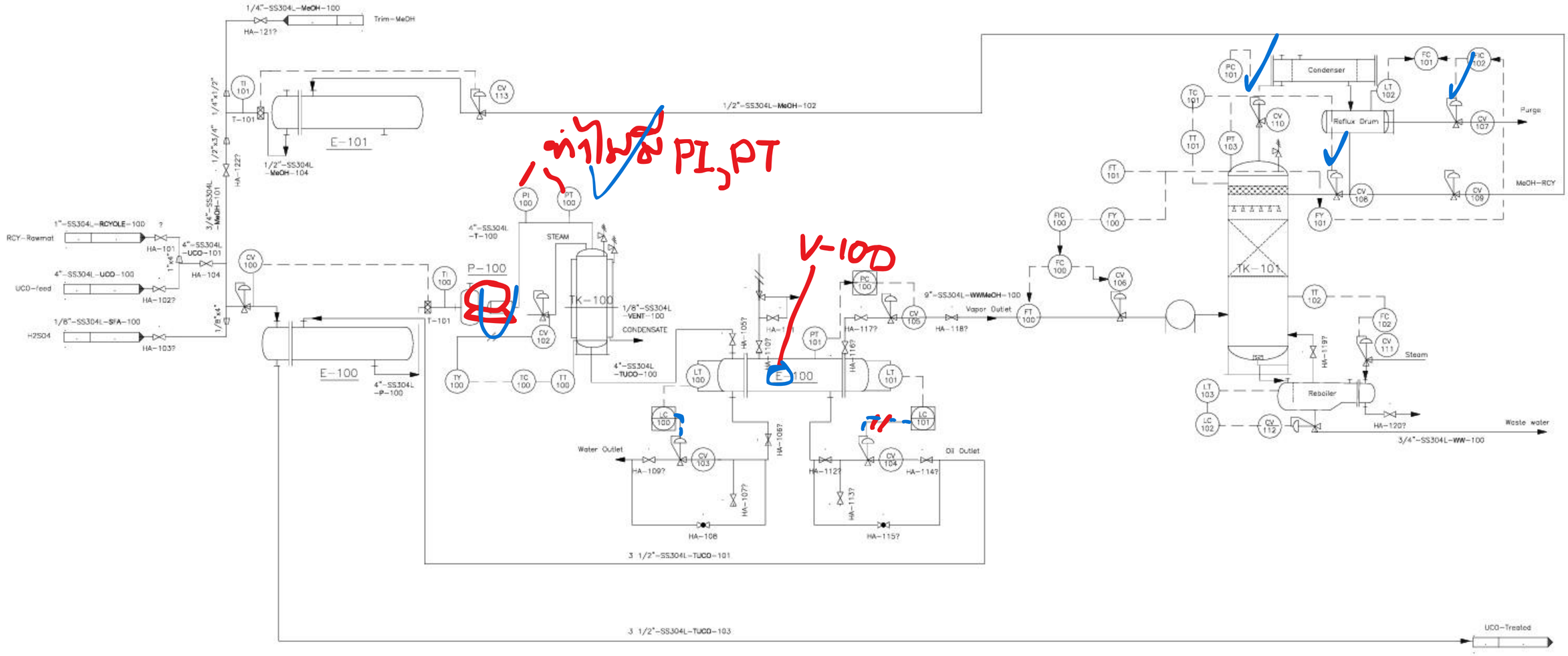
To summarize the kinetics used in the AspenHYSYS simulation based on this findings, the value of **rate constant, activation energy, and Arrhenius pre-exponential factor are 0.0212 L/mol-min, 8.608 kcal/mol, and 4,495.355 L/mol-min, respectively.**

desmet

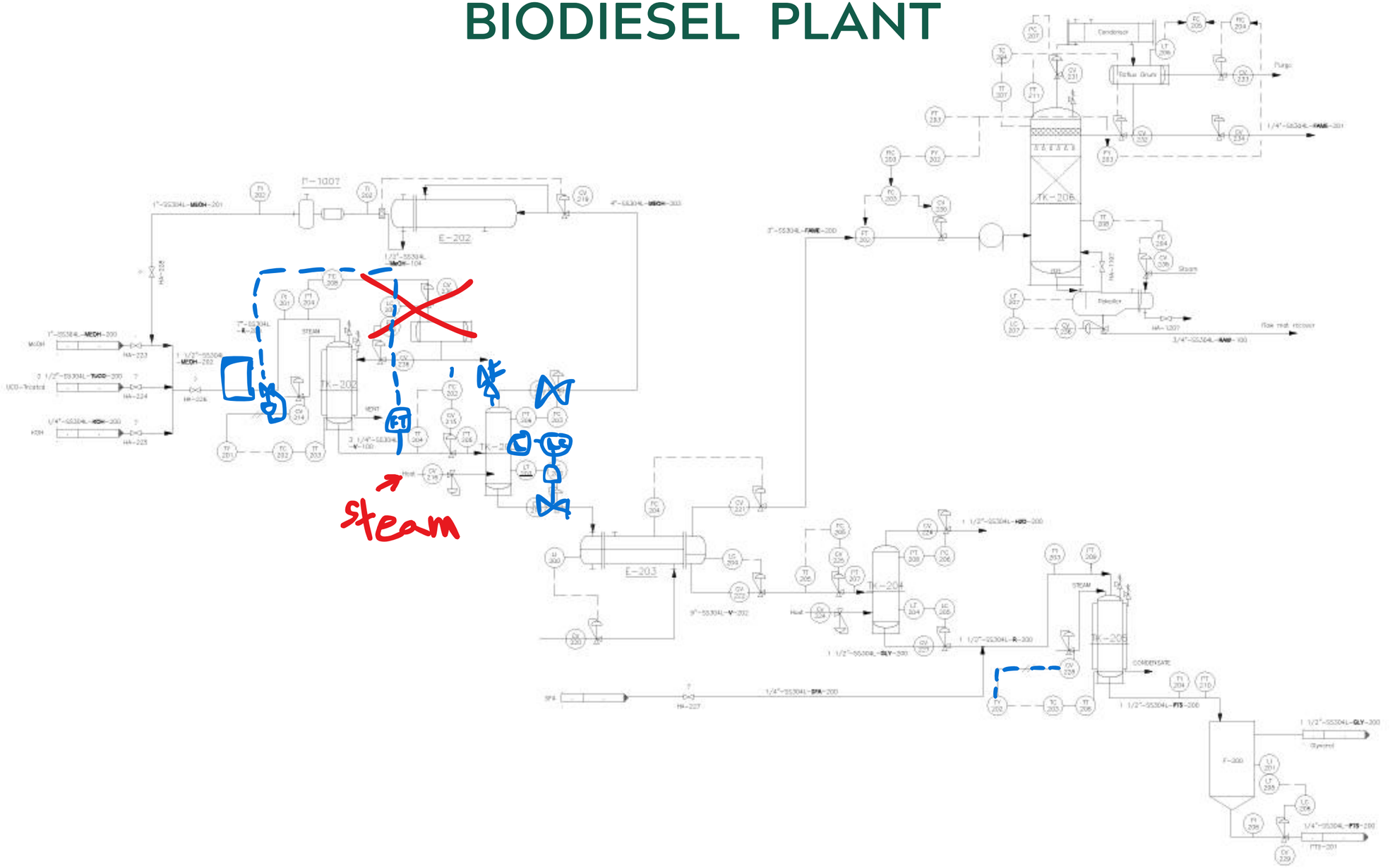

PFAD
(second generation feedstock)
Esterification
Neutralisation
Crude Edible Oil
100%
Pre-treatment
Transesterification
Glycerin Separation
Methylester Washing & Drying
Biodiesel
100%
Methanol
Methanol Rectification
Glycerin Purification & Concentration
Glycerin

P&ID

PRETREATMENT PLANT

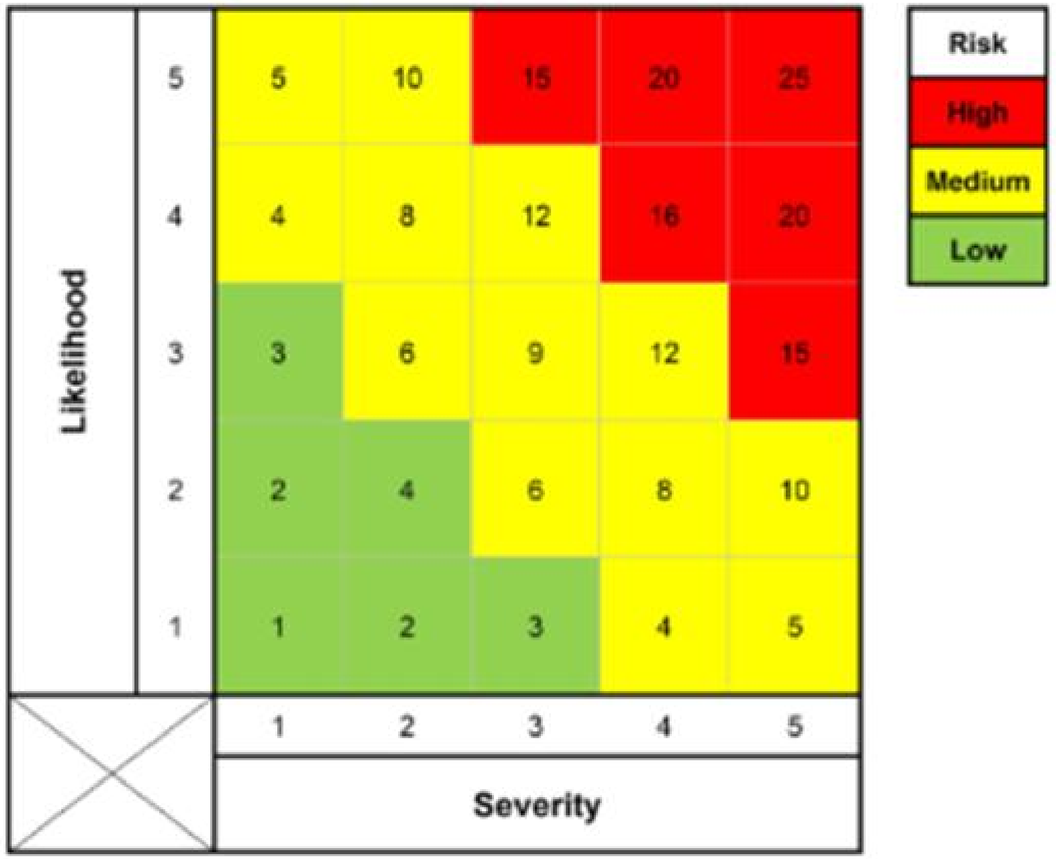


BIODIESEL PLANT

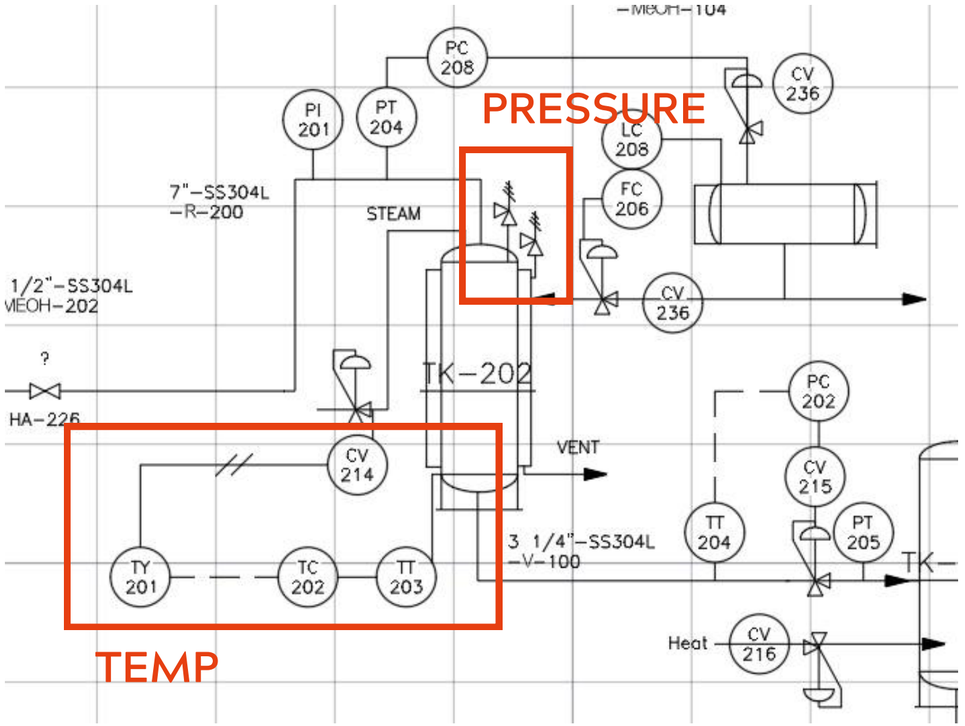


SAFETY

SAFETY ANALYSIS METHODOLOGY (SLR-HAZOP INTEGRATION)



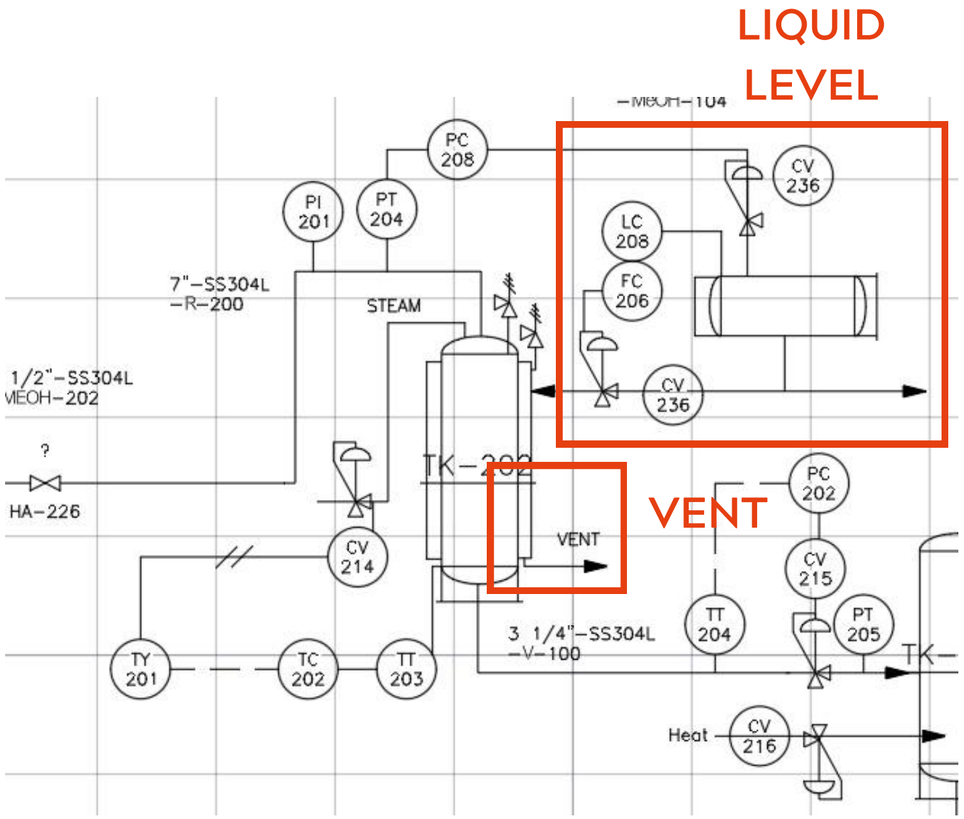
HAZOP EXAMPLE : REACTOR



Parameter	Deviation	Possible Causes	Possible Consequences	Existing Safeguards	S	L	R	Risk Level	Recommendations
			acid carryover						
Reactor temperature	Low	Heater failure, insufficient steam/hot oil, poor control, cold feed surge	Reaction rate decreases, incomplete conversion, FFA remains high, viscosity increases	Temperature indicator/controller, low-temp alarm	3	2	6	Medium	Add low-temperature alarm and feed cutback when below operating limit
Reactor temperature	High	Heater runaway, control valve fail open, wrong setpoint, hot utility upset	More methanol and water vaporization, higher vent rate, pressure rise, methanol loss, off-spec effluent, accelerated corrosion	TIC, vent line, pressure indication	5	3	15	High	Add independent HH temperature trip to isolate heating medium and reduce methanol feed
Reactor pressure	High	Vent blockage, outlet blockage, excessive vaporization, overfilling reducing vapor space	Overpressure, seal/gasket leakage, methanol-containing vapor release, vessel integrity risk	Pressure indicator, vent nozzle, possible PSV if installed	5	2	10	High	Verify PSV/rupture disc sizing, add high-pressure alarm and blocked-vent scenario review
Reactor pressure	Low / vacuum tendency	Condensation after hot operation, venting upset,	Air ingress, flammable vapor-air mixture at vent space, vessel	Open vent / pressure control if present	4	2	8	Medium	Consider nitrogen blanketing or vacuum breaker depending on

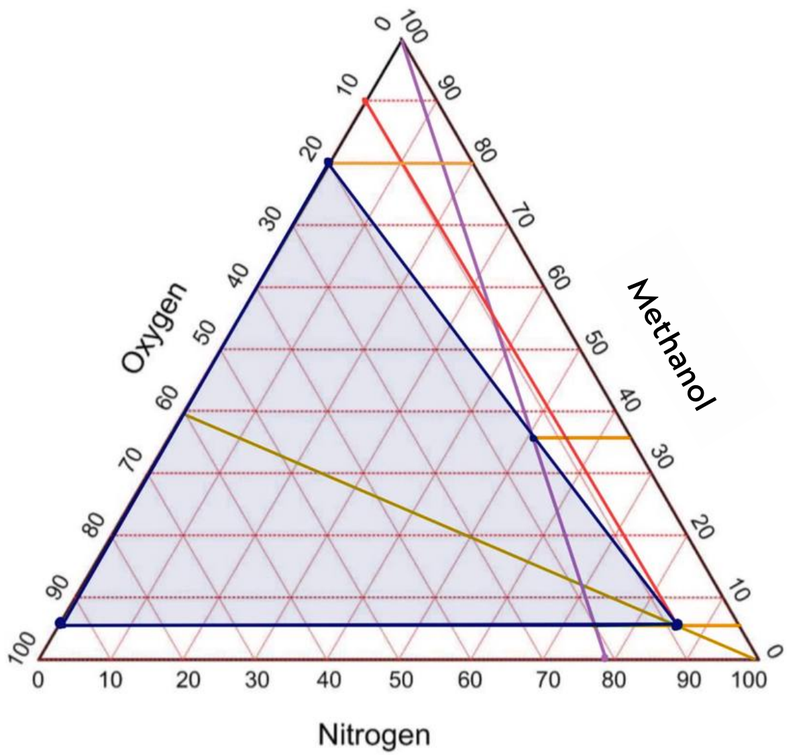
Parameter	Deviation	Possible Causes	Possible Consequences	Existing Safeguards	S	L	R	Risk Level	Recommendations
		downstream suction effect	stress						final design

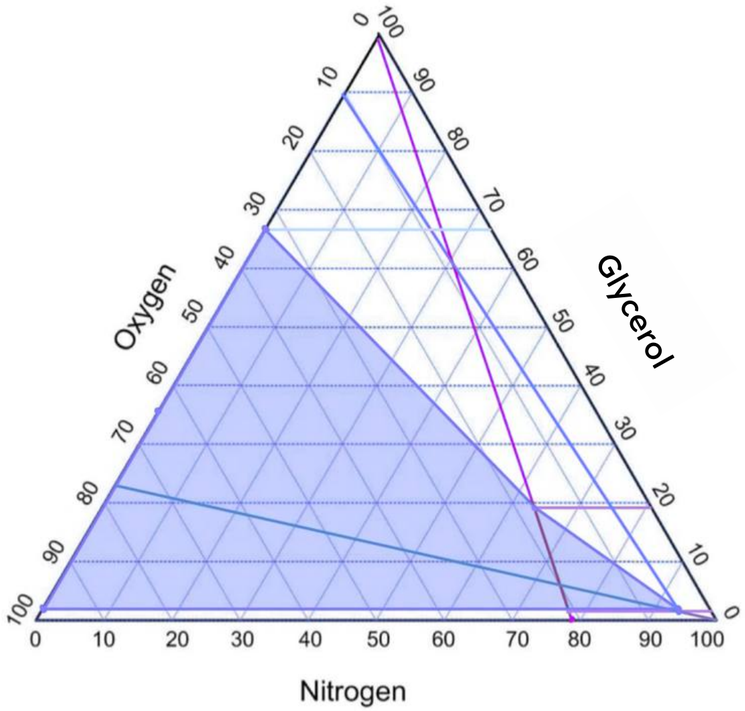
HAZOP EXAMPLE : REACTOR



Parameter	Deviation	Possible Causes	Possible Consequences	Existing Safeguards	S	L	R	Risk Level	Recommendations
Reactor liquid level	Low	Feed loss, outlet too high, leak, wrong level control	Reduced residence time, agitator ineffective, unstable reaction, hot spots or poor mixing	Level indication/control	3	2	6	Medium	Add LLL alarm and interlock to stop outlet pump / protect agitator
Reactor liquid level	High	Outlet blockage, downstream pump failure, excess inflow, bad level control	Reduced vapor space, higher carryover to vent, overflow risk, pressure increase	Level transmitter, high-level alarm	4	2	8	Medium	Add HH level trip to stop feeds and protect vent system
Vent system	No vent / blocked vent	Fouling, closed valve, condenser blockage, line plugging	Pressure build-up, vessel overpressure, release through weak points	Vent nozzle, PI, possible PSV	5	2	10	High	Conduct mandatory blocked-vent review, install pressure protection and inspection plan
Vent system	Excess venting	Too high reactor temperature, too much methanol feed, low condenser efficiency	Methanol loss, flammable vapor release, emission increase, lower process efficiency	Normal vent path	4	3	12	High	Add vent condenser/recovery check and monitor vent composition/flow

FIRE TRIANGLE





MECHANICAL DESIGN

Reactor (R-200)

ASME Section VIII Division 1

Parameter	Value	Unit
Vessel inside diameter, D	174	inch
Vessel radius, R	87	inch
Cylindrical Length, L	260	inch
Jacket diameter	180	inch
Head	Hemispherical	
Ground support	Skirt support	
Operating pressure	15	psig
Design pressure	40	psig
External Pressure	15	psig
Jacket pressure	5	psig
Jacket Design pressure	30	psig
Temperature	176	°F
Maximum allowable stress, S (SS316L @300°F)	15600	psig
Joint efficiency	0.85	
Corrosion allowance	0.125	
3 process nozzles (inlet/outlet/vent)	14	inch
2 measuring instrument nozzles	2	inch
1 safety relief nozzle	3	inch

Thickness jacketed Shell	→	0.375 inch
Thickness jacketed Head	→	0.375 inch
Thickness Shell	→	0.6875 inch
Thickness Head	→	0.6875 inch

Flash Drum (V-200)

ASME Section VIII Division 1

Parameter	Value	Unit
Vessel inside diameter, D	24	inch
Vessel radius, R	12	inch
Cylindrical Length, L	72	inch
Head	1:2Ellipsoidal	
Ground support	Leg support	
Operating pressure	15	psig
Design pressure	40	psig
External Pressure	15	psig
Temperature	320	°F
Maximum allowable stress, S (SS316L @300°F)	13300	psig
Joint efficiency	0.85	
Corrosion allowance	0.125	
3 process nozzles (inlet/outlet/vent)	2	inch
Liquid nozzle	4	inch
2 measuring instrument nozzles	2	inch
1 safety relief nozzle	2	inch

Thickness Shell → **0.6875 inch**

Thickness Head → **0.6875 inch**

Distillation Column (T-100)

ASME Section VIII Division 1

Parameter	Value	Unit
Vessel inside diameter, D	59	inch
Vessel radius, R	29.5	inch
Cylindrical Length, L	392	inch
Operating pressure	1.5	psig
Design pressure	26.5	psig
External Pressure	15	psig
Temperature	550	°F
Maximum allowable stress, S (SS316L @700°F)	12100	
Joint efficiency	0.85	
Corrosion allowance	0.125	

Thickness Shell → **0.375 inch**

PLANT LAYOUT

REF.

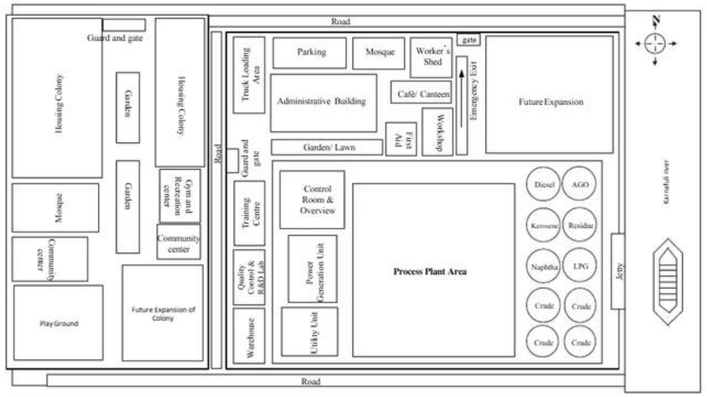
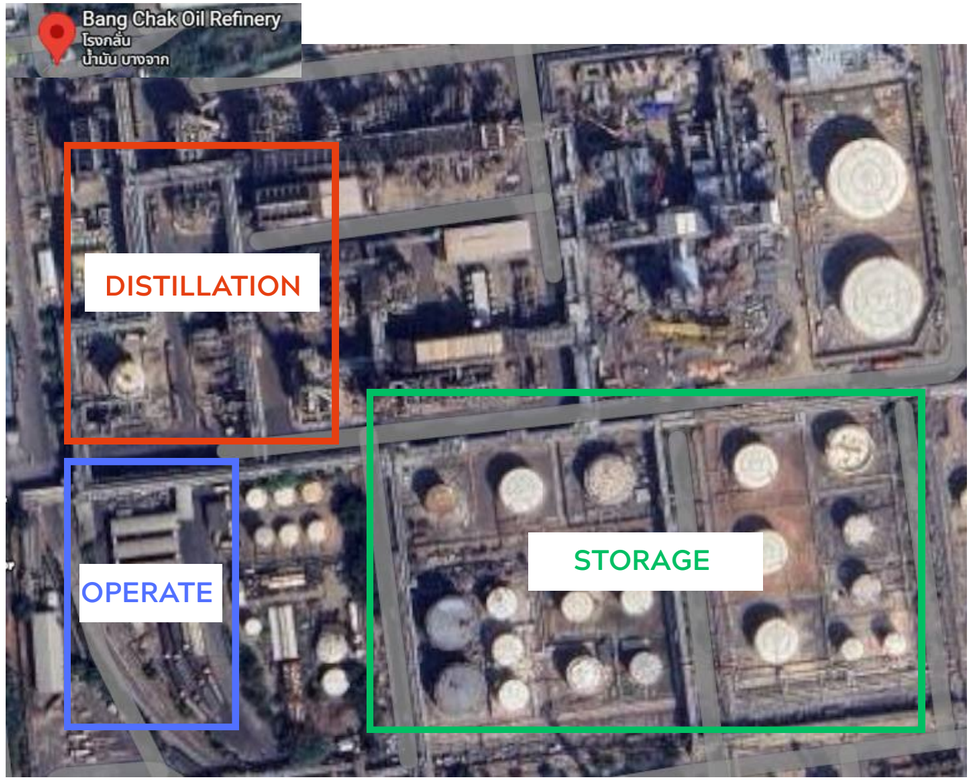


Figure :Plot Plant of a crude oil refinery plant



Thank you