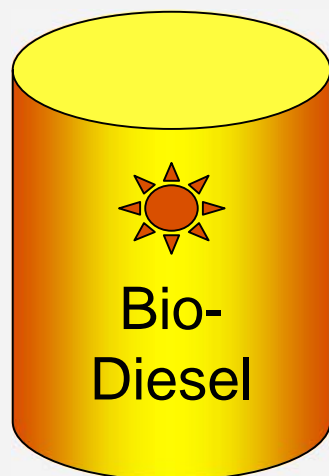


Biodiesel purification with Lewatit® Ion Exchange Resins

(Potential) Applications with Lewatit Ion Exchange Resins in Biodiesel Production

Catalysis of:

Esterification &
Transesterification



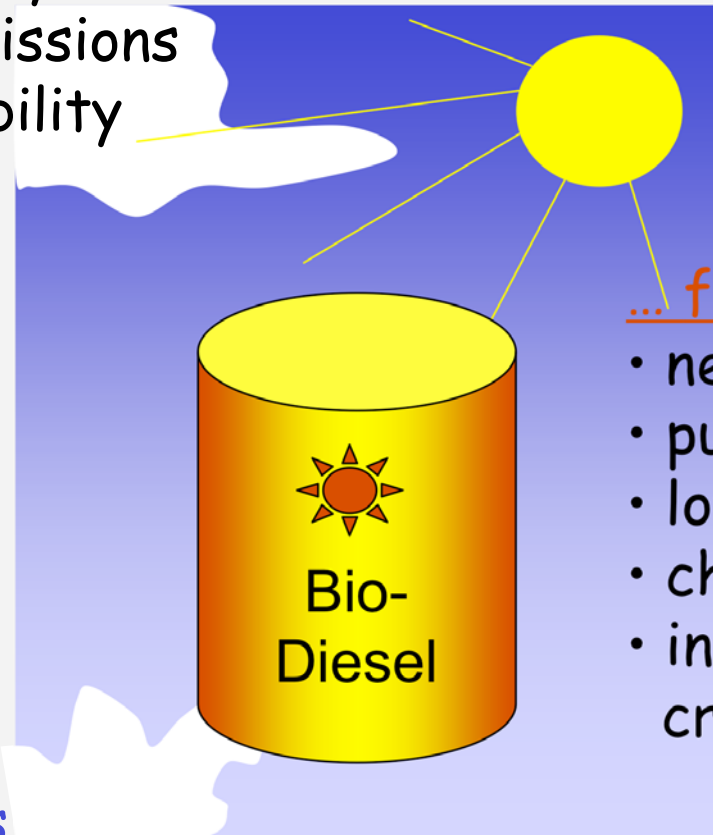
Removal of:

Glycerine &
Fatty Acids
KOH

Bio-Diesel-Advantages

... for environment

- CO₂-neutrality
- no sulfur-emissions
- bio-degradability
- reuse waste

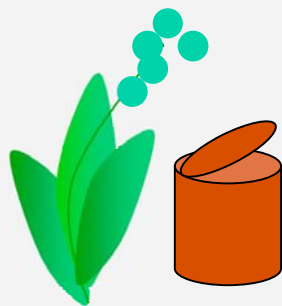


... for people

- new jobs
- push for agriculture
- low toxicity
- cheap fuel (?)
- independence from crude oil

... for engines

- high cetane number
- improved lubricant properties (save other additors)
- can be mixed with petrochemical diesel (up to 30%)



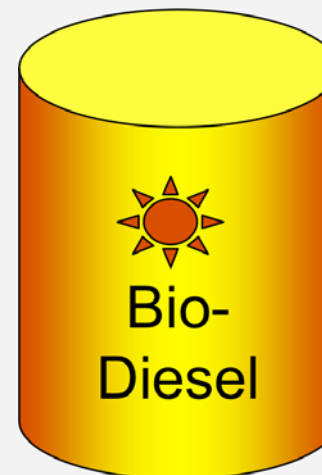
From Raw Materials to Bio-Diesel

e.g.: Palmtree Oil
Sunflower Oil,
Raps Oil,
Canola Oil,
Corn Oil,
Jatropha Nut Oil,
Soybean Oil,
Spent Cooking Oil,
Animal fats

....

- High viscosity
- Poor combustion properties

Bio-Diesel
Production
Process



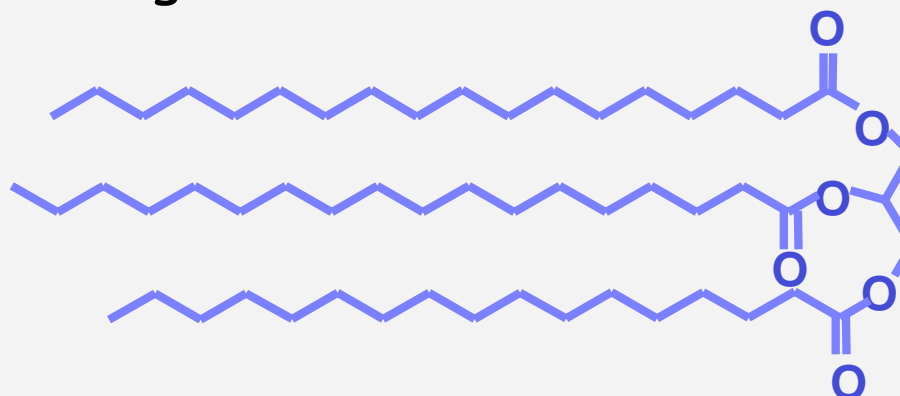
- Low viscosity
- Excellent combustion properties

Main Constituents of Raw Materials

**Triglycerides:
(Glycerine-Fatty-Acid-Esters)**

> 95%

e.g.:



Fatty-Acids:

< 5%

e.g.:



Others:

H₂O, Suspended Solids, Micelles,
Carbohydrates, Ash, ...

Bio-Diesel-Quality Standards

Property	ASTM Method	Limits	Units
Flash Point	93	100 min.	°C
Water&Sediment	2709	0.05 max	vol. %
Carbon Residue	4530	0.050 max	wt. %
Sulfated Ash	874	0.020 max	wt. %
Kin. Viscosity 40°C	445	1.9-6.0	mm_/sec.
Sulfur	5453	0.05 max	wt. %
Cetane	613	40 min	
Cloud Point	2500	by customer	°C
Copper Corrosion	130	No 3 max	
Acid Number	664	0.08 max	mg KOH/g
Free Glycerine	6584	0.02 max	wt. %
Total Glyderine	6584	0.240 max	wt. %



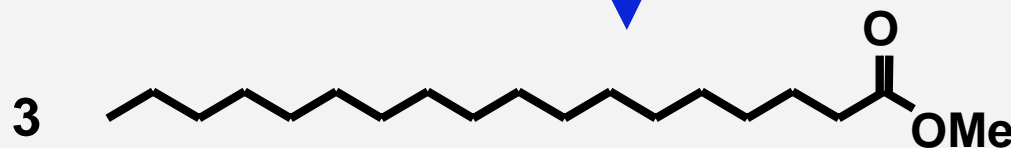
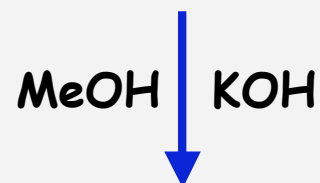
Chemistry of „Conventional“ Bio-Diesel Production

(Transesterification-Reaction)

e.g.:

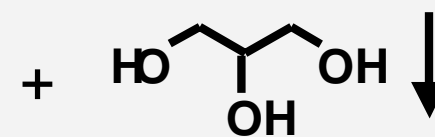


Triglyceride



Fatty-Acid-Methyl-Ester
(Biodiesel)

(hydrophobic)



Glycerine

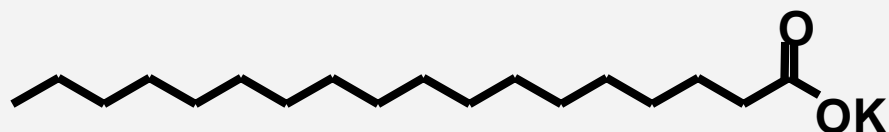
two
phases

(hydrophilic)

Chemistry of „Conventional“ Bio-Diesel Production

(Side-Reaction)

e.g.:



(Soap)
Fatty-Acid-Salt

(hydrophilic)

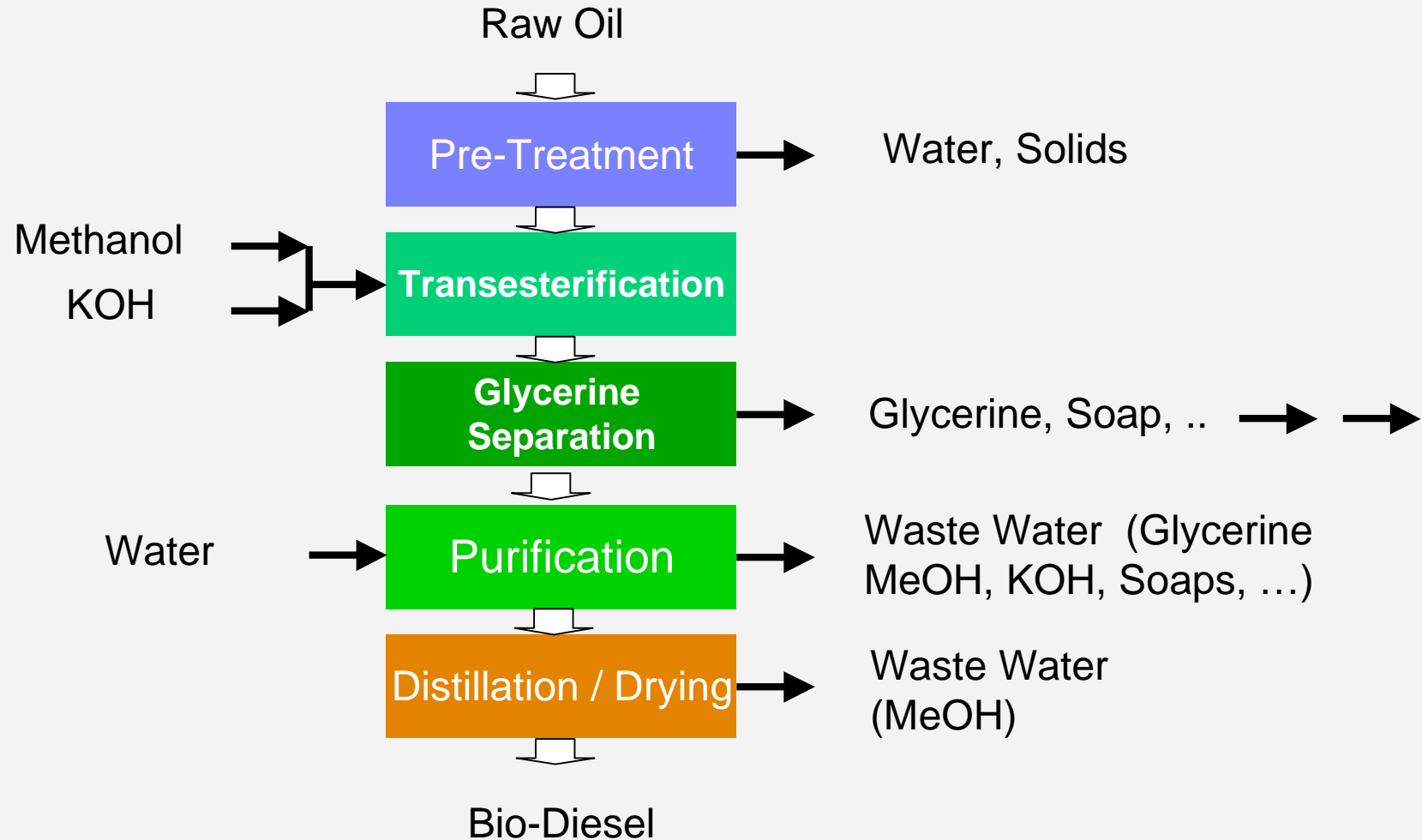
Disadvantages:

- loss of KOH for transesterification
- loss of fuel-yield
- emulsifying properties

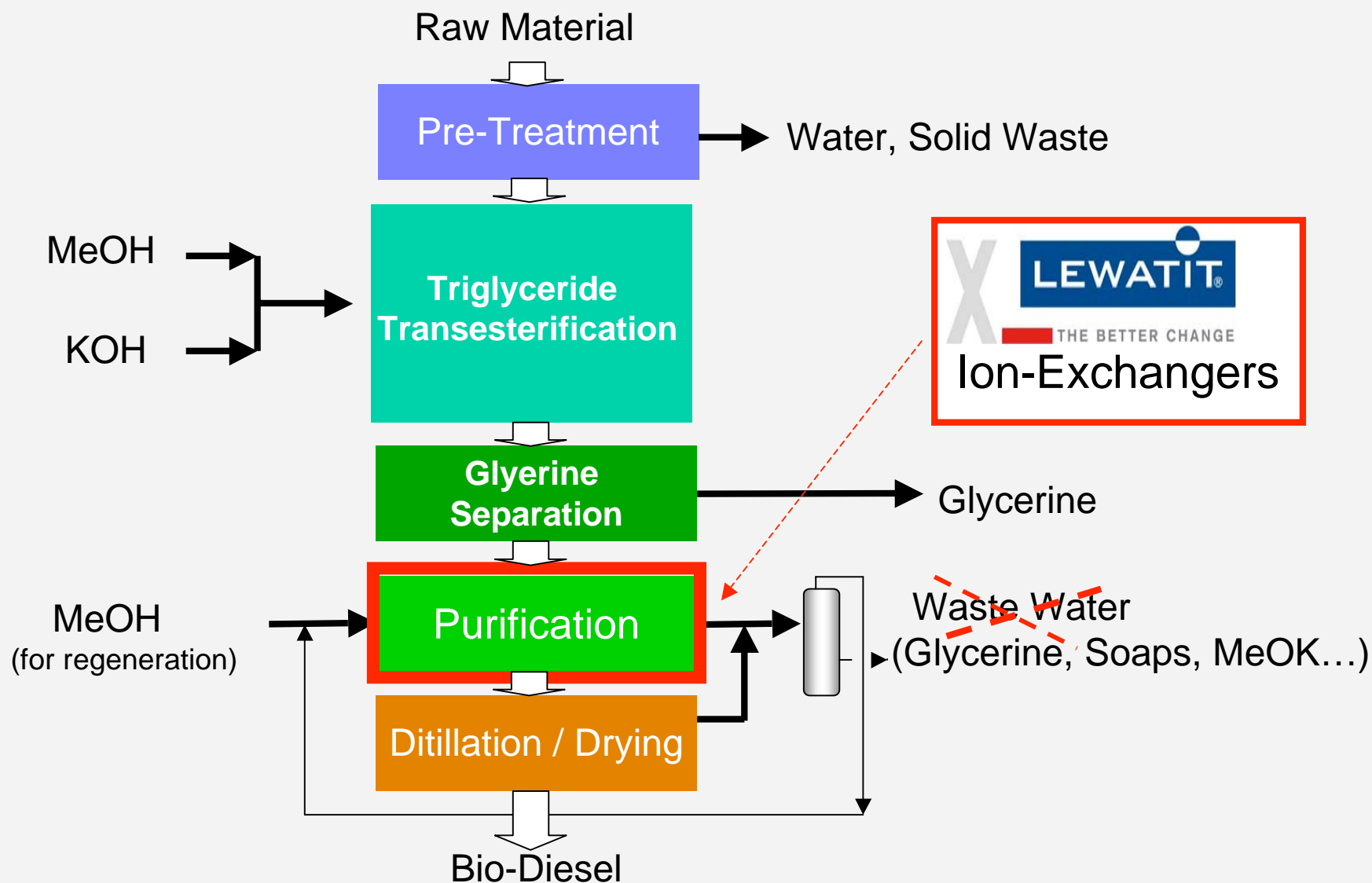


Common Bio-Diesel Production Process

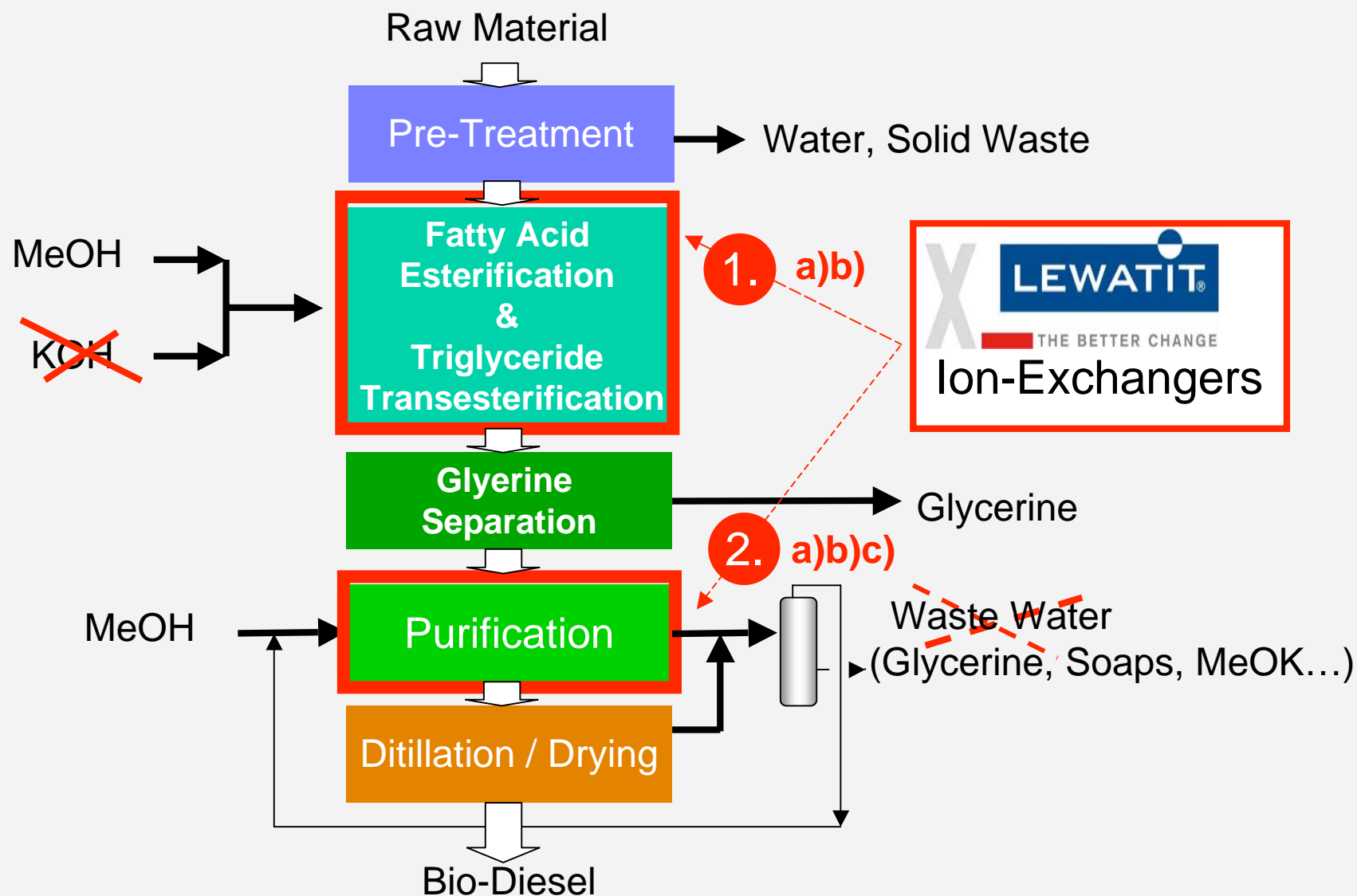
e.g.:



Potentials for Lewatit®-Ion Exchanges in Bio-Diesel Production Process



Potentials for Lewatit®-Ion Exchanges in Bio-Diesel Production Process



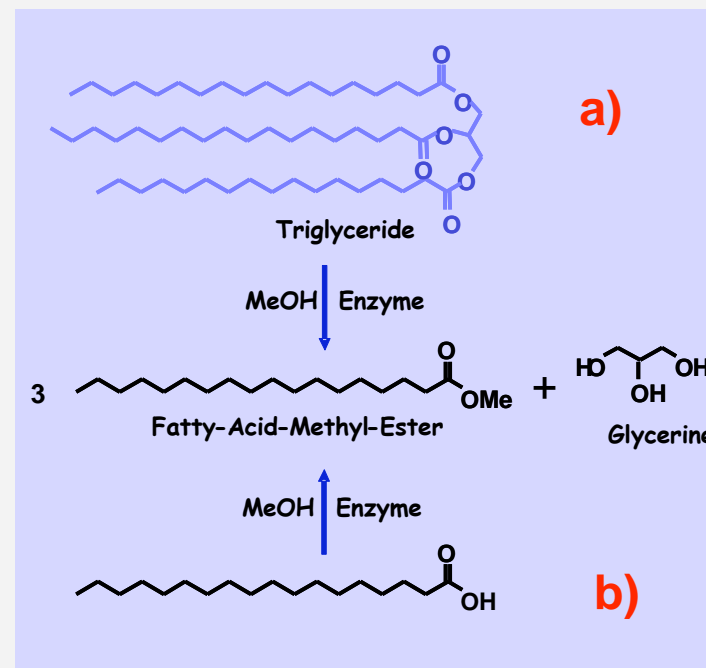
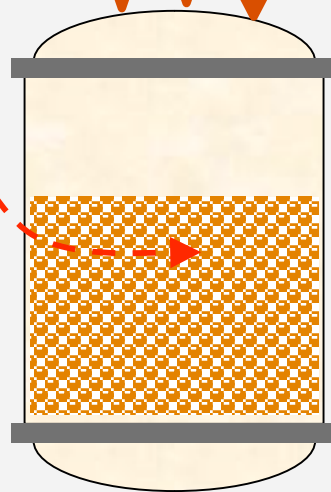
1. a)b) Catalytic Transesterification & Esterification

pre-treated raw material with triglycerides (>95%) and fatty acids (<5%)

Lipase Enzyme immobilized on **Lewatit® OC 1600**

MeOH

H₂O



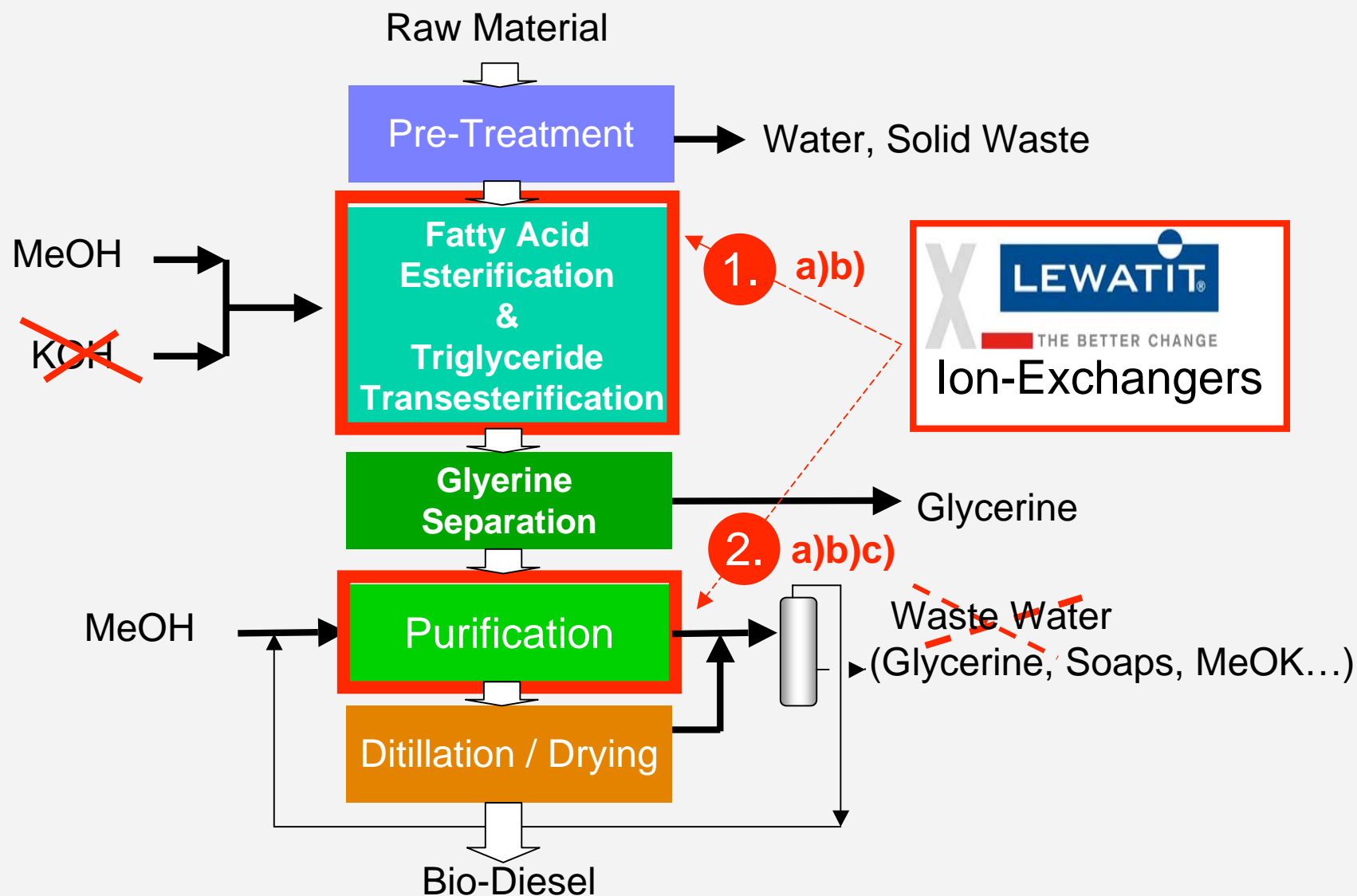
Operating Conditions:

Temperature:	35°C
LV:	0.4 BV/hr
Op. Capacity:	-
Throughput p.c.:	-
Regeneration:	-
Lifetime:	1 year

to glycerine removal
(10 - 15% free glycerine)
< 0.5 % fatty acids)

Reference: Hsu, A.C., Jones, K.C., Foglia, T.A., Marmer, W.N. : "Immobilized Lipase-Catalyzed Production Of Alkyl Esters Of Restaurant Grease As Biodiesel. Biotechnology Applied Biochemistry. 2002. V. 36. P. 181-186.

Potentials for Lewatit®-Ion Exchanges in Bio-Diesel Production Process



2. a)b)

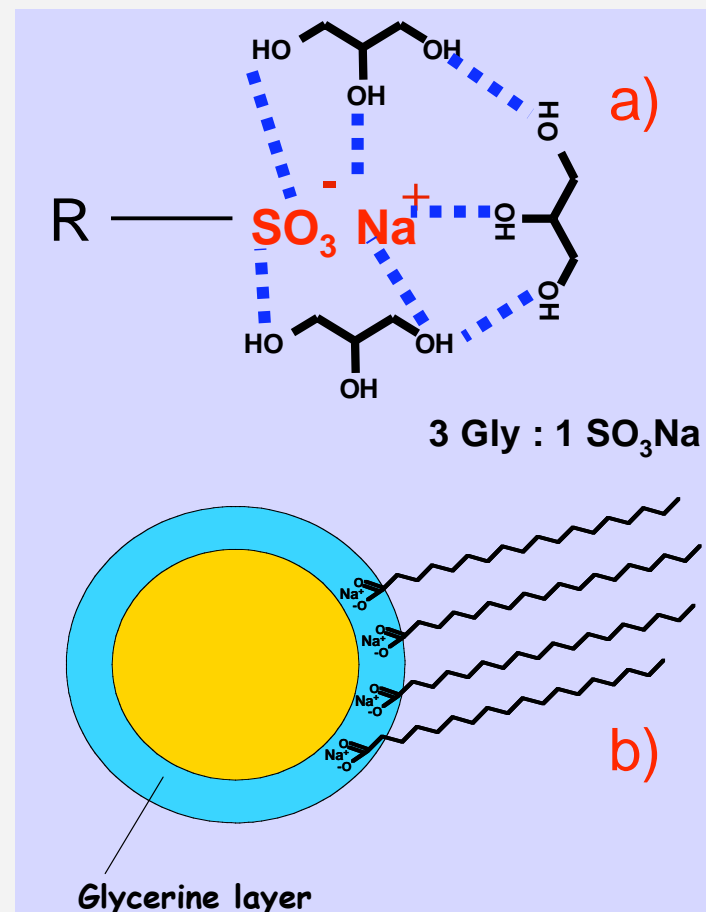
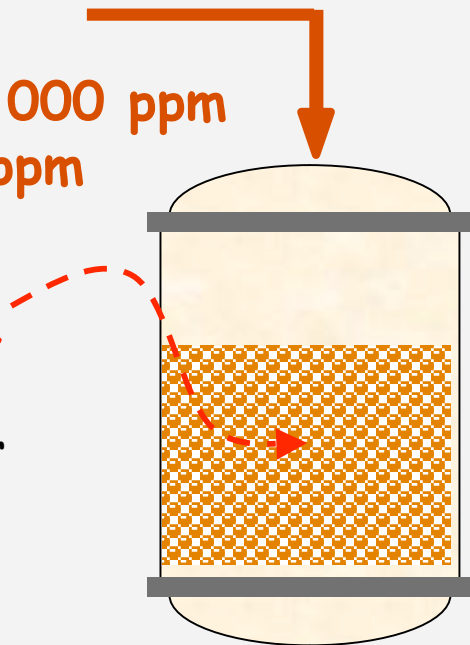
Removal of glycerine and soap

Biodiesel from phase separation
glycerine: 600...1000 ppm
soap: 10 - 100 ppm

Lewatit® K 2567
(Makroporous Strongly Acidic Cation Exchanger Resin in Na-form)

Operating Conditions:

Temperature:	30°C - 40°C
LV:	1.5 - 2 BV/hr
Op. Capacity:	180 g/L Glycerine
Throughput p.c.:	> 300 BV
Regeneration:	MeOH @ 20-35°C
Resin life (av.):	30 months



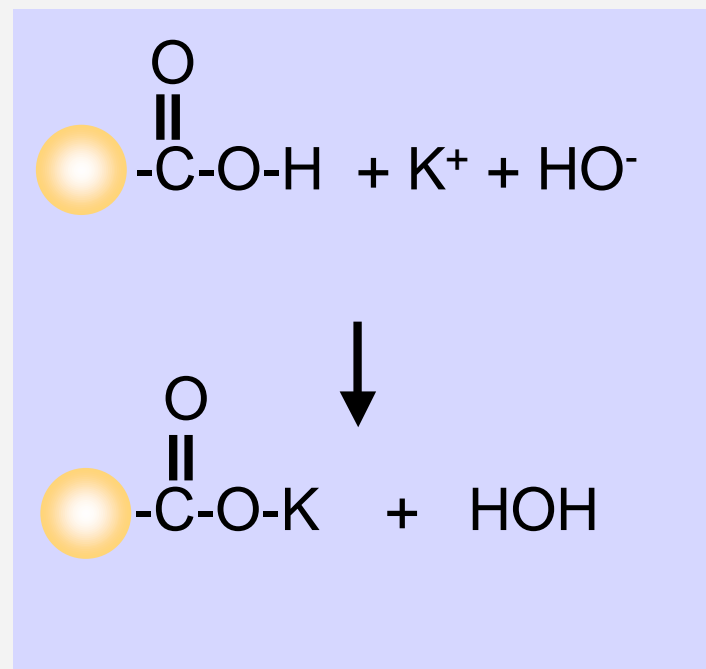
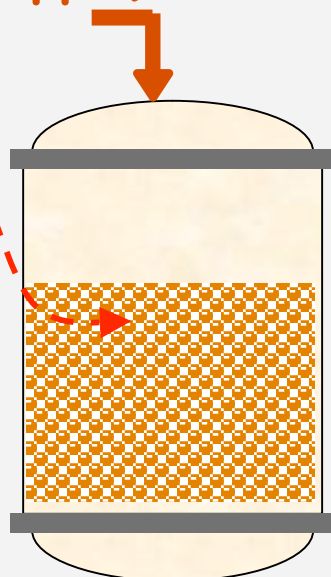
refined biodiesel
glycerine < 10 ppm
soap < 5 ppm

2. c)

Removal/Adsorption of KOH *

Biodiesel after glycerine removal
containing KOH (<1000 ppm)

Lewatit® CNP 80
(Weakly Acidic Cation
Resin in H-form)



Operating Conditions:

Pretreatment:	MeOH
Temperature:	30°C - 40°C
LV:	1.5 - 2 BV/h
Op. Capacity:	60 g/L K ⁺
Throughput p.c.:	> 50 BV
Regeneration:	MeOH / H ₂ SO ₄

Biodiesel
KOH < 5 ppm

*) application only applied for
classical KOH-catalysis

Advantages of Using Ion-Exchange in Bio-Diesel Production

1. Fatty Acid Esterification by IX-Enzyme Catalysis:

- a)
 - Up to 5% more yield of Biodiesel
 - Improved phase separation
 - Improved purity of glycerine
 - Reduction of organic waste contributing to Waste Water

1. Transesterification by IX-Enzyme Catalysis :

- b)
 - No later KOH removal from Biodiesel required
 - Moderate Operating Conditions
 - Significant Color Reduction

2. Biodiesel Purification by IX-Adsorption:

- a)
 - Reduction of Waste Water (nearly zero emission)
- b)
 - No liquid/liquid phase separation / no centrifuges
- c)
 - Less water in biodiesel to be removed in drying step
 - Higher purity of end product
 - Recovery and Recycling of Methanole in following distillation

References: Lewatit® Ion Exchangers in Bio-Diesel Production

references for glycerine and soap removal only:

Company	Country	K 2567 (m3)	Biodiesel (tpa)
Dico Saipol	France	12	150,000
Sofi Proteol	France	30	375,000
Novaol	Italy	20	250,000
Bakelite (Oil.B)	Italy	24	120,000



- Biodiesel has several advantages over petrol diesel, thus is of growing interest
- Lewatit® ion exchangers can be used at different process steps of innovative biodiesel production
- Two operating principles: catalysis / adsorption
- Use of ion exchangers has diverse advantages compared to conventional processing
- Several Biodiesel plants already use Lewatit® ion exchangers (mainly for adsorption of impurities)
- Technology / Market under fast development



For further discussions we kindly invite you to the
ÖKOTEK-Stand at F-12

Backup

OEM's and Licence Sources in Biodiesel Market

Lurgi	{	100 000 – 400 000 tpy
AAXENS-IFP		
Sunho-Biodiesel		
AT-Agrartechnik		
Cimbrea SKET		
BDI		

Bio-King	{	30 000 – 40 000 tpy
...		
....		

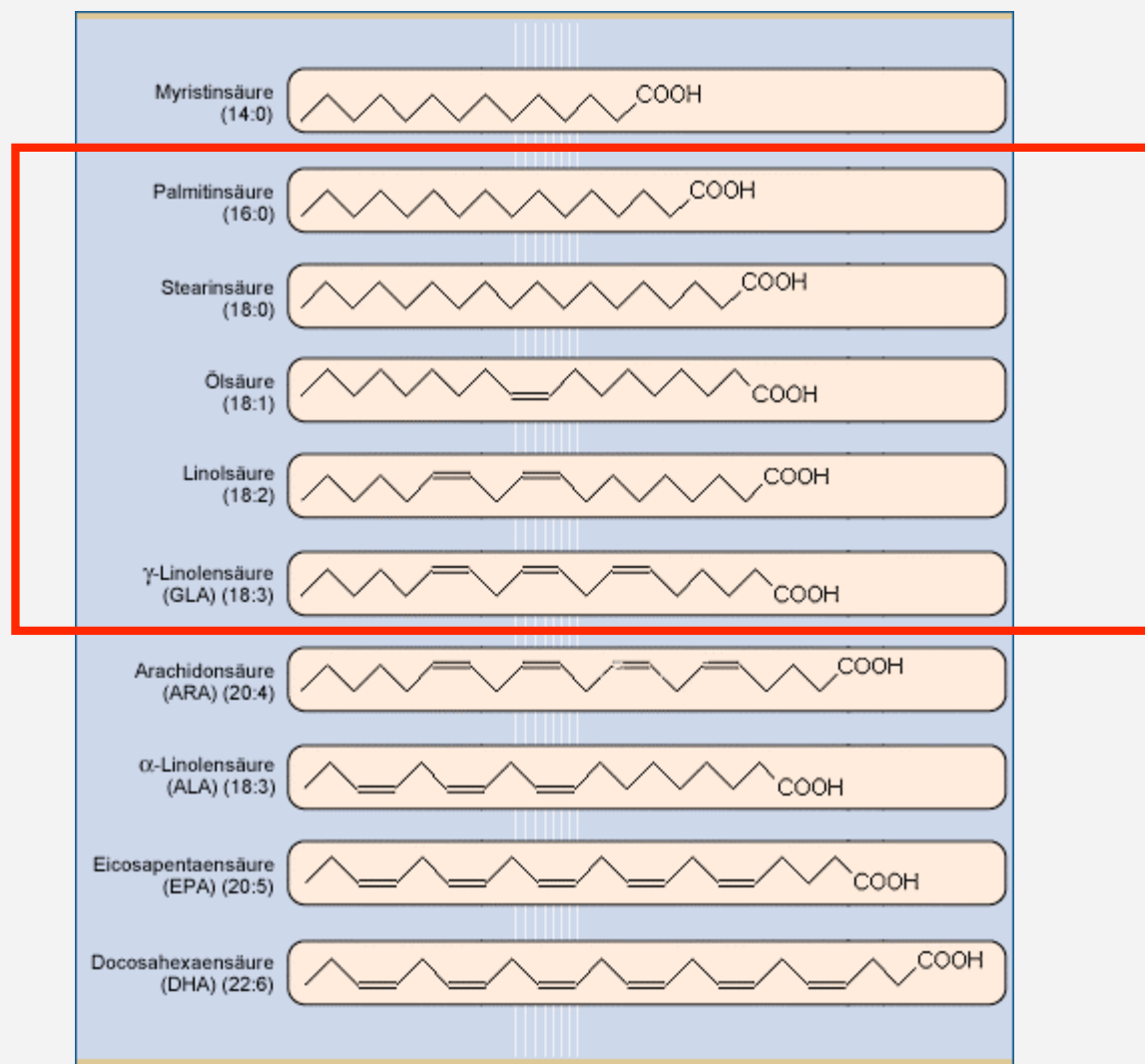
Biodiesel Purification with Lewatit® Ion Exchange Resins

- Pressure drop calculation -

$$DP = h \text{ (m)} * m/h * \text{vel-factor} * DP\text{-Factor} * \text{viscosity}$$

Resin bed	Throughput	Factors																
	<p>Liquid Me - oleate</p> <table border="0"> <tr> <td>cbm / h</td> <td>cbm / h</td> </tr> <tr> <td></td> <td>4.000</td> </tr> <tr> <td>BV / h</td> <td>BV / h</td> </tr> <tr> <td>2.000</td> <td>2.000</td> </tr> <tr> <td>m/h</td> <td>m/h</td> </tr> <tr> <td></td> <td>2.000</td> </tr> </table>	cbm / h	cbm / h		4.000	BV / h	BV / h	2.000	2.000	m/h	m/h		2.000	<p>T (°C) 40</p> <p>Vel.-Factor 1.00</p> <p>DP-Factor (/cm/cm/h) 1.100</p> <p>Visc. (cP) 4.81</p>				
cbm / h	cbm / h																	
	4.000																	
BV / h	BV / h																	
2.000	2.000																	
m/h	m/h																	
	2.000																	
<table border="1"> <tr><td>Nozzles / m²</td><td>80</td></tr> <tr><td>Nozzle number</td><td>160</td></tr> <tr><td>cm² / Nozzle</td><td>1,68 KSE Typ V</td></tr> <tr><td>Total cm²</td><td>268,80</td></tr> <tr><td>Total m²</td><td>,027</td></tr> <tr><td>Nozzle slits</td><td>0,2 mm / 79 mesh</td></tr> </table>	Nozzles / m ²	80	Nozzle number	160	cm ² / Nozzle	1,68 KSE Typ V	Total cm ²	268,80	Total m ²	,027	Nozzle slits	0,2 mm / 79 mesh	<p>Pressure drop (bar = kg/cm²) :</p> <table border="1"> <tr><td>.11</td></tr> <tr><td>1.53 psi</td></tr> <tr><td>.47 psi/ft</td></tr> <tr><td>10.56 k Pas</td></tr> </table>	.11	1.53 psi	.47 psi/ft	10.56 k Pas	
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Fatty Acids Overview

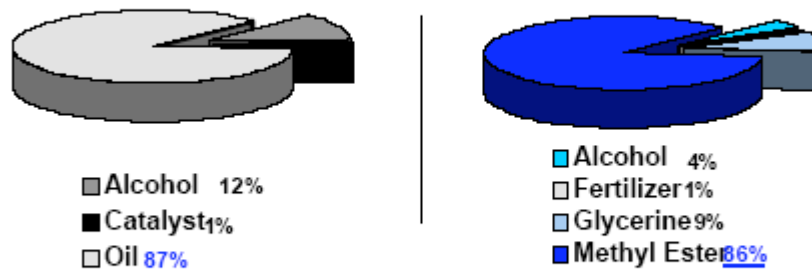


these fatty acids are found in Biodiesel raw products

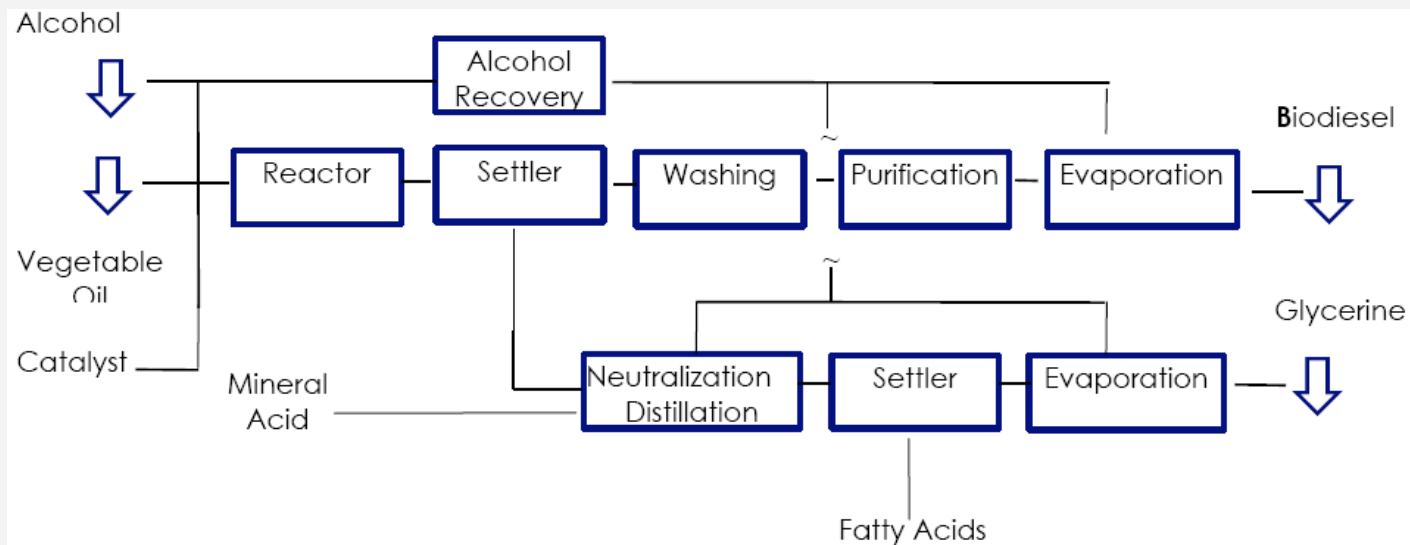


Plant Concept & Mass Flows

Process Input Levels = Process Output Levels

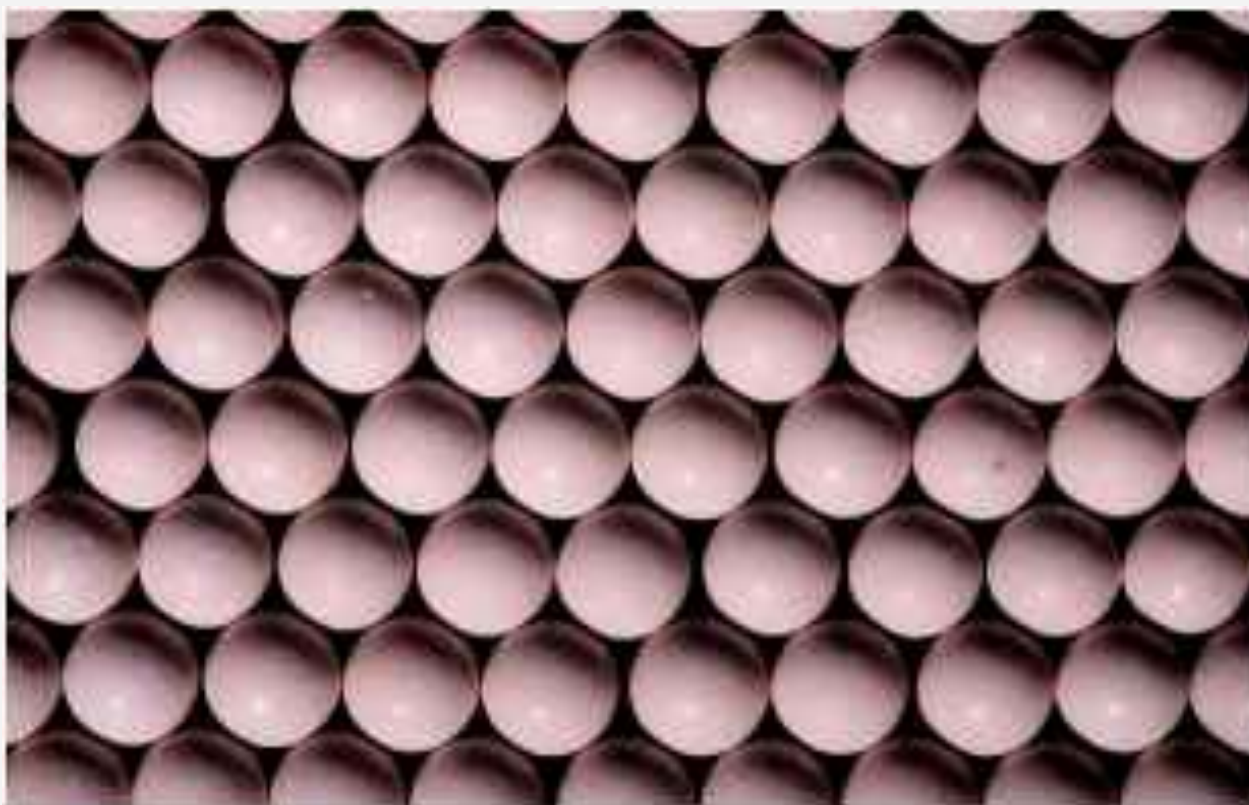


Nothing is wasted



Biodiesel Purification with Lewatit® Ion Exchange Resins - Removal of Glycerine -

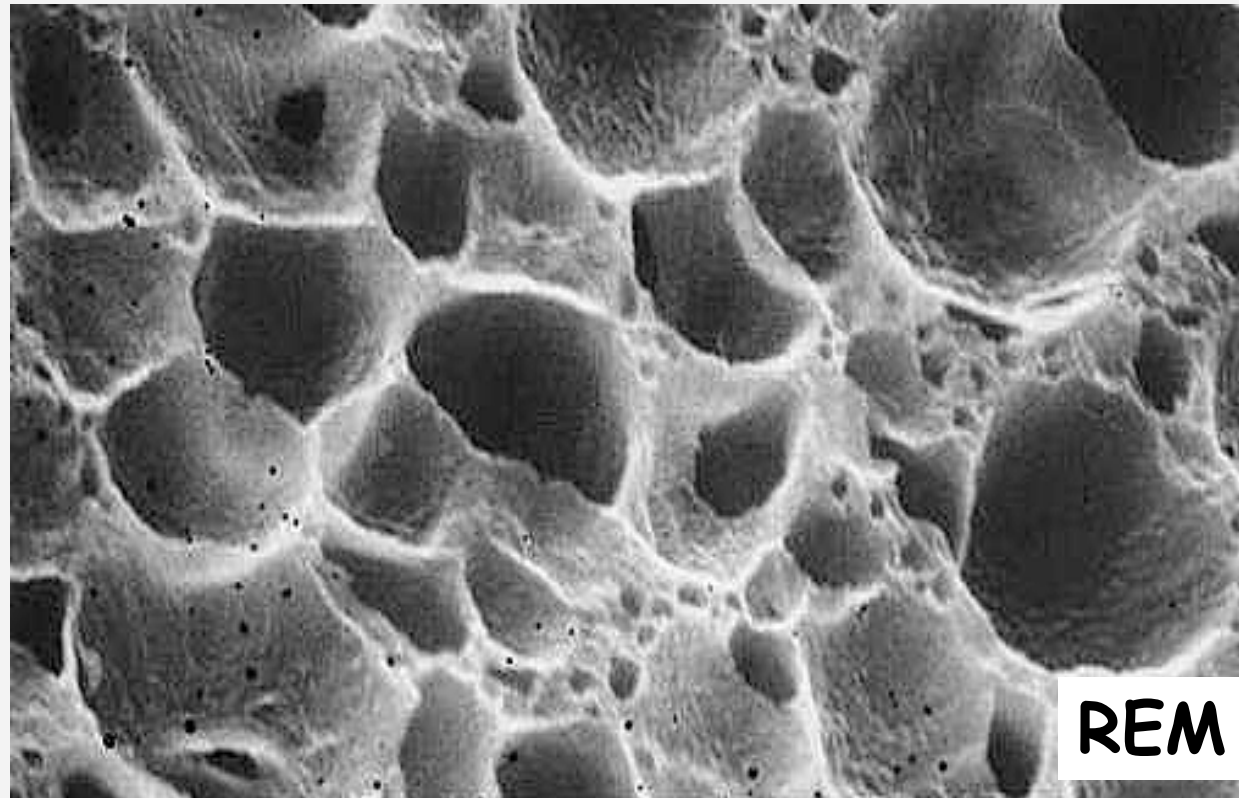
Lewatit MonoPlus SP 112



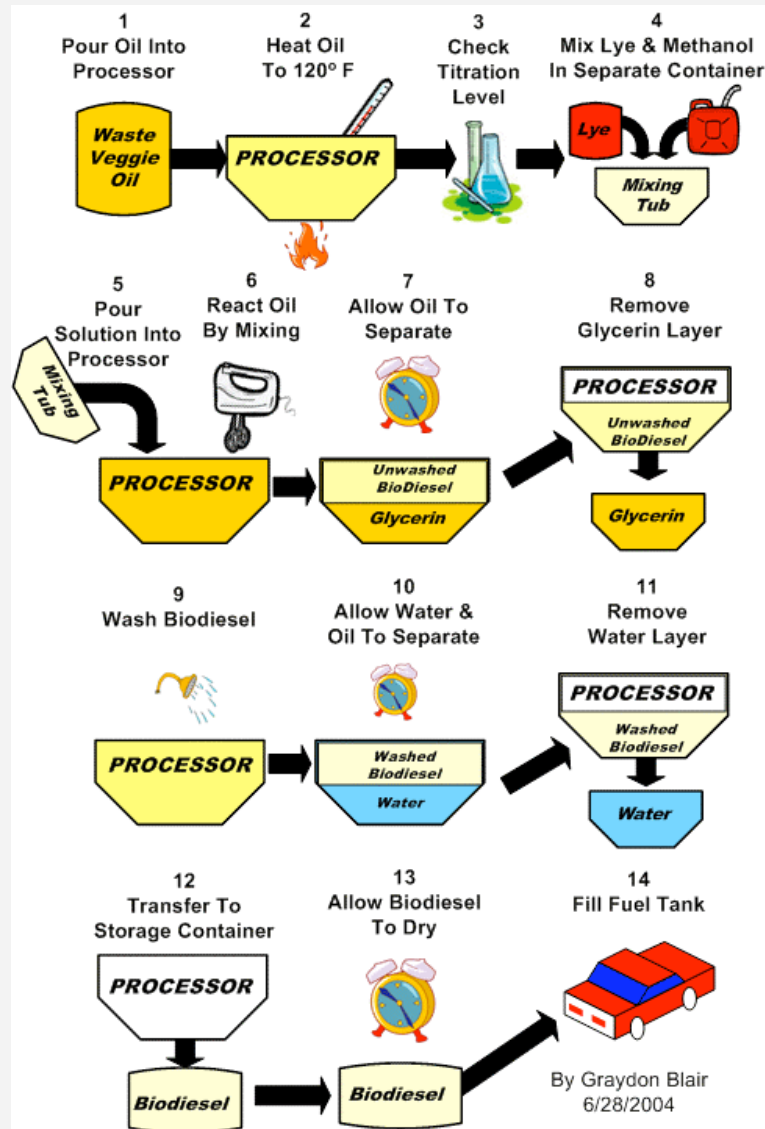
Hexagonal packing

Biodiesel Purification with Lewatit® Ion Exchange Resins - Removal of Glycerine -

SP 112 "sponge-structure"



Do-it-yourself-recipe



Methyl-Esters layer

Glycerine layer

Example for Plant Design

**Quantity of Lewatit MonoPlus SP 112
required for the glycerine removal
in a 200.000 to./ a biodiesel plant:**

20.000 Liters (15 Tons)

Average resin lifetime: 30 months

Biodiesel Purification with Lewatit® Ion Exchange Resins

Additional Information

www.lewatit.de

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