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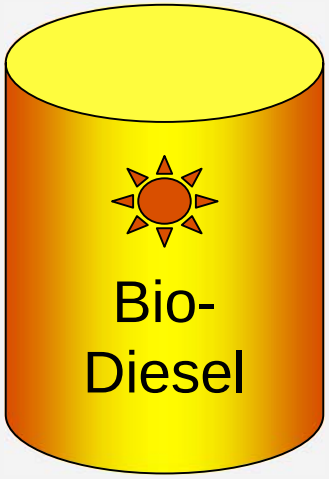
Biodiesel purification with Lewatit® Ion Exchange Resins

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



Catalysis of:

Esterification &
Transesterification

Removal of:

Glycerine &
Fatty Acids
KOH

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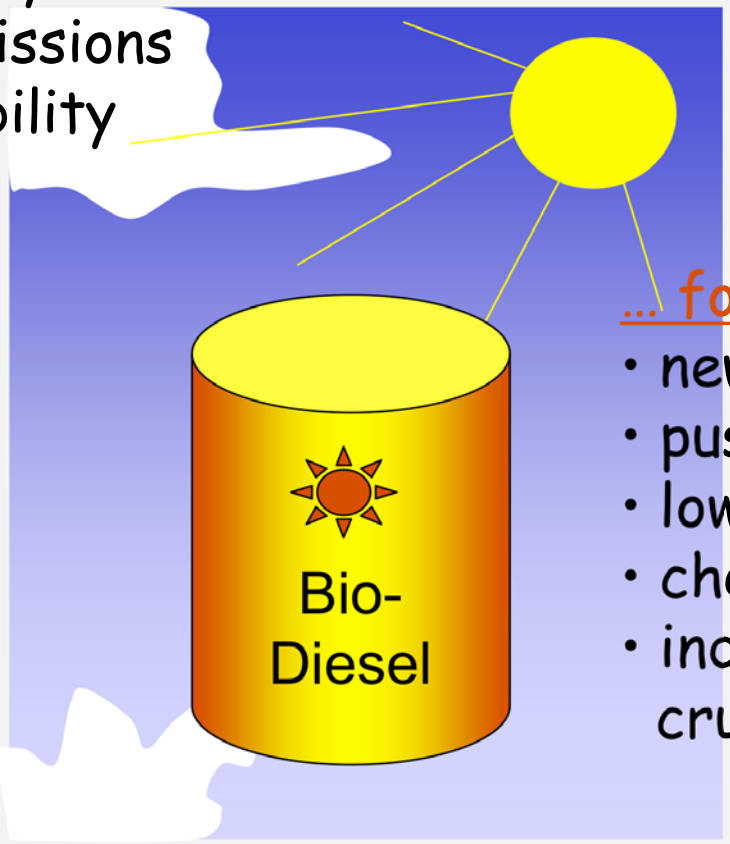
Bio-Diesel-Advantages

… for environment

- CO_2-neutrality
- no sulfur-emissions
- bio-degradability
- reuse waste



… for people

- new jobs
- push for aggriculture
- 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%)

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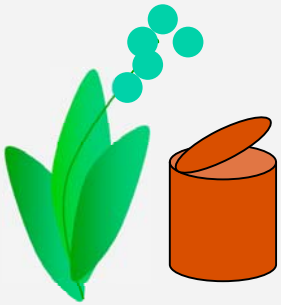
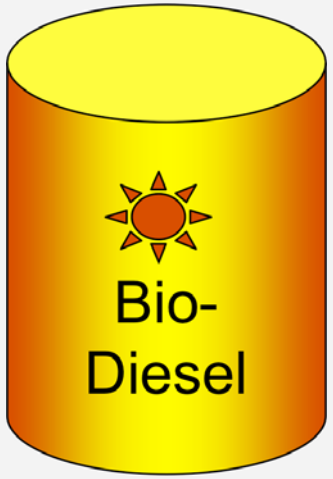
From Raw Materials to Bio-Diesel



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

Bio-Diesel Production Process



- High viscosity
- Poor combustion properties

- Low viscosity
- Excellent combustion properties

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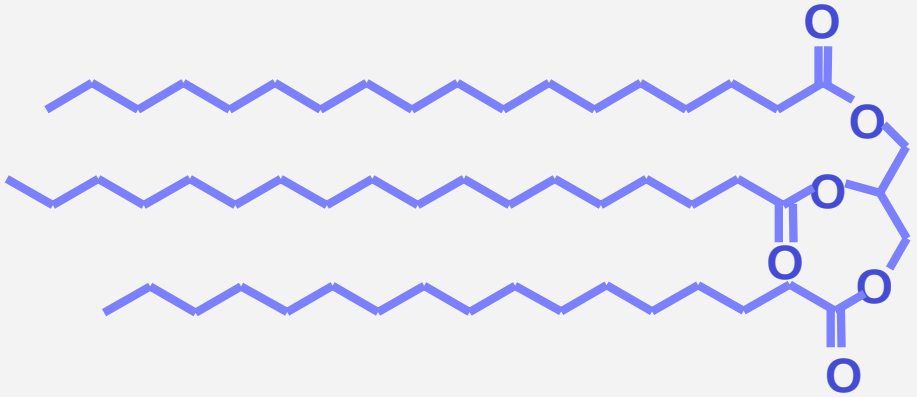
Main Constituents of Raw Materials

Triglycerides:
(Glycerine-Fatty-Acid-Esters)

> 95%

e.g.:



Fatty-Acids:

< 5%

e.g.:

Others:

H_2O, Suspended Solids, Micelles, Carbohydrates, Ash, …

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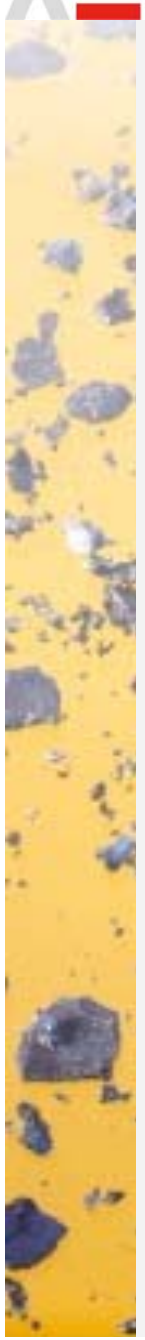
Bio-Diesel-Quality Standards



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. %

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Chemistry of „Conventional" Bio-Diesel Production

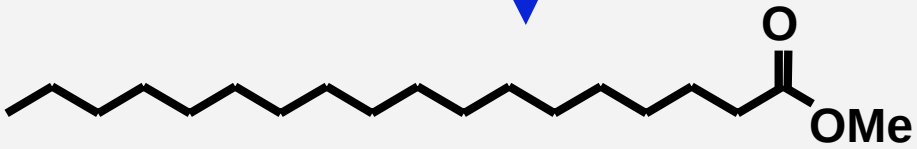
(Transesterification-Reaction)

e.g.:

Triglyceride

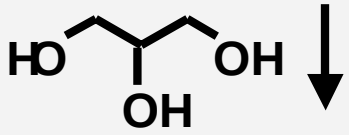
MeOH | KOH

3



Fatty-Acid-Methyl-Ester
(Biodiesel)

+



Glycerine

(hydrophobic) ⟷ two phases ⟷ (hydrophilic)

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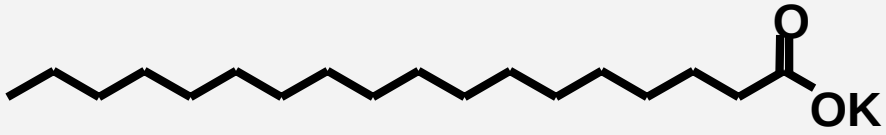
Chemistry of „Conventional" Bio-Diesel Production

(Side-Reaction)

e.g.:

KOH



+ H_2O

(Soap)
Fatty-Acid-Salt

(hydrophilic)

Disadvantages:

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

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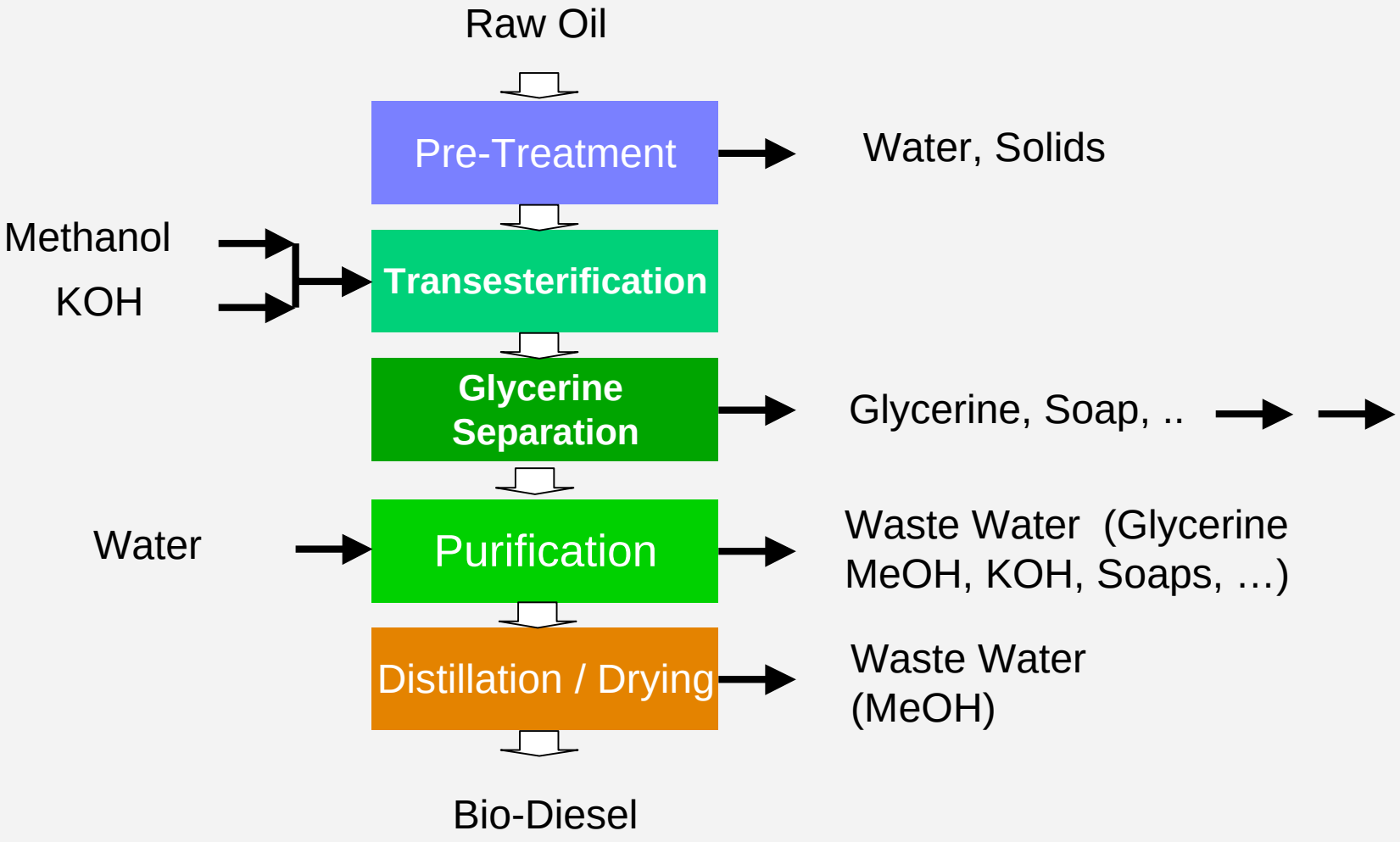
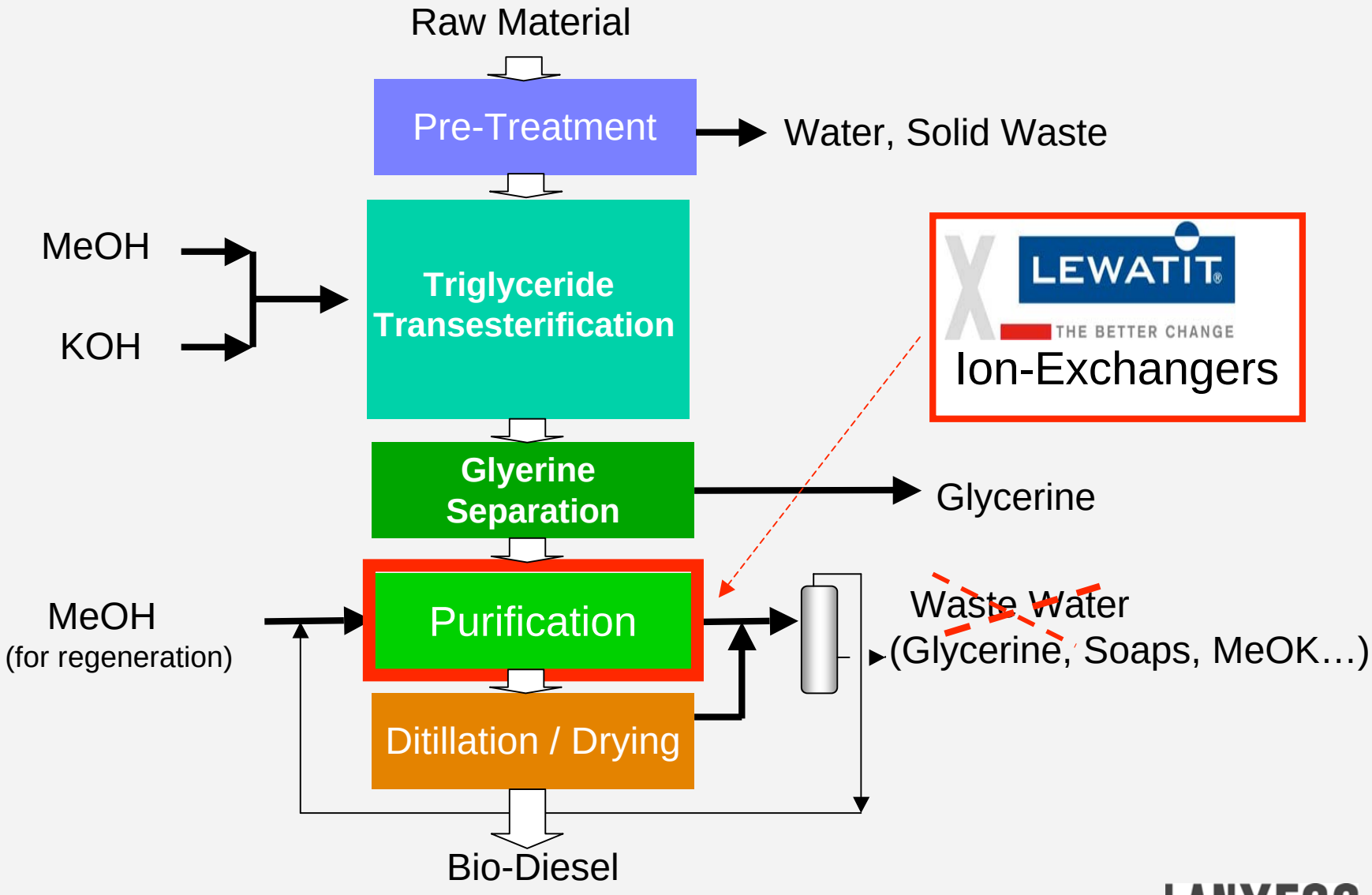
Common Bio-Diesel Production Process

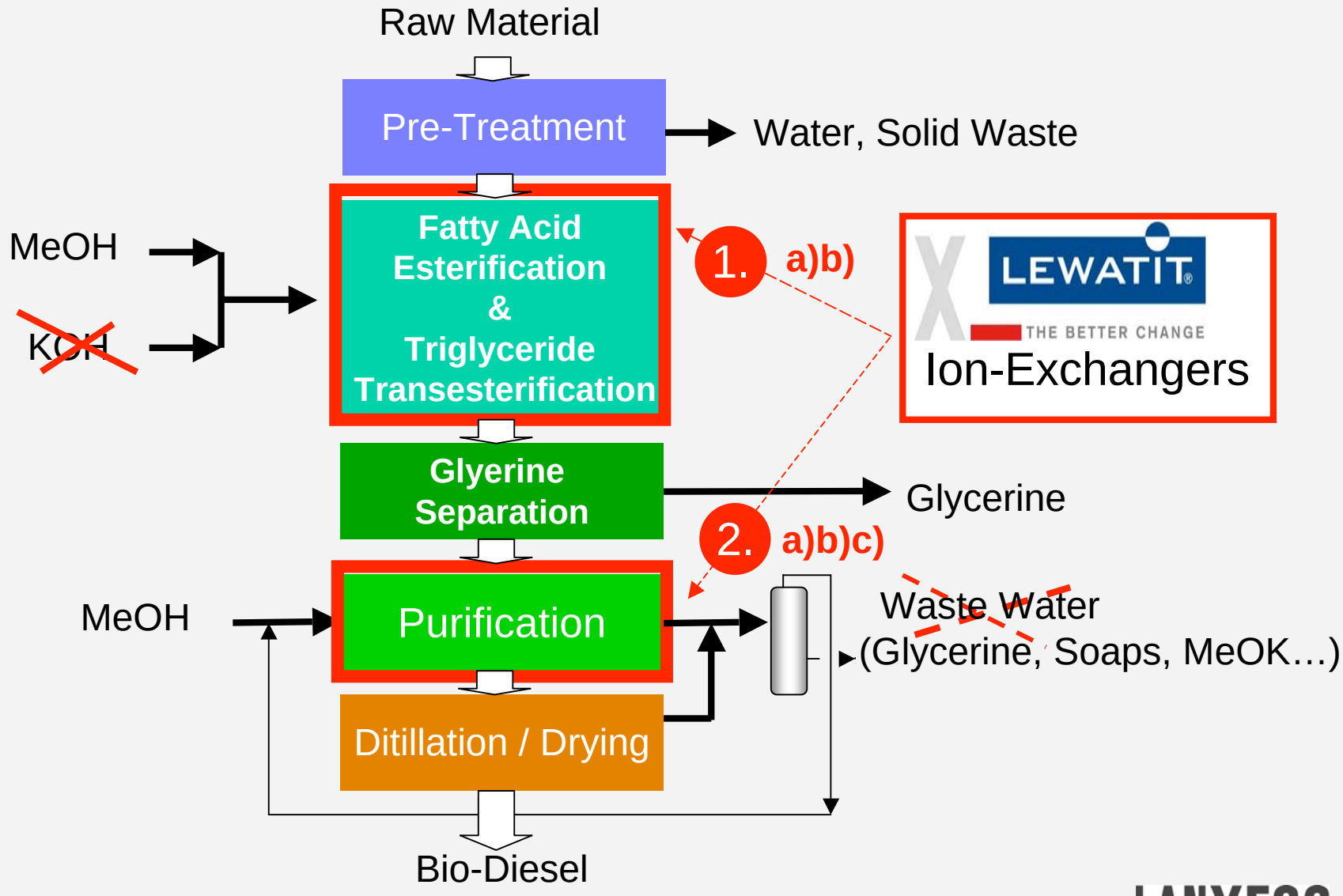
e.g.:



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



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



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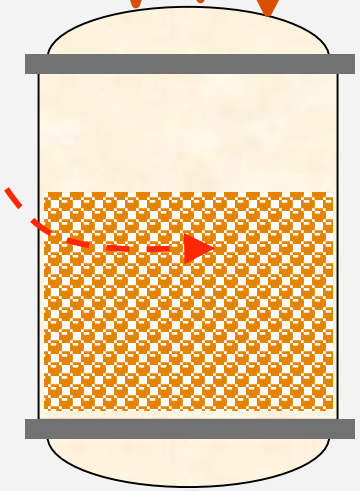
1. a)b) Catalytic Transesterifaction & Esterification

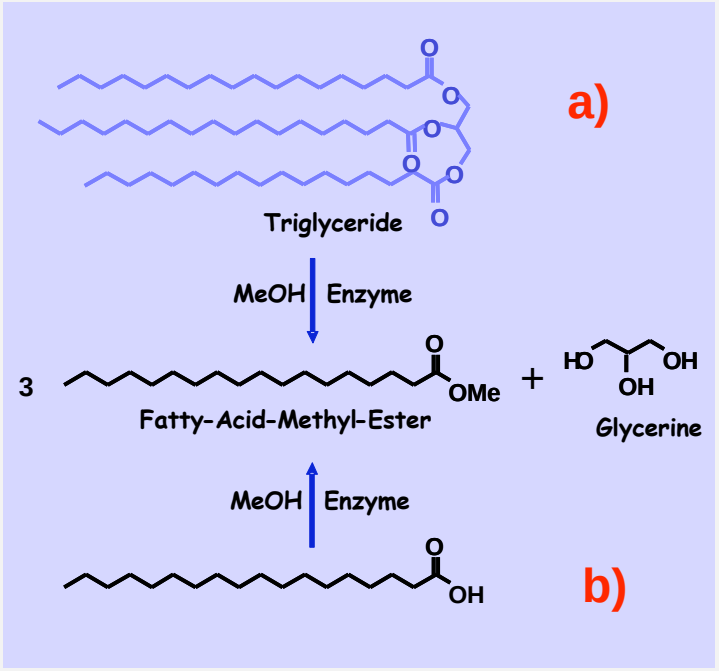
pre-treated
raw material
with triglycerdides (>95%)
and fatty acids (<5%)

MeOH

H_2O



Lipase Enzyme
immobilized on
Lewatit® OC
1600



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.

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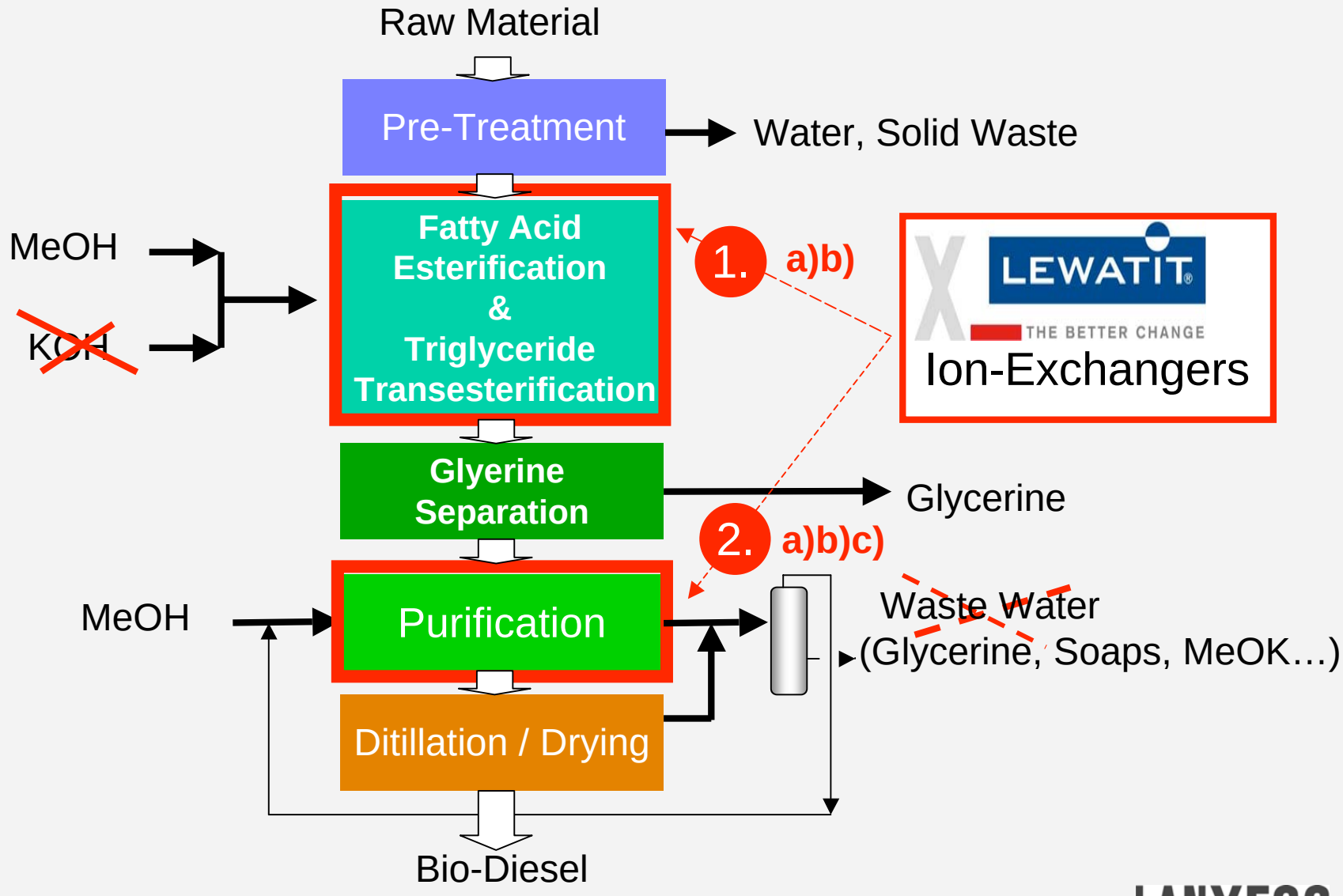
Potentials for Lewatit®-Ion Exchanges in Bio-Diesel Production Process



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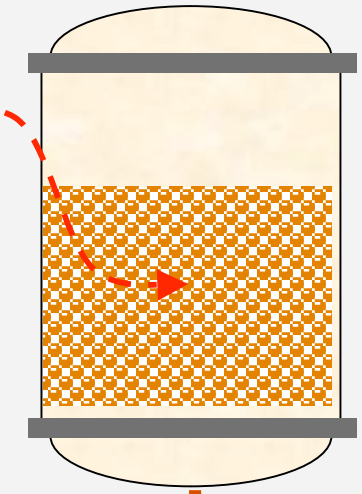
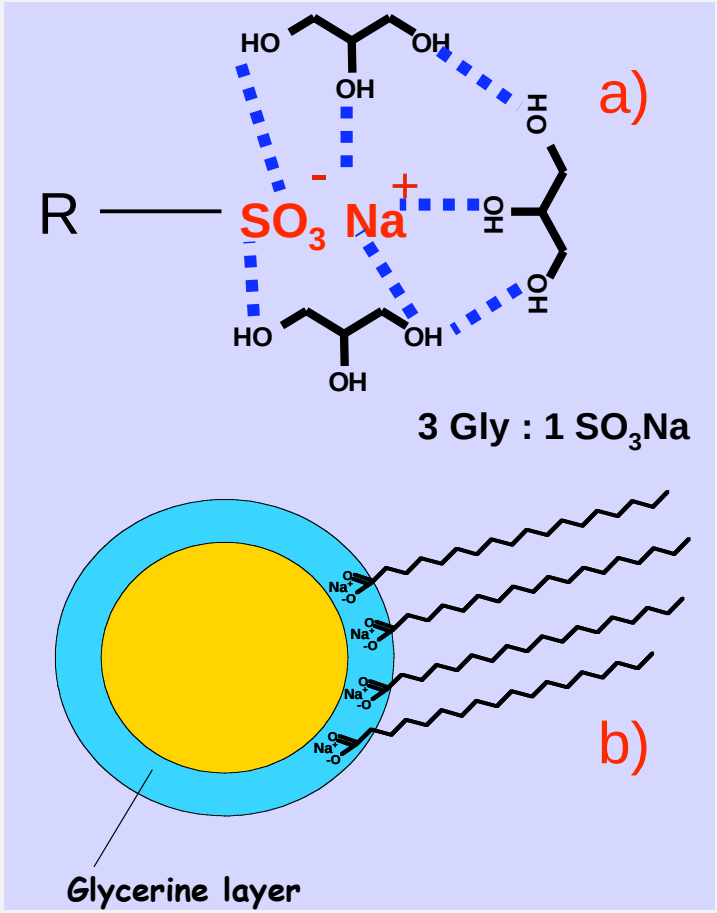
2. a)b) Removal of glycerine and soap

Biodiesel from phase separation
glycerine: 600…1000 ppm
soap: 10 – 100 ppm

Lewatit® K 2567
(Makropourus 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

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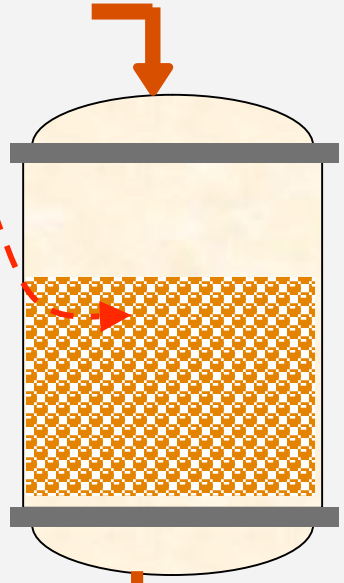
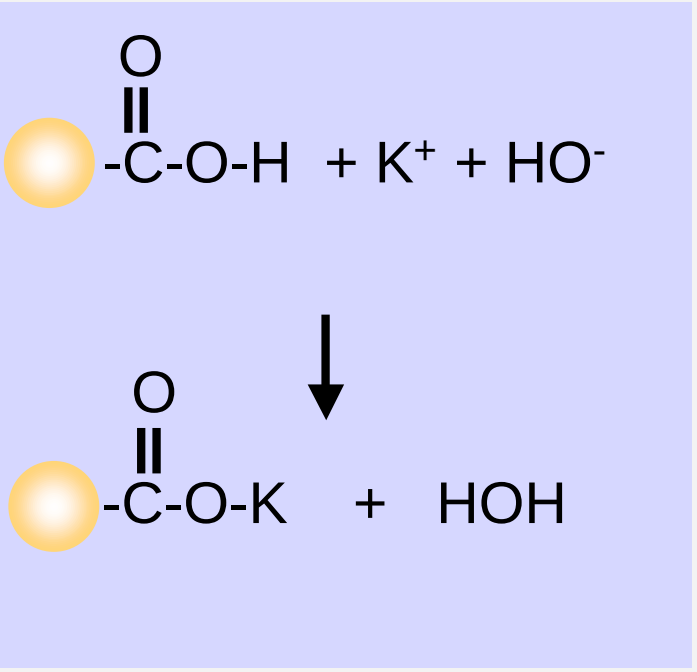
2. c) Removal/Adsorption of KOH *

Biodiesel after glyerine removal containing KOH (<1000 ppm)

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





Biodiesel
KOH < 5 ppm

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_2SO_4

*) application only applied for classical KOH-catalysis

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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

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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

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Conclusion / Summary

- 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

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

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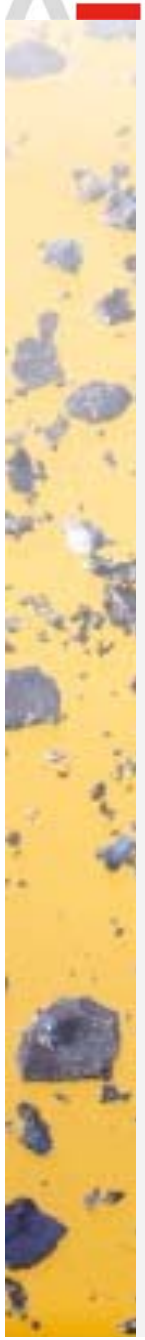

Backup

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OEM‘s and Licence Sources in Biodiesel Market

Lurgi AAXENS-IFP Sunho-Biodiesel AT-Agrartechnik Cimbrea SKET BDI	100 000 – 400 000 tpy
Bio-King … ….	30 000 – 40 000 tpy

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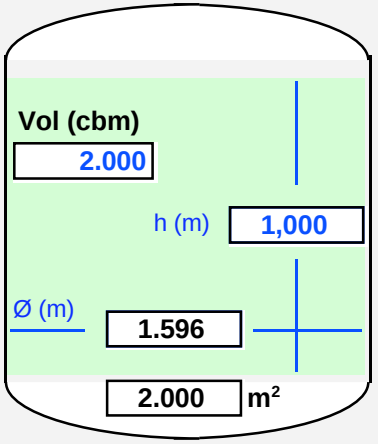
Biodiesel Purification with Lewatit® Ion Exchange Resins
- Pressure drop calculation -

DP = h (m) * m/h * vel-factor *DP-Factor * viscosity

Resin bed



Throughput

Liquid	Me - oleate	
cbm / h		4.000
BV / h	2.000	2.000
m/h		2.000

Factors

T (°C)	40
Vel.-Factor	1.00
DP-Factor (/cm/cm/h)	1.100
Visc. (cP)	4.81

Nozzles / m²	80
Nozzle number	160
cm² / Nozzle	1,68 KSE Typ V
Total cm²	268,80
Total m²	,027
Nozzle slits	0,2 mm / 79 mesh

Pressure drop (bar = kg/cm2) :

.11	
1.53	psi
.47	psi/ft
10.56	k Pas

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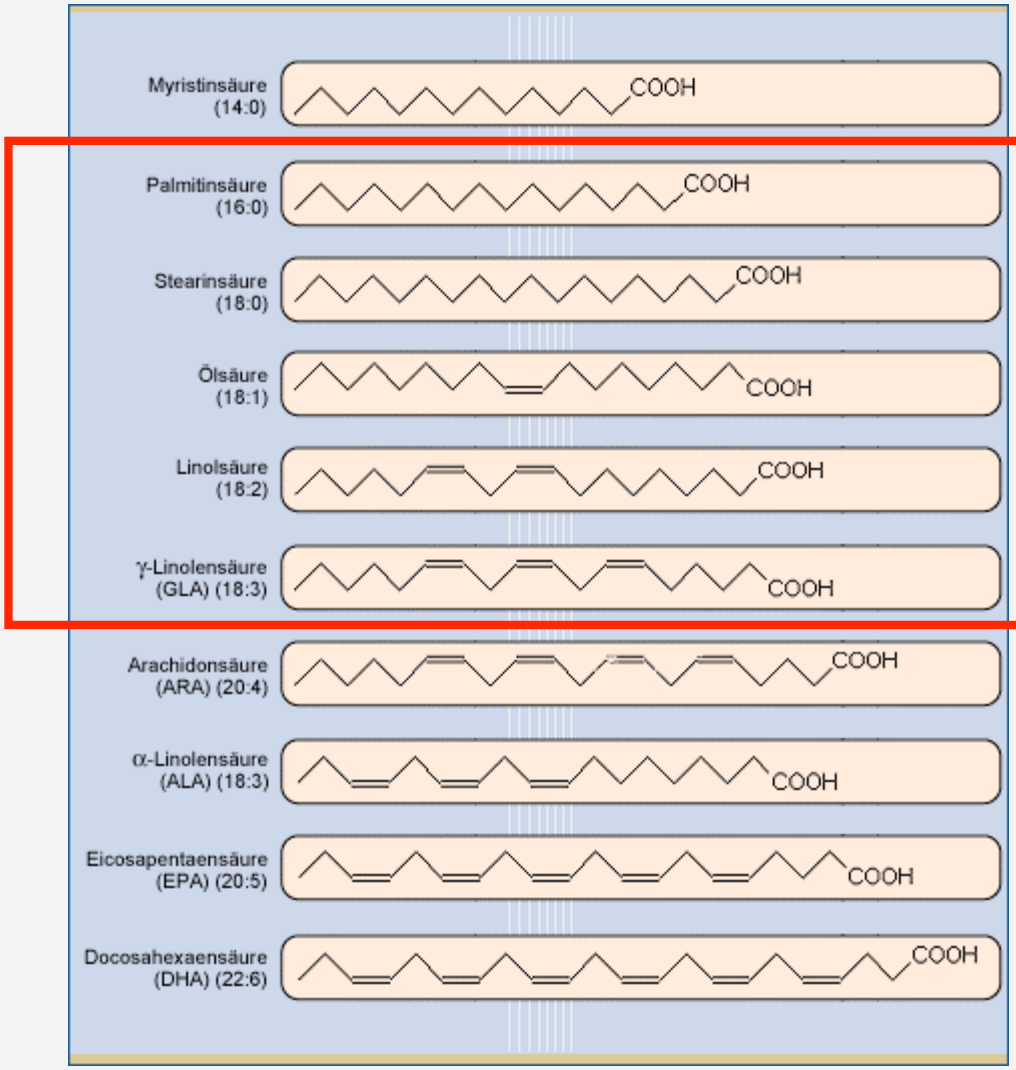
Fatty Acids Overview



these fatty acids are found in Biodiesel raw products

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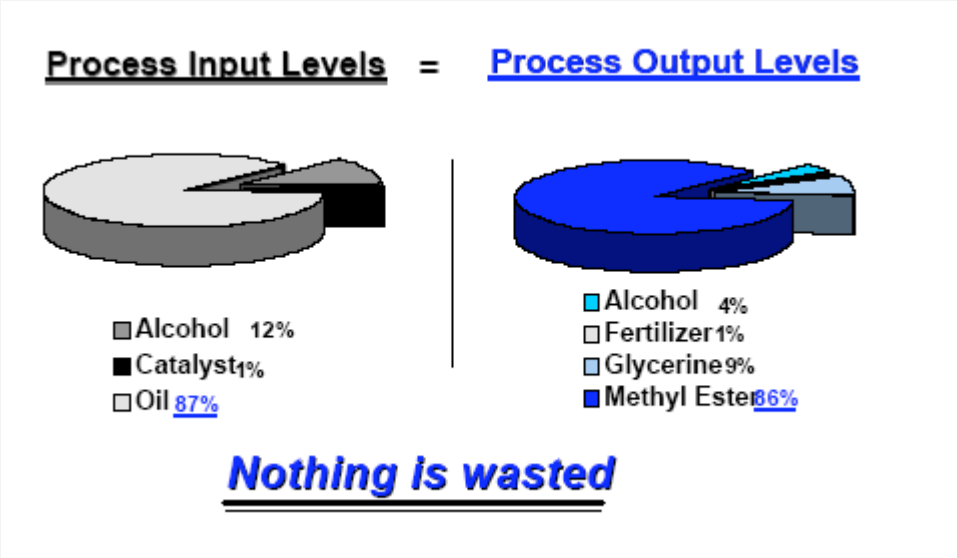
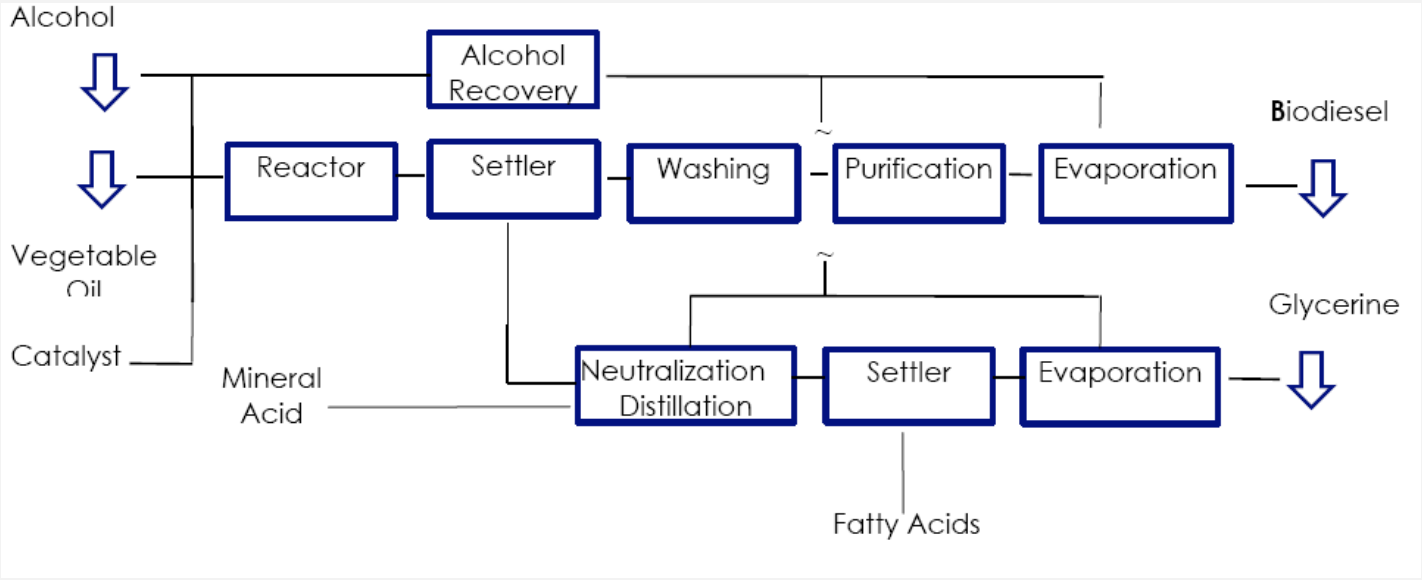
Plant Concenpt & Mass Flows





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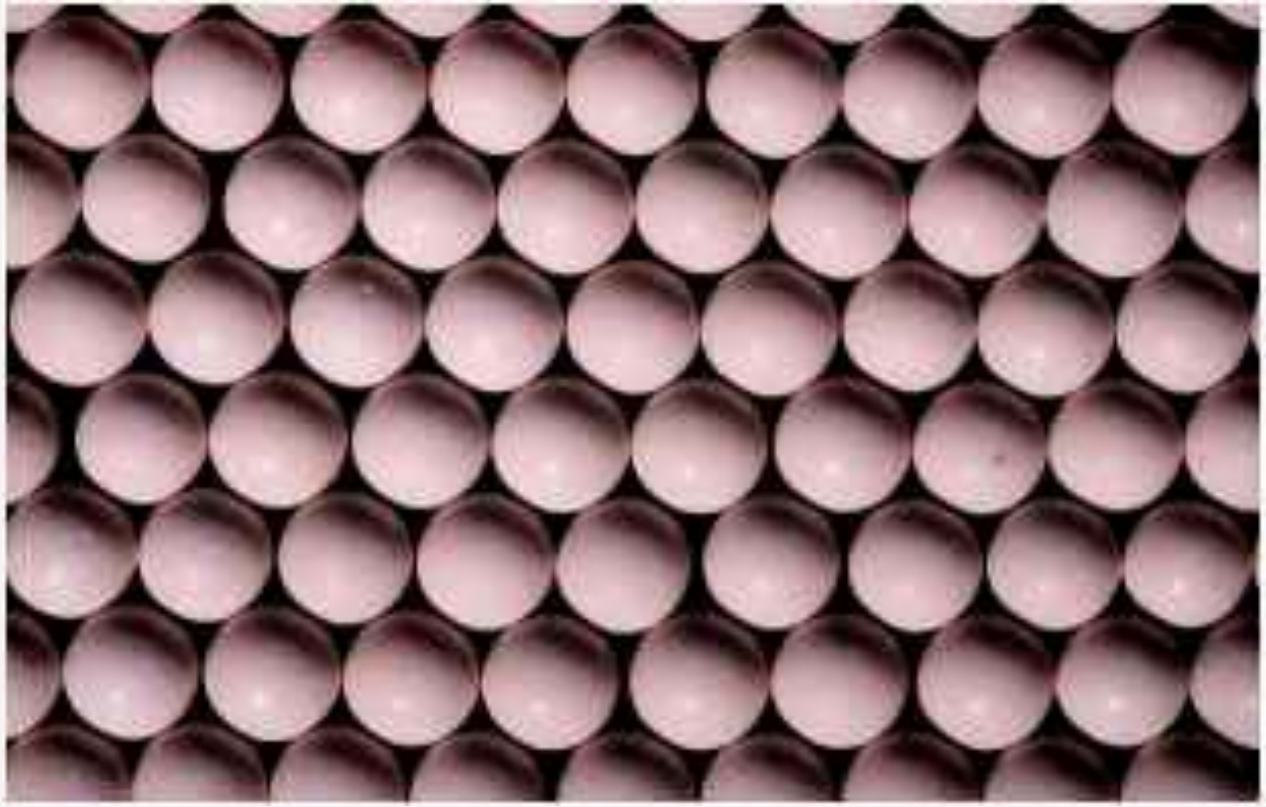
Biodiesel Purification with Lewatit® Ion Exchange Resins
- Removal of Glycerine -

Lewatit MonoPlus SP 112



Hexagonal packing

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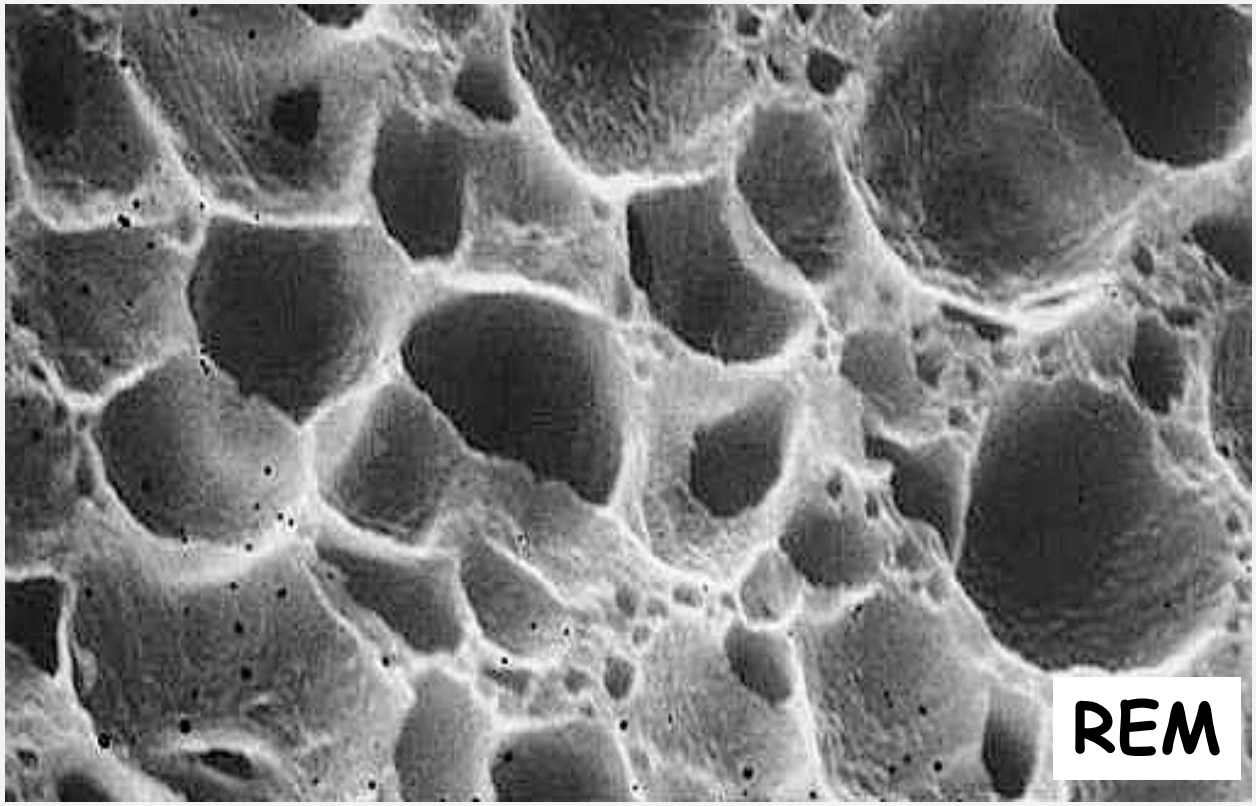
Biodiesel Purification with Lewatit® Ion Exchange Resins
- Removal of Glycerine -

SP 112 "sponge-structure"



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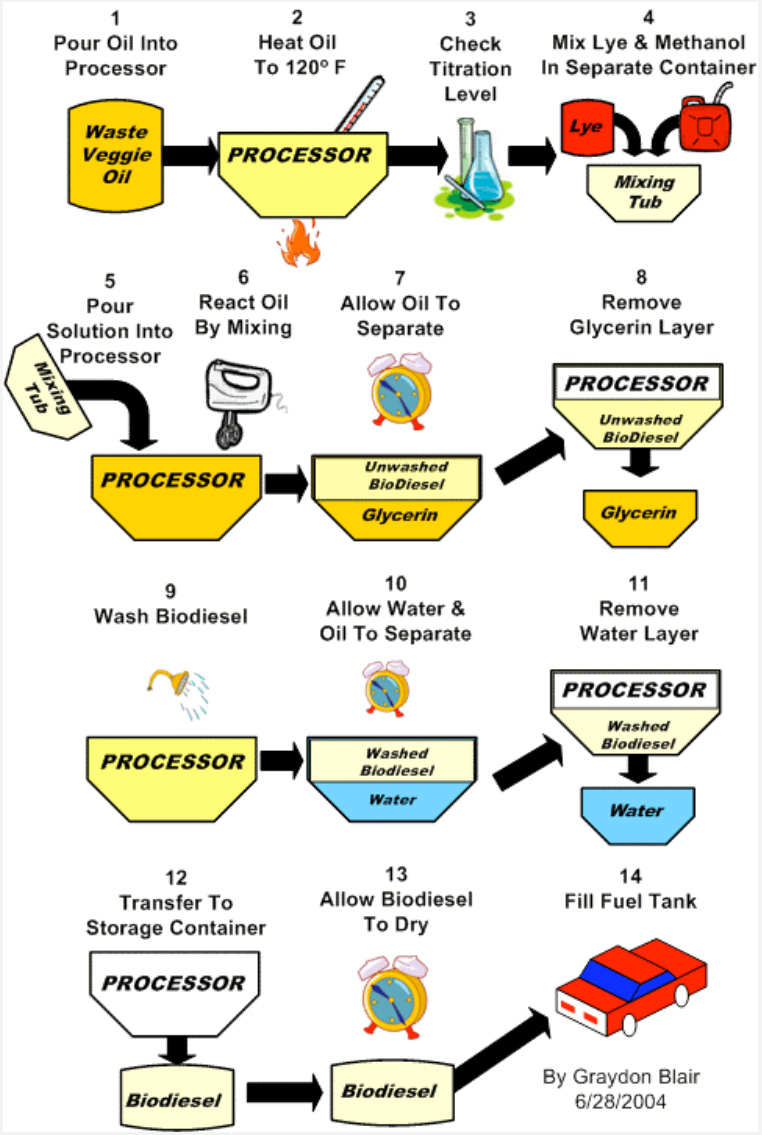
Do-it-yourself-recipe



Methyl-Esters layer

Glycerine layer

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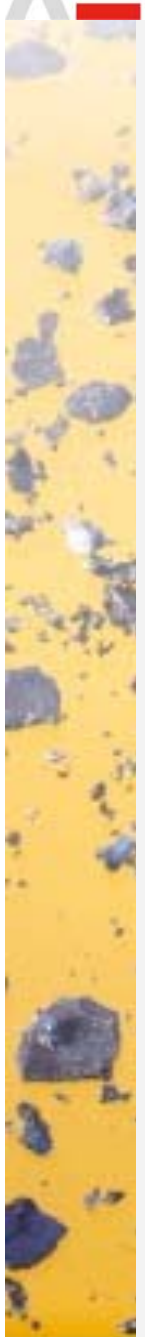
Example for Plant Design



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

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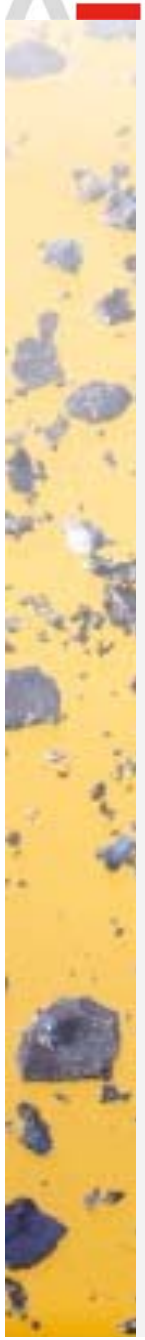
Biodiesel Purification with Lewatit® Ion Exchange Resins



Additional Information

www. lewatit.de

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