
ALFA
LAVAL

Novel Deodorization Technology with Focus on Micronutrient Recovery in Soybean Oil

– International Soy Conclave, Oct. 7-8th, India

Dr. Ling Hua
Alfa Laval Copenhagen A/S

Agenda

- A short introduction to Alfa Laval's Oils & Fats portfolio
- Alfa Laval's deodorization solutions
- Micronutrients recovery solutions
- Summary

Our Oils & Fats process line portfolio

– Comprehensive solutions

Crush and extract

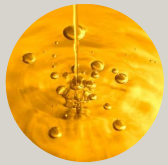
Crude palm oil
Olive oil
Avocado oil

Clarify and water degum

Seed oil clarification
Water degumming (lecithin drying)

Degum/ neutralize/ dewax

Neutralization
Degumming (acid/enzymatic)
Dewaxing
Soapstock splitting



Bleach

Bleaching (absorption) to remove impurities

Deodorize

Deodorization (continuous or semi-continuous) to remove volatile components and thermally stabilize/bleach the oil

Modify

Modify by fractionation, interesterification or hydrogenation to produce liquid oils and fats with specific melting behaviours

Biodiesel/HVO feedstock

Cooking oils

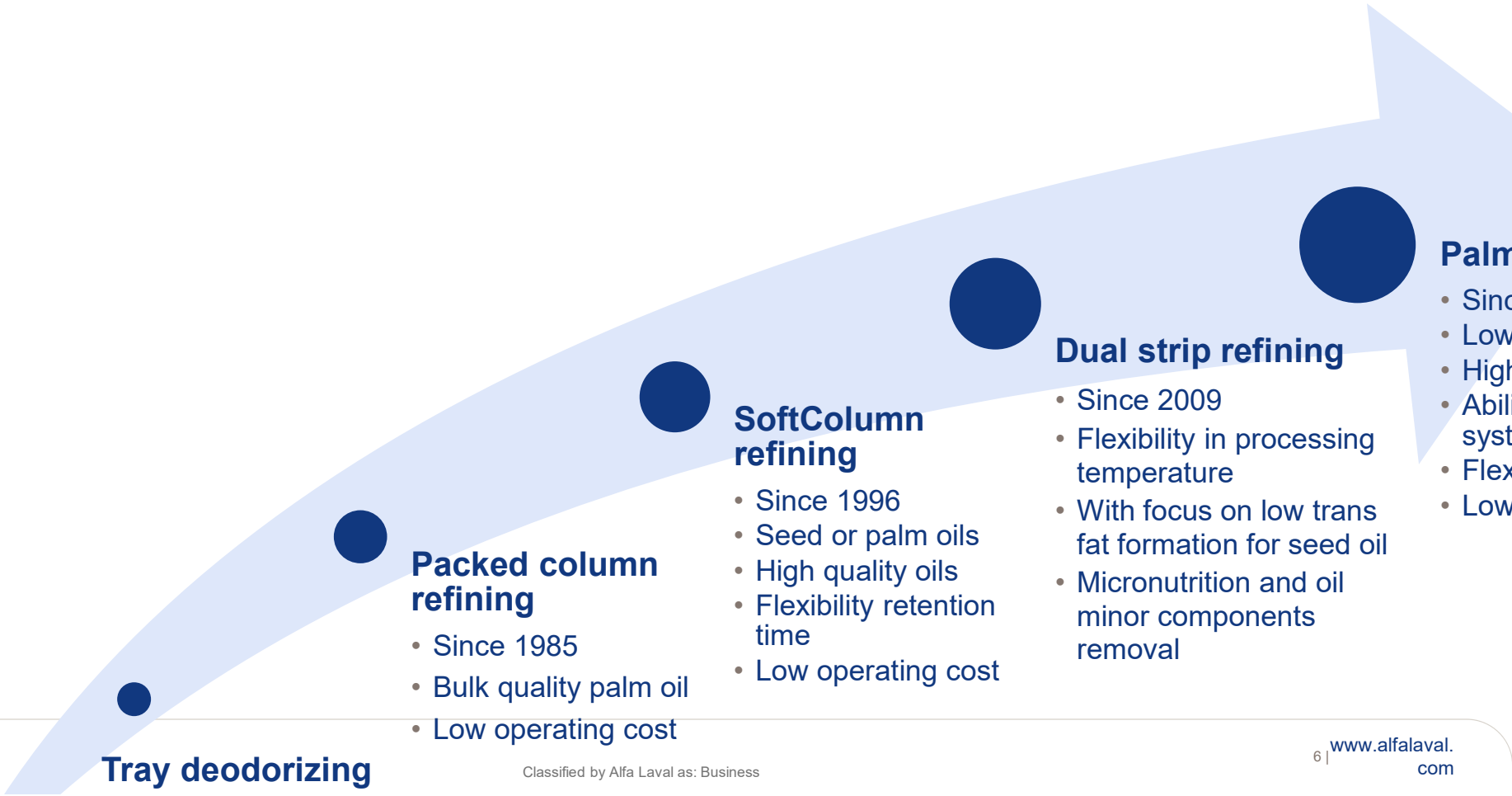
Margarine and shortening

Specialty fats end product

Alfa Laval’s Deodorization solutions

Development of Alfa Laval deodorizing technology

– A commitment to continuous development



Tray deodorizing

Packed column refining

- Since 1985
- Bulk quality palm oil
- Low operating cost

SoftColumn refining

- Since 1996
- Seed or palm oils
- High quality oils
- Flexibility retention time
- Low operating cost

Dual strip refining

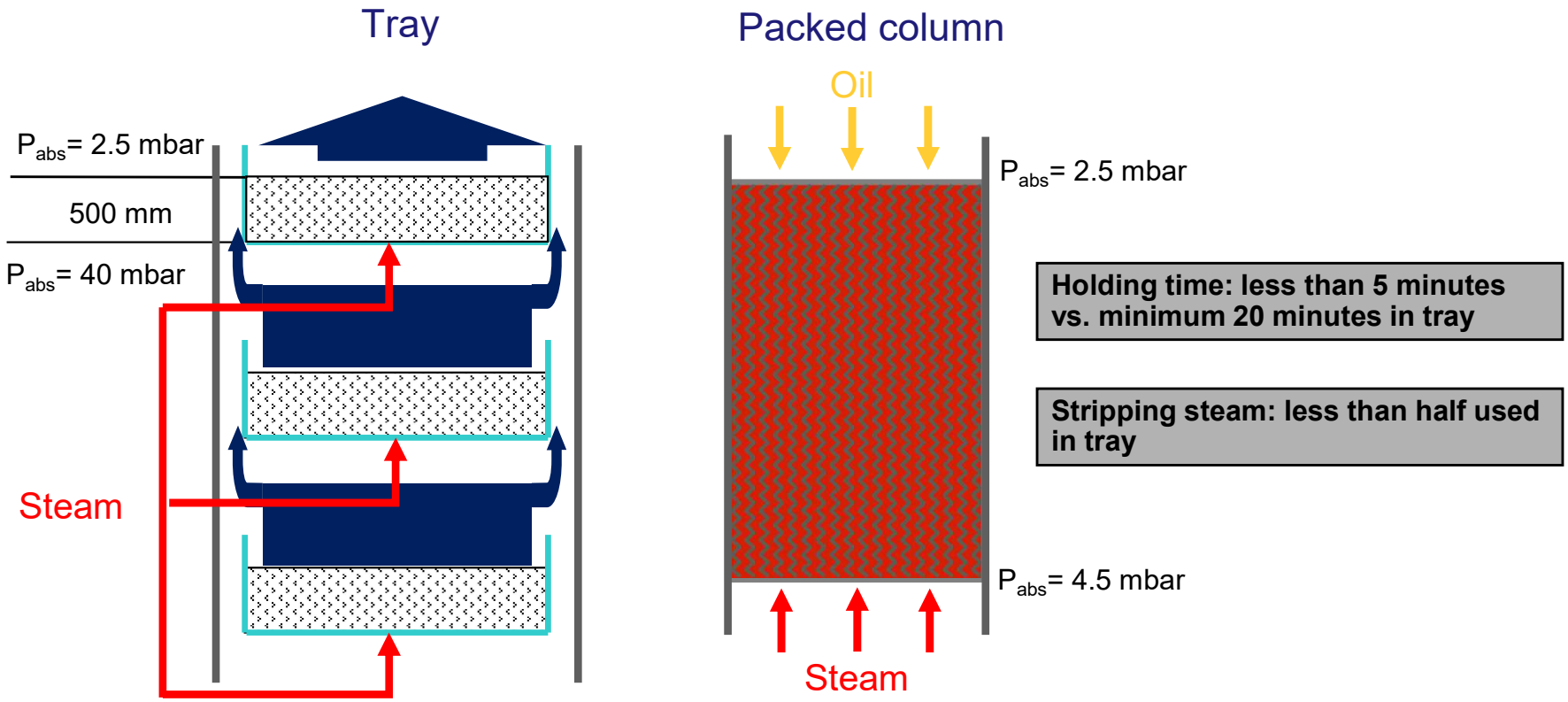
- Since 2009
- Flexibility in processing temperature
- With focus on low trans fat formation for seed oil
- Micronutrition and oil minor components removal

Palm

- Sinc
- Low
- High
- Abil
  syst
- Flex
- Low

A glance back to SoftColumn™ deodorizer

– Tray vs. Packed column



A glance back to SoftColumn™ deodorizer

Physical separation process

Steam stripping
Control by steam and temperature

Removal of FFA and other volatiles

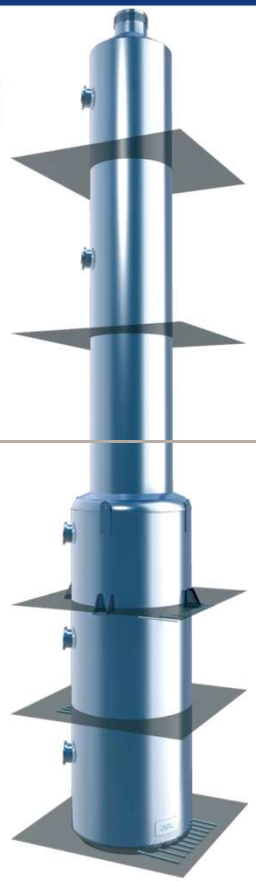
Fast

Chemical reaction process

Retention time
Control by time and temperature

Deodorization/Heat bleaching

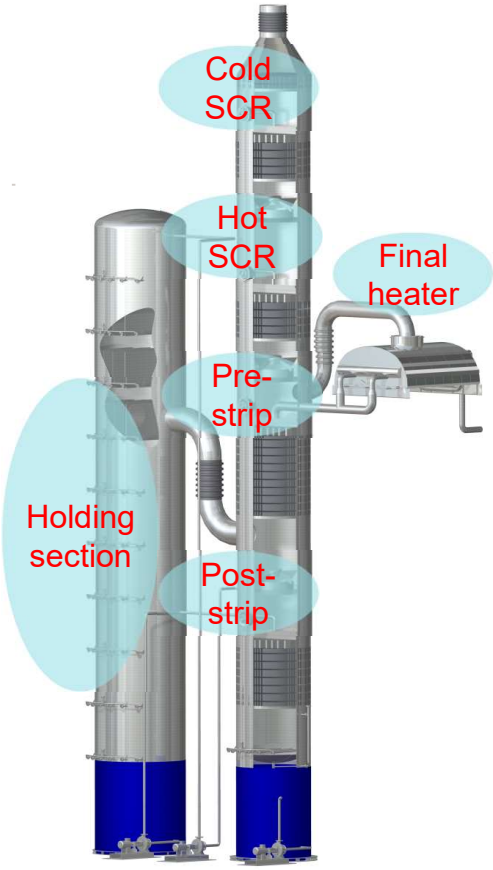
Flexible



A glance back to SoftColumn™ deodorizer

Dual Strip

- Two stage stripping: Before & after holding section.
- More complete stripping.
- Significantly improved heat recovery.
- Possible dual temp process by installing HEX in top holding tray.
- Possible retrofit solution.



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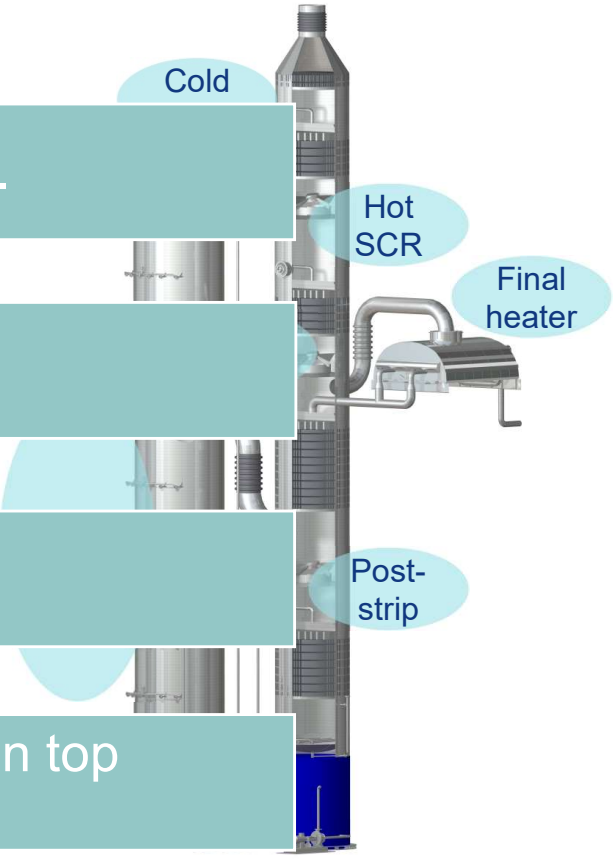
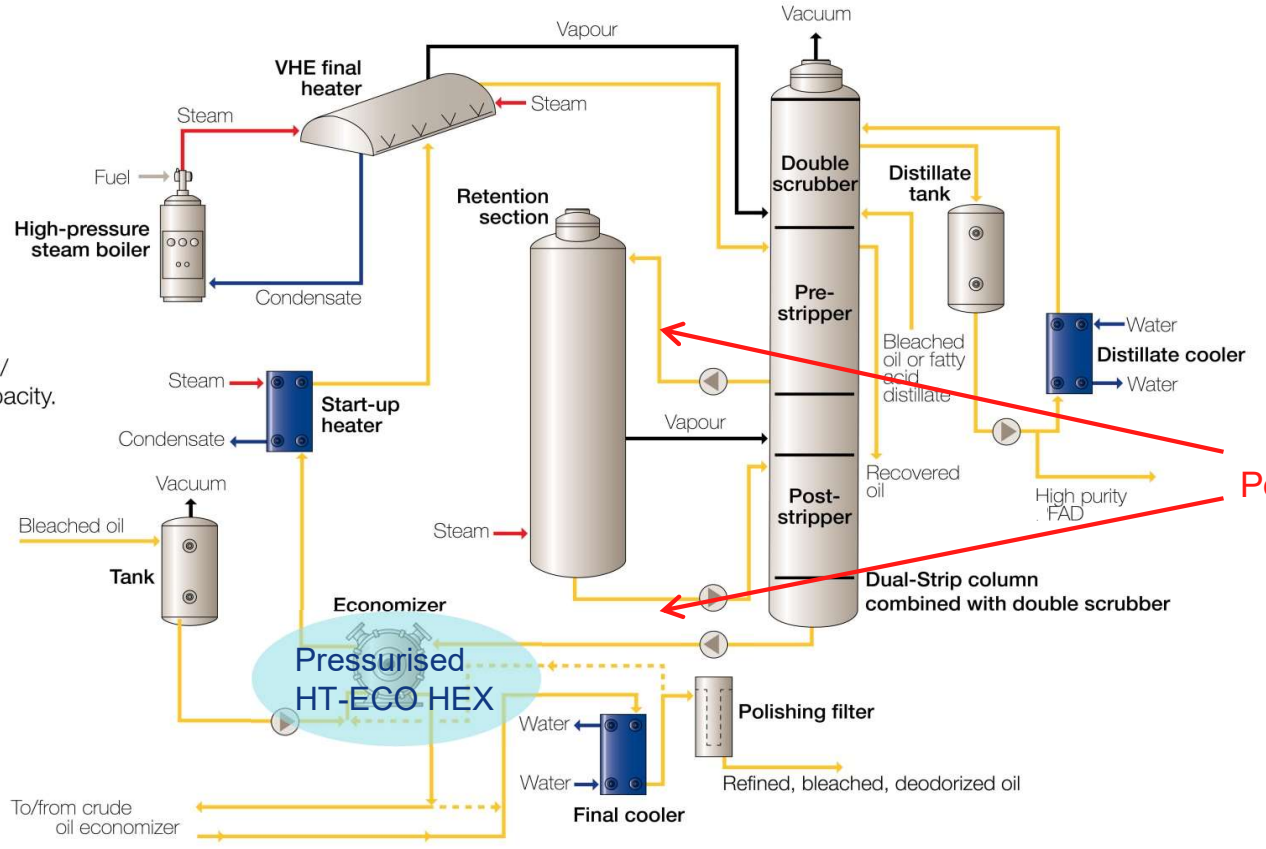


Dual Strip process overview

SoftColumn Dual-Strip continuous deacidification/ deodorization for high capacity.



Possible to add HEX

Achieve the highest quality

- Consistent high-quality oil
- Flexibility in operating choices
- Low operating cost with high heat recovery
- Flexibility in plant layout
- Safe and easy operation and maintenance
- Modularized setup and easy upgrade

Micronutrients recovery solutions

Occurrence in crude oils

– In PPM

Toco's [1]

T = tocopherols,
TT = tocotrienols

	α-T*	β-T	γ-T	δ-T	α-TT*	β-TT	γ-TT	δ-TT
palm	89	-	18	-	128	-	323	72
soybean	100	8	1021	421	-	-	-	-
maize	282	54	1034	54	49	8	161	6
sunflower	670	27	11	1	-	-	-	-
rapeseed	202	65	490	9	-	-	-	-

Sterols [1]

15 – 60% esterified

	Corn oil	cottonseed	olive	palm	rapeseed	safflower	soybean	sunflower
cholesterol	-	-	-	26	-	-	-	-
campesterol	2691	170	28	358	1530	452	720	313
stigmasterol	702	42	14	204	-	313	720	313
β-sitosterol	7722	3961	1310	1894	3549	1809	1908	2352
Δ5-avenasterol	468	85	29	51	122	35	108	156
Δ7-stigmastenol	117	-	58	25	306	696	108	588
Δ7-avenasterol	-	-	-	-	-	104	36	156
brassicasterol	-	-	-	-	612	-	-	-
other	-	-	-	-	-	69	-	39

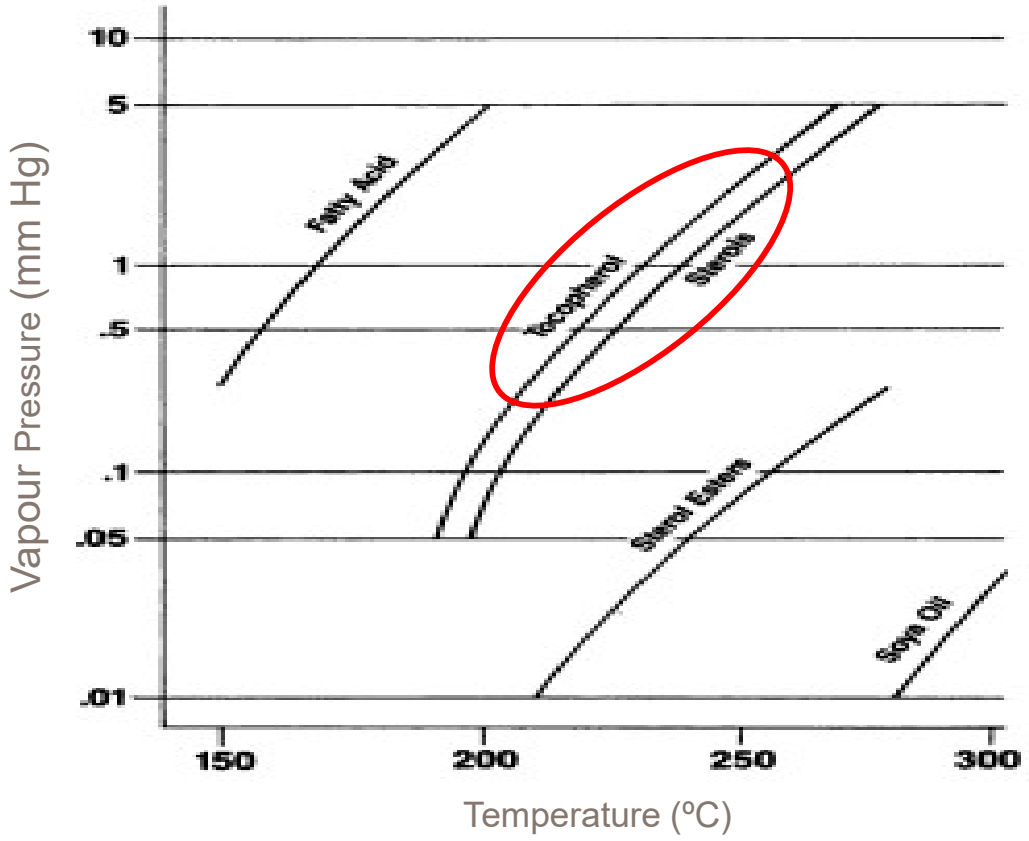
Squalene [2]

Corn oil[a]	133
Corn oil[b]	280
Olive oil[a]	2 400
Olive oil[b]	3 830
Sesame oil[a]	25
Sesame oil[b]	50
Sunflower oil[a]	15
Sunflower oil[b]	120
Safflower oil[a]	29
Peanut oil[a]	123
Peanut oil[b]	270
Soyabean oil[a]	31
Soyabean oil[b]	120
Shark liver oil[c]	27×10^4
Shark liver oil[d]	71×10^4
Crude palm oil[a]	580
Crude palm oil[b]	588

1) lipidlibrary.aocs.org

2) Gapor MT, Hazrina AR. Squalene in oils and fats. Palm Oil Developments 2000; 32: 36-40; (Malaysian Palm Oil Board).

Pure component vapour pressures



Squalene (estimated)	
Pressure mmHg	Temperature oC
0.05	184
0.1	193
0.5	217
1	228
5	255

Reference: “Deodorizer Distillate Values and Uses in the Evolving Edible Oil Process”, Winters, Robert L., p 154ff, Proceedings from World conference on emerging technologies in the fats and oil industry (1986)

Uses for micronutrients

Class	Prominent sources	Examples of use		
		Food	Feed	Personal care & cosmetics **)
Tocopherols	soybean oil	antioxidant (E 306)	antioxidant	antioxidant, masking, skin conditioning
Tocotrienols	palm oil	antioxidant, but no E number	n/a	oral care, skin conditioning, UV absorber
Sterols	soy, corn	food additive (functional), GRAS status *)	n/a	e.g. SOY STEROLS: Emulsifying, humectant, skin conditioning
Squalene	shark liver oil, olive, ricebran and palm oils	?	n/a	Antistatic, emolient, hair conditioning, refatting, skin conditioning. Hydrogenated to **squalane** (more stable) as above, but not as antistatic

*) Generally Regarded As Safe, health claims being debated

**) as per INCi (international Nomenclature Cosmetic Ingredient) classification.

Distillate Composition

VODD types	FFAs	Acylglycerols	Tocopherols	Free phytosterols	FASEs	Squalene	Others [b]
SODD	73.8	7.67	7.51	6.32	4.45	0.65	N.A [a]
CODD	81.2	0.72	1.42	2.71	0.62	0.21	13.12
CODD	77.1	2.20	3.31	5.42	N.A	0.99	10.98
SuODD	70.82	3.33	1.28	3.67	0.09	1.00	19.81
SODD	57.80	N.A	8.97	N.A	N.A	N.A	N.A
SuODD	82.00	N.A	10.00	2.00	2.00	4.00	0

[a]Not available.
[b]Hydrocarbons, aldehydes, ketones, pesticides, herbicides, breakdown product of tocopherols and phytosterols.

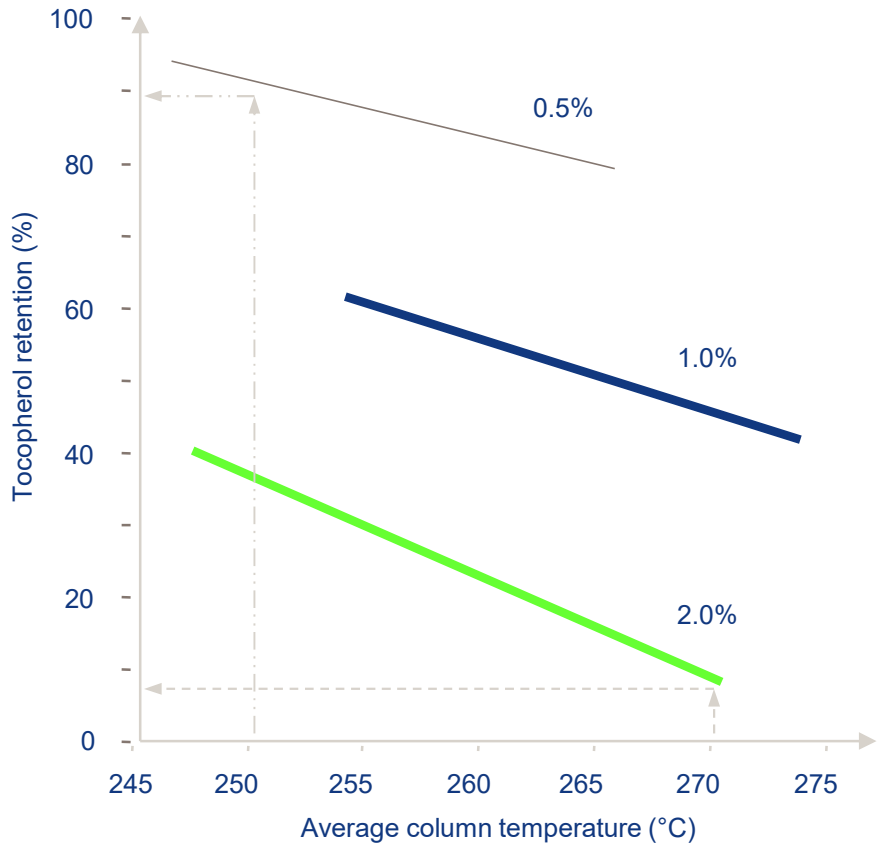
VO = Vegetable Oil, SO= Soybean Oil, ,CO = Corn Oil , SuO = Sunflower Oil, PFAD = Palm Oil Fatty Acid Distillate

Reference: “Vegetable Oil Deodorizer Distillate: Characterization, Utilization and Analysis”, Gunawan, S. and Yu, Y-H. , Separation and Purification Reviews, p 207ff (2009)

Unsaponifiables

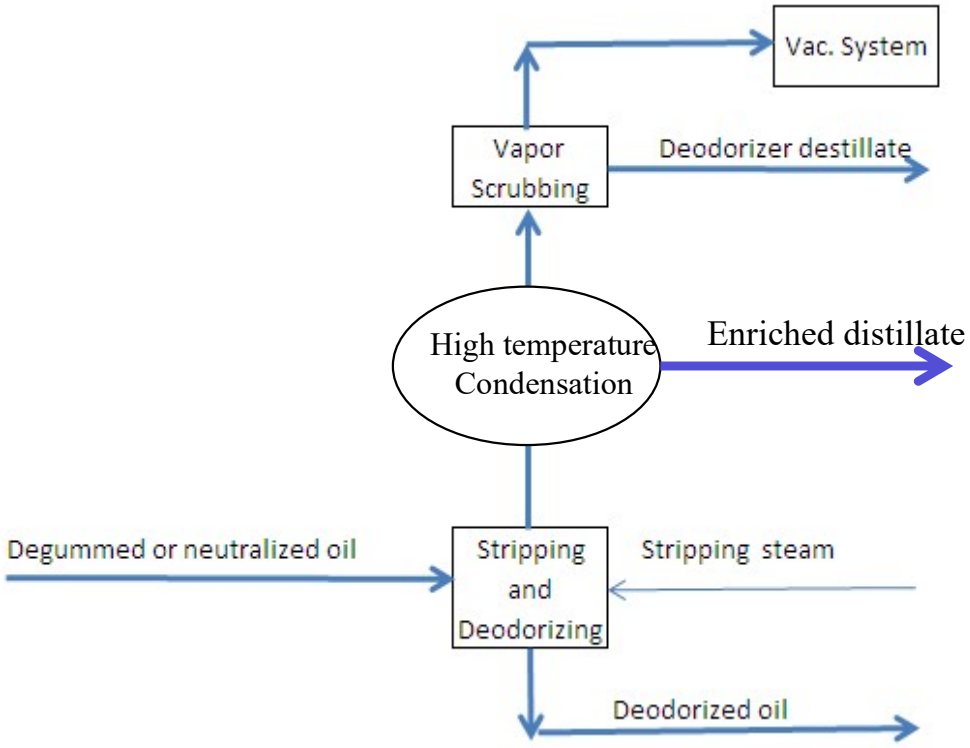
– retention or removal?

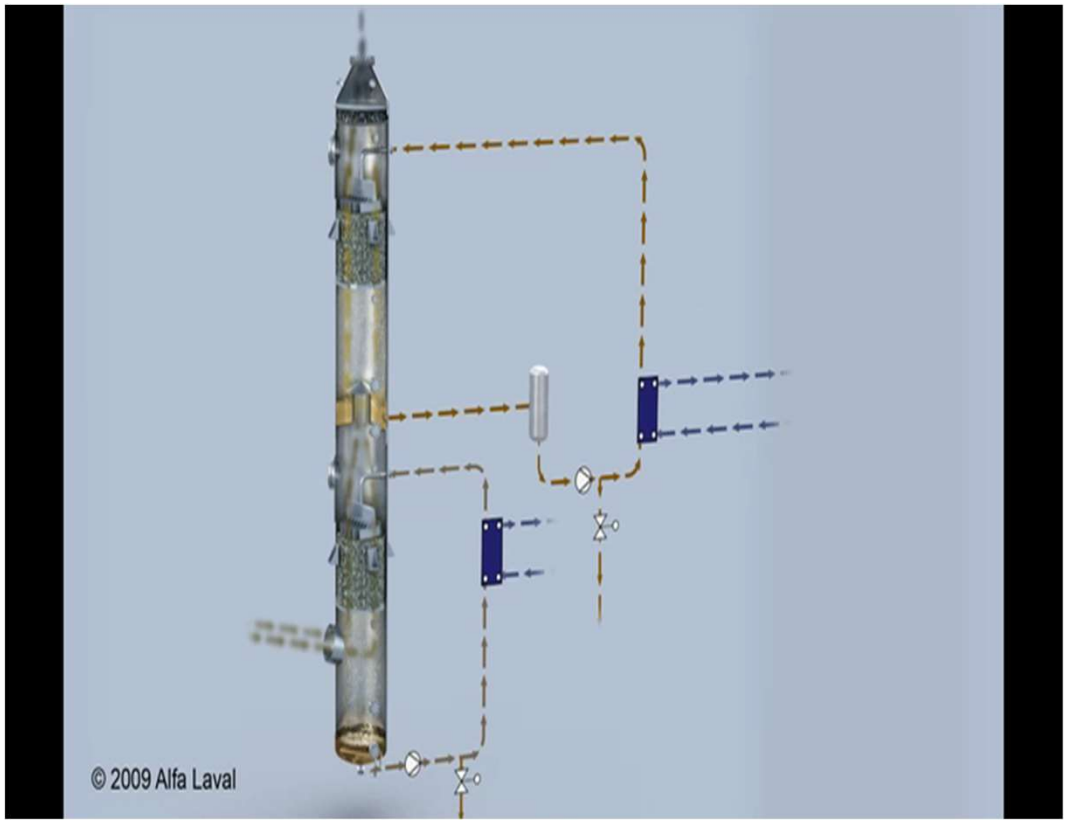
- Unique flexibility in final unsaponifiable concentration
- Example: tocopherol
  - 0.5% stripping steam
  - 1.0% stripping steam
  - 2.0% stripping steam



Double scrubber

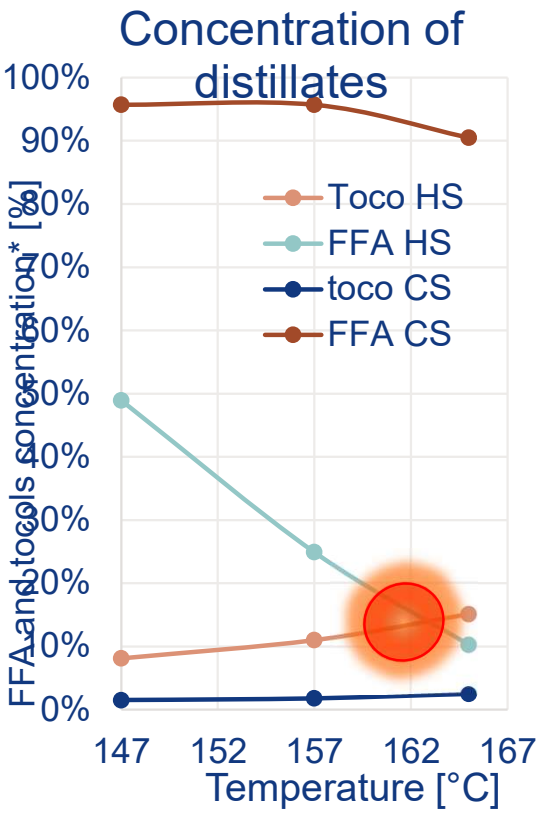
– Adding a condensation zone

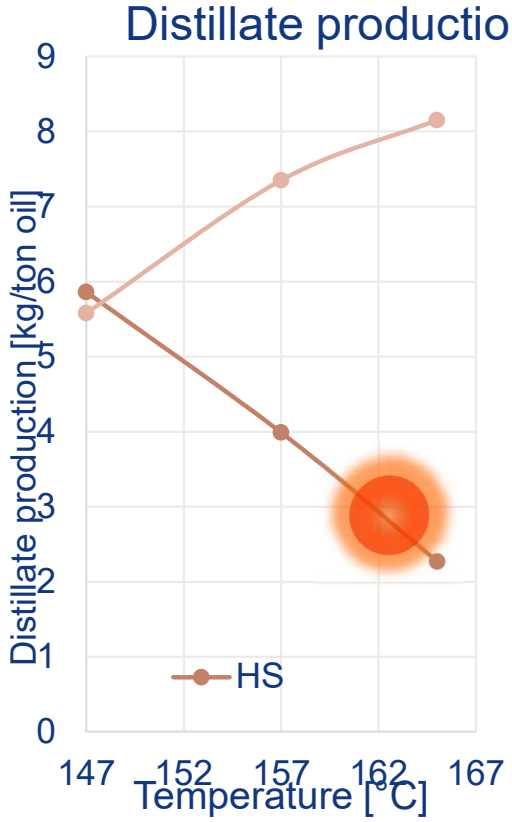


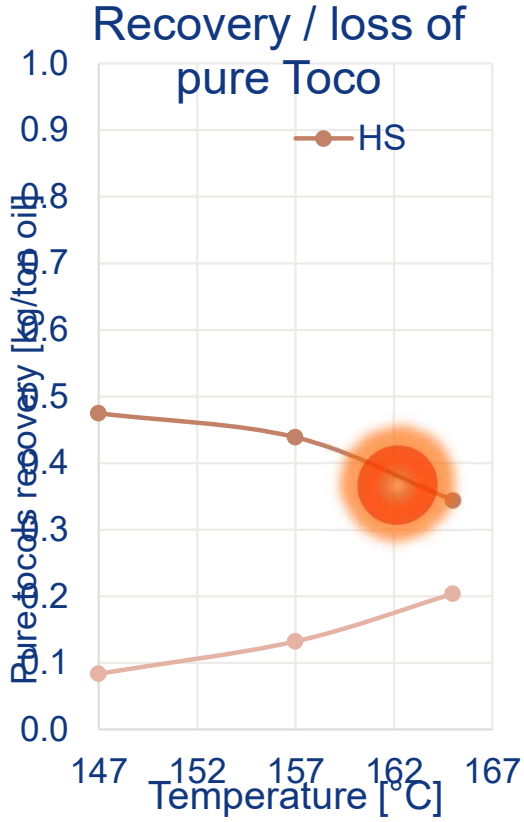


Tocopherol recovery in seed oil

– Actual plant data for Double Scrubber installation of circulating loop type







HS: Hot Scrubber
CS: Cold Scrubber

* FFA measured by titration based on MW 282

Tocol concentration / recovery dilemma

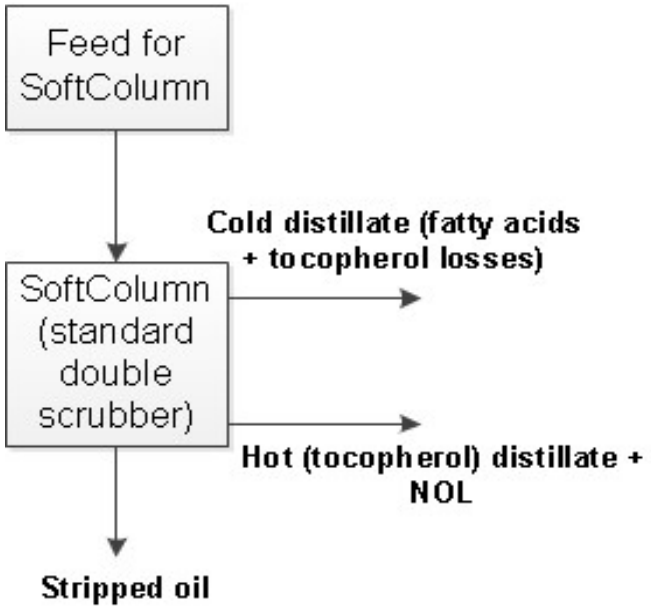
– The limitation / dilemma using Double Scrubber system

- The Double Scrubber, in principle being 2 simple condensation zones at high and low temperature, cannot “by nature” offer full separation between tocols and FFA.
- At low HSCR temp the tocols will be diluted with condensing FFA - at high HSCR temp the tocols will not be fully condensed in HSCR (so passing to CSCR = loss).
- If really low tocols losses to CSCR are required, the obtained concentration resembles single scrubber performance, because most of fatty acids will be condensated in Hot Scrubber.
- The higher desired concentration, the higher losses of tocols to CSCR will take place.

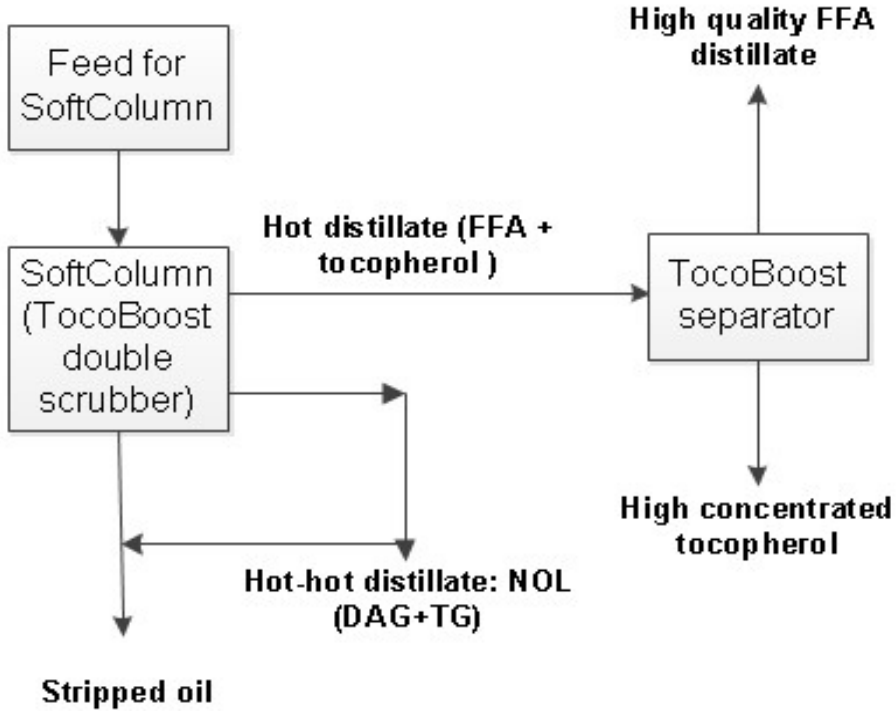
TocoBoost ®

- Increasing BOTH the Tocol recovery AND the concentration

Standard double scrubber

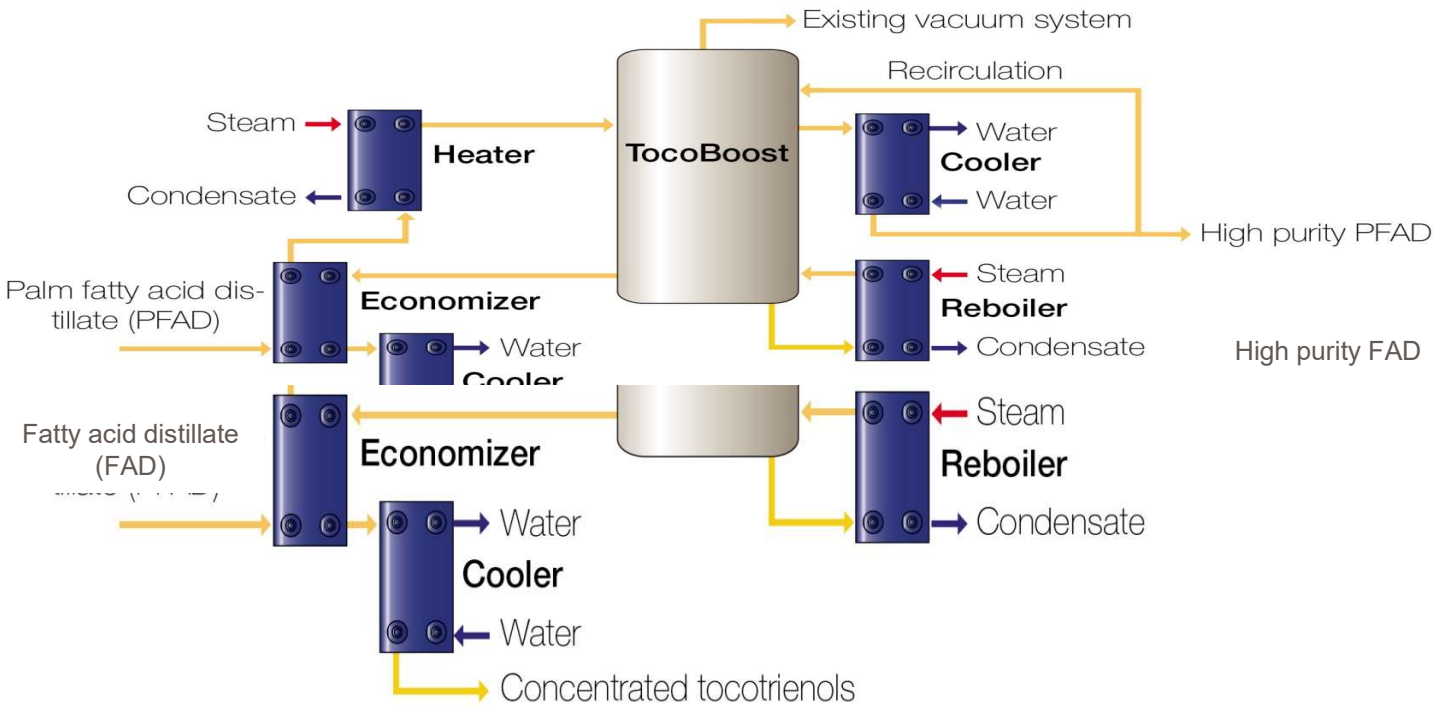


TocoBoost Technology



TocoBoost ®

– Example of stand-alone unit



TocoBoost ®

– Comparison with other configurations for soybean oil duty

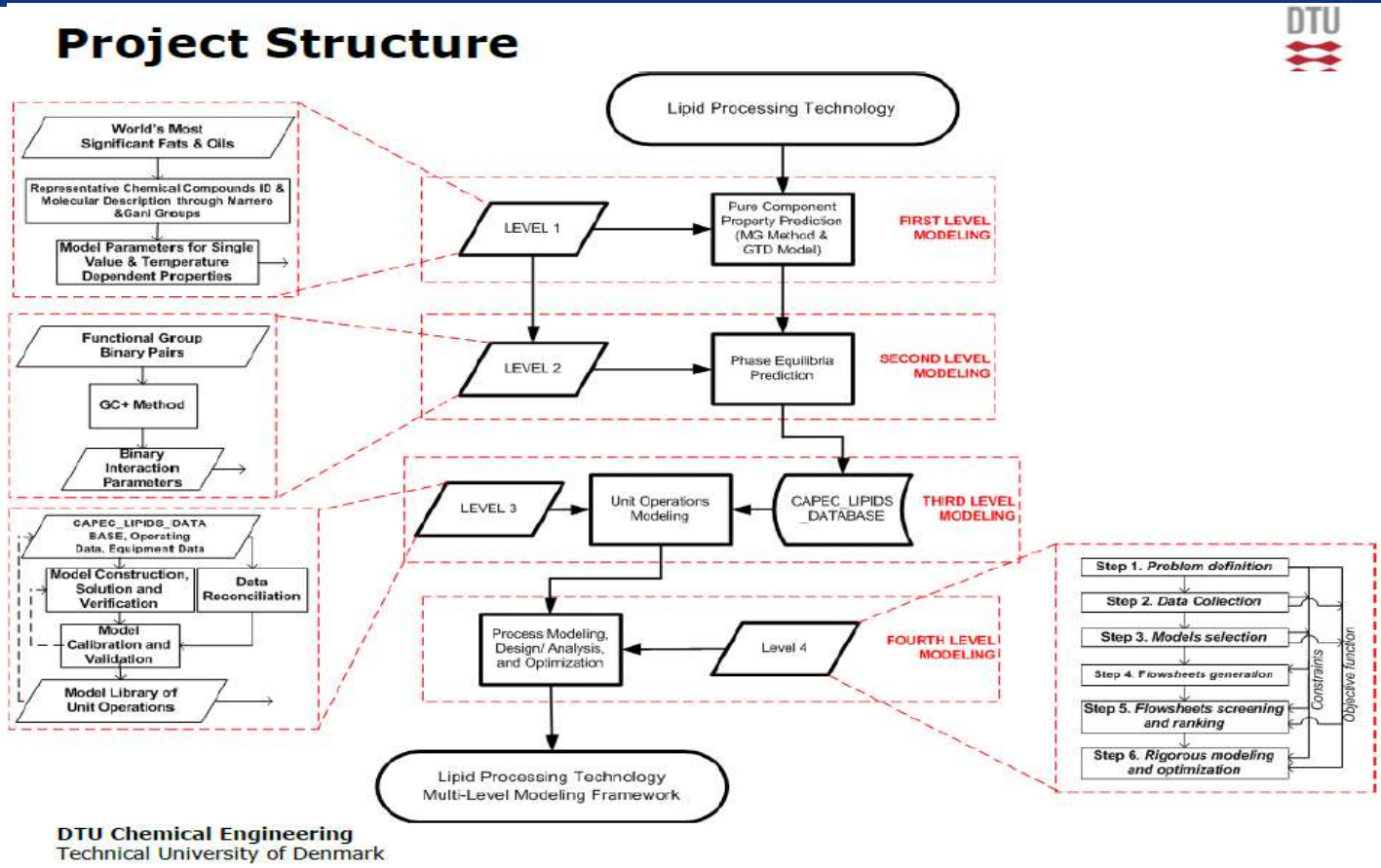
Parameters	Tococontain, Single Scrubber	Tococontain, Double Scrubber	Tocostrip, Single Scrubber	TocoBoost technology*
Tocols concentration	3-7%	7-10%	6-14%	15+%
Tocols recovery [kg pure tocols / ton feed]	0.1-0.2	0.08-0.16	0.4-0.6	0.1-0.6
FFA[a] in FAD [%]	40-50	50-70	30-40	95+
Neutral oil loss [%]	0.1-0.2	0.1-0.2	0.1-0.2	<0.1

[a] Measured by titration using the actual, average molecular weight of FA assessed by GLC

*The TocoBoost design can be tailor-made to feed quality and desired separation, and the specific performance can be predicted by advanced modeling/simulation

Design tool

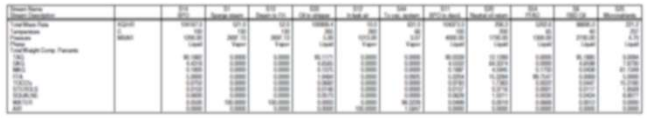
- **Modeling activities anchored in "CAPEC" in Techn. Univ. of Denmark**



Design tool

- Modeling the separation options: TocoBoost **Integrated**

Case TB2. Integrated TocoBoost Column



Thank you for your attention!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