

מחזוריות



Alfa Laval PalmFlex refining technology

reduction of GE and MOSH in refined palm oil

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A global company

– 138 years old company



- 39 production units*
- More than 100 service centres
- Sales companies in 55 countries
- Other sales representation in 45 countries



* Plus a number of minor production and assembling units



Making our world better, every day

– Advancing better™



Alfa Laval products are used to optimize the performance of our customers' processes to:

- make food and pharmaceutical production safer
- reduce water and energy usage
- protect the environment



We serve most industries

Edible oils
Biotech and pharmaceutical
Chemicals
Oil and gas
Engine and transport
Fluid power
Food and beverages
HVAC
Industrial fermentation
Latex
Biofuel (including HVO)



Crude oil refinery
Metal working
Mining and mineral processing
Marine and diesel
Power
Pulp and paper
Refrigeration and air-conditioning
Semiconductor systems
Steel and coke oven gas
Sugar
Wastewater treatment



Hazardous compounds in edible oils and fats



Health concern

– Latest challenges of hazardous compounds



3-monochloropropanediol esters
(3-MCPDE)

- Possible effect on kidney & male fertility*
- Formed >140°C in the presence of acidity and chloride ions*
- Difficult to remove after formation

glycidyl esters
(GE)

- Genotoxic and carcinogenic (can damage DNA & cause cancer)**
- IARC group 2A carcinogen (probably carcinogenic to human) ***
- Formed rapidly >220°C at long retention time
- Main pre-cursor Diacylglycerides (DAG)
- Can be removed by direct stripping or post-refining

mineral oil hydrocarbons
(MOSH & MOAH)

- Long chain heavy molecule hydrocarbons
- Pose potential health hazards
- Coming from malpractices in process operation

* Institute of Food Science & Technology, UK (IFST)

** European Food Safety Authority (EFSA)

*** International Agency for Research on Cancer (IARC)

MOSH = Mineral Oil Saturated Hydrocarbons

MOAH = Mineral Oil Aromatic Hydrocarbons



How much is parts per million ?

10 ppm GE = one pail of 10 kg pure contaminant poured into a 1,000 tons storage tank

100 ppm MOH = one barrel of 100 kg pure contaminant poured into a 1,000 tons storage tank



Glycidyl Esters (GE)



EU legislation on GE affects supply chain

Glycidyl fatty acid esters expressed as glycidol

Maximum level $\mu\text{g}/\text{kg}$

Vegetable oils and fats placed on the market for the final consumer or for use as an ingredient in food with the exception of the foods below

1,000
(1.0 ppm)

Vegetable oils and fats destined for the production of baby food and processed cereal-based food for infants and young children

500
(0.5 ppm)

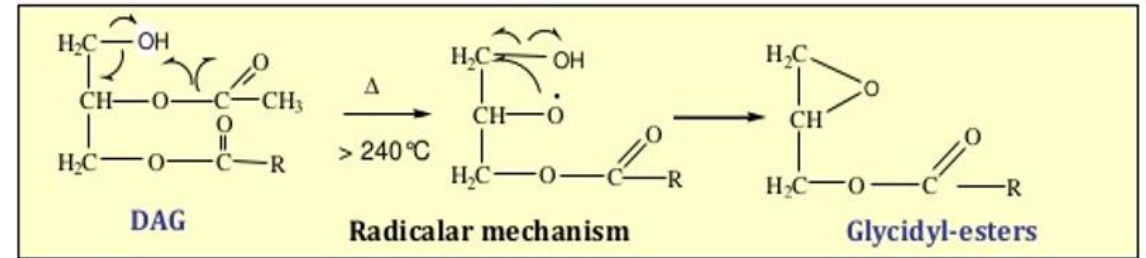
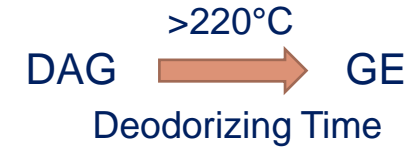
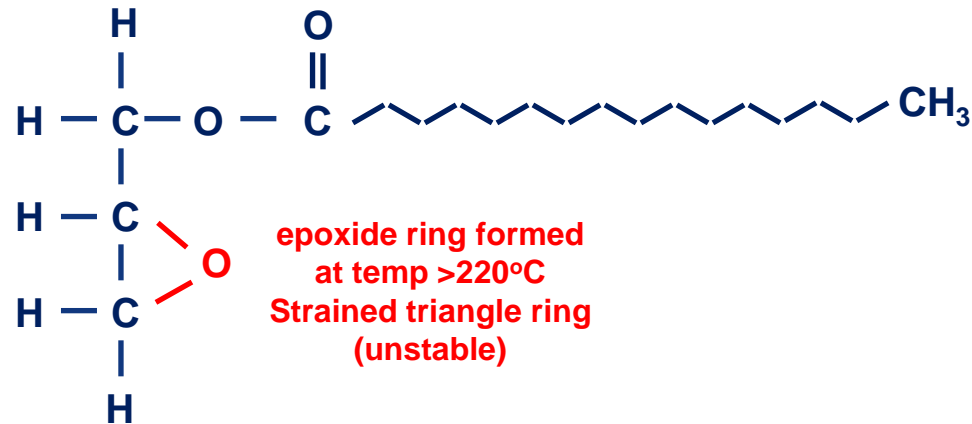
Commission Regulation (EU) 2018/290, of 26 February 2018



GE formation and the contributing factors

Glycerol backbone

1 bonded fatty acid

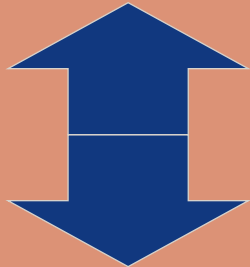


Contributing factors :

- High Diacylglycerides (DAG)
- High deodorizing temperature (>220°C)
- Long retention time in deodorizer
- Hydrolysis at high temperature with steam effect

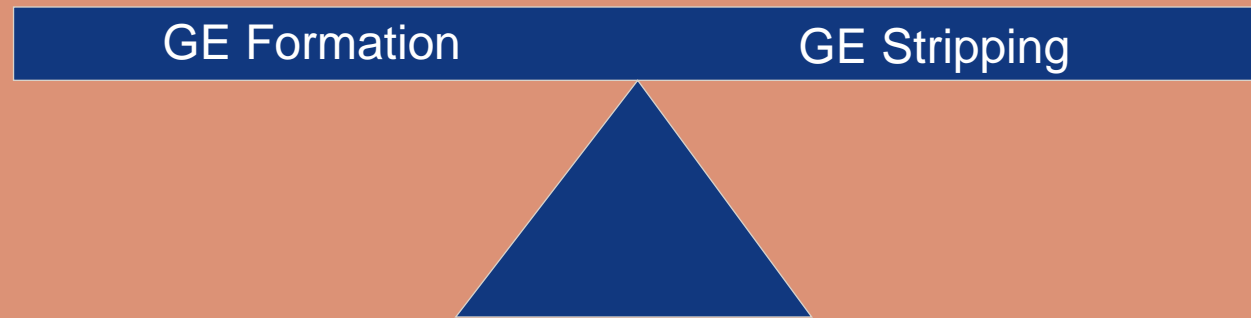


High temperature
High DAG in feed
Long retention time

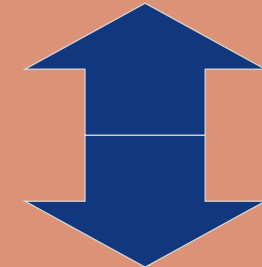


Low temperature
Low DAG in feed
Short retention time

GE “Formation / Stripping Balance”



High temperature
High steam sparging
Stronger vacuum



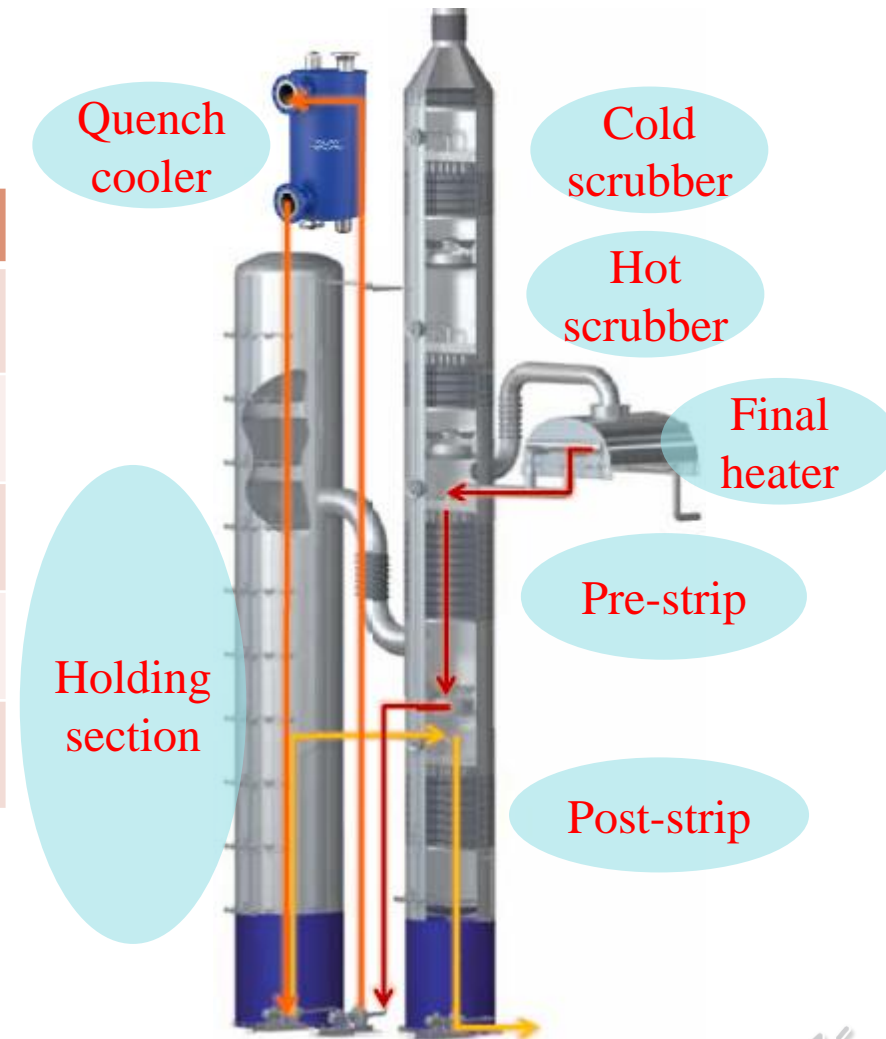
Low temperature
Low steam sparging
Weaker vacuum



Palm oil deodorisation with GE reduction

by dual temperature and dual stripping

Parameter	1	2	3	4	5	6	7
Stripping temperature (°C)	260	260	260	260	260	260	260
Deodorizing temperature in 60 minutes (°C)	255	240	230	230	225	220	215
Colour in Red (5¼" Lovibond)	2.5	2.5	2.5	2.6	2.8	2.8	3.2
GE in refined oil, ppm	8.5	4.5	3.2	3.5	3.0	2.5	2.2
Pressure, mbar	2.5	2.5	2.5	2.5	2.5	2.5	2.5



GE stripping pilot test result

- Test conducted for RBD palm oil



Alfa Laval pilot stripping plant in Denmark

No.	Sample	GE result (mg/kg)	3-MCPD result (mg/kg)
1	GE of RBDPO feed	9.4	0.91
2	GE test at 200°C	1.1	0.86
3	GE test at 210°C	0.3	0.84
4	GE test at 220°C	0.1	0.86
5	GE test at 230°C	0.1	0.83
6	GE test at 240°C	0.2	0.80

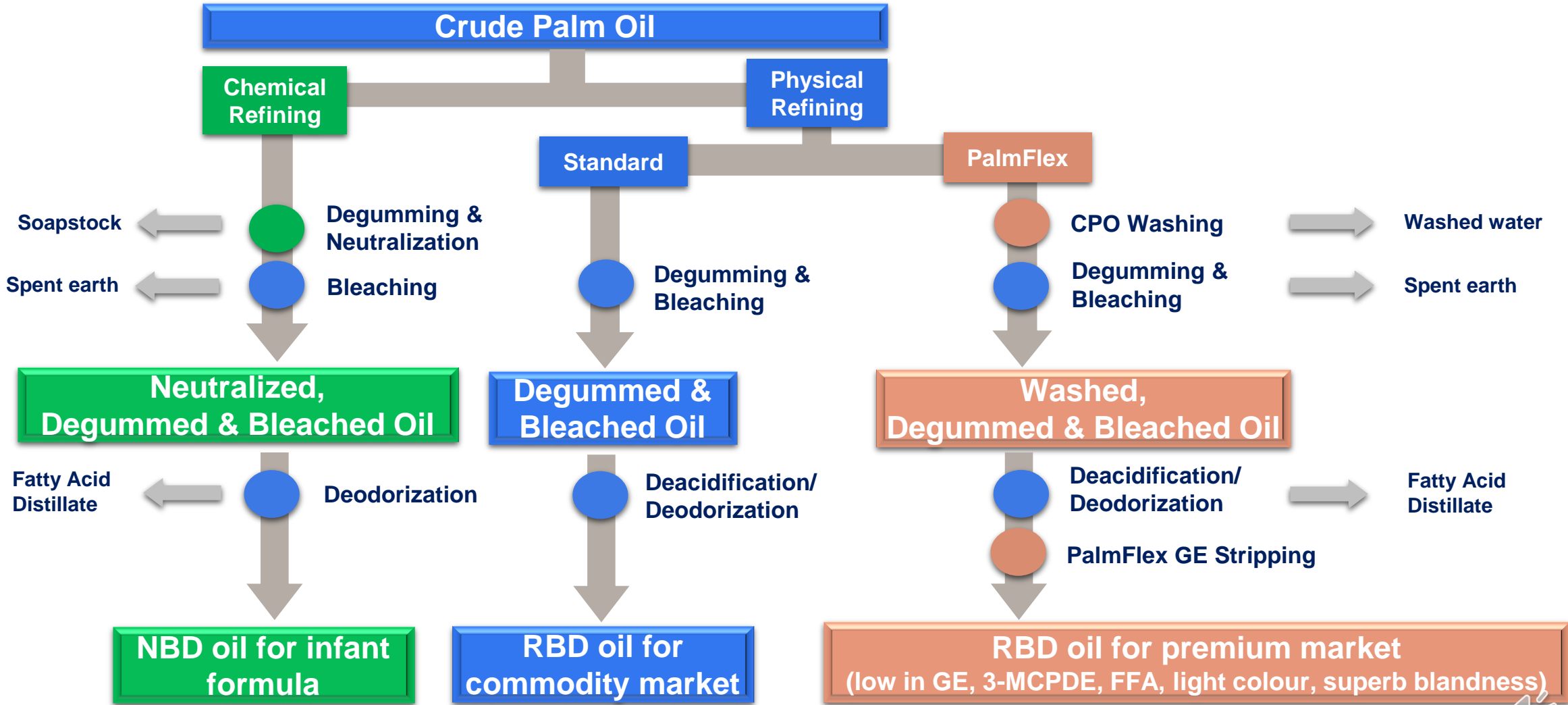


Analysis method: AOCS Cd 29c-13

Proces parameters: Suction pressure 0.7 mbara / sparge-steam amount 1.7%



Alfa Laval PalmFlex – the most optimum refining route



Achieve the highest quality

– Optimal refined, bleached and deodorized (RBD) palm oil



Quality of RBD Palm Oil	Standard	PalmFlex
Free fatty acids (FFA)	Max. 0.05%	0.03~0.04%
Moisture and volatile matter	Max. 0.05%	Max. 0.03%
Colour (Lovibond 5¼" cell)	Max. 2.5 red / 25 yellow	Max. 2.0 red / 20 yellow
Peroxide value	Nil	Nil
Taste / odour	Bland / odourless	Superb bland / odourless
Palm fatty acid distillate purity (based on 5% FFA in feed)	Min. 89%	Min. 89%
3-MCPDE	4–6 ppm	< 1 ppm (with washing)
Glycidyl esters (GE)	8–15 ppm	0.3~0.5 ppm

Note: Final oil quality may vary subject to feedstock and process variation.



Mineral Oil Hydrocarbons



MOSH & MOAH

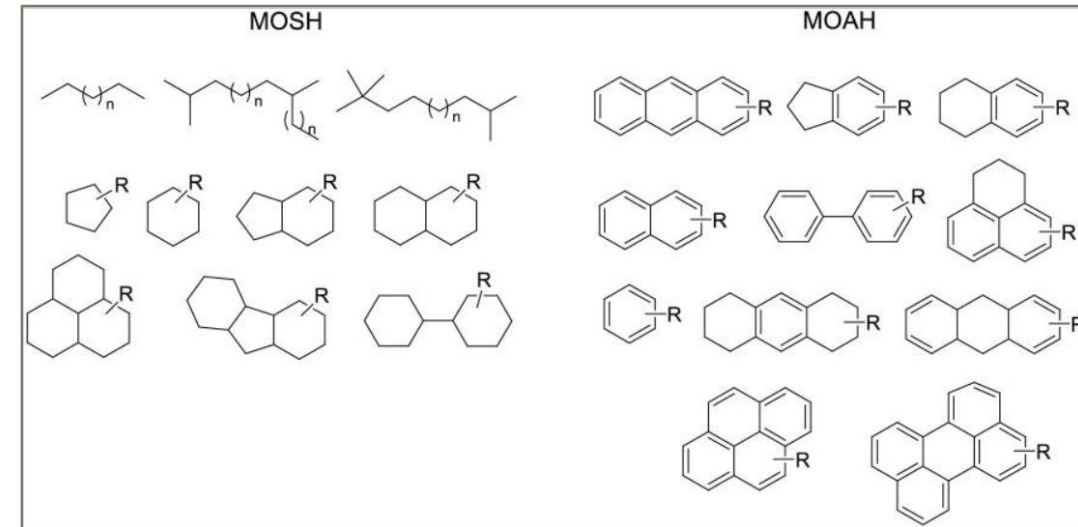
– Latest challenges of hazardous compounds

Mineral Oil Hydrocarbons (MOSH, MOAH) - complex mixture of hydrocarbons C10 up to C50

- Pose potential health hazards in animal studies
- For MOSH & MOAH C10-C24, high temperature deodorization with steam stripping and vacuum could reduce them
- For C24-C30, partial removal is possible depending on steam stripping, strong vacuum and temperature
- Good manufacturing practices is still the best to address these contaminants
- Usage of food-grade lubricants

MOSH = Mineral Oil Saturated Hydrocarbons

MOAH = Mineral Oil Aromatic Hydrocarbons



MOSH & MOAH market requirement

– max level in vegetable oils and fats set by a large food company



	Max level (applicable 01.07.2020)		
	Palm oils and Coconut oils	Other vegetable oils and Animal Fats including Fish oils	Infant Grade ingredients ** ALARA
MOSH	< 20 mg/kg oil	13 mg/kg oil	< 10 mg/kg oil
MOAH	< 2 mg/kg oil	<LOQ mg/kg oil*	< 2 mg/kg oil

- As of to-date, there are no EU legislation regulating the limits of MOH in vegetable oils and fats due to unavailability of standard method
- Large food companies are setting their own standard

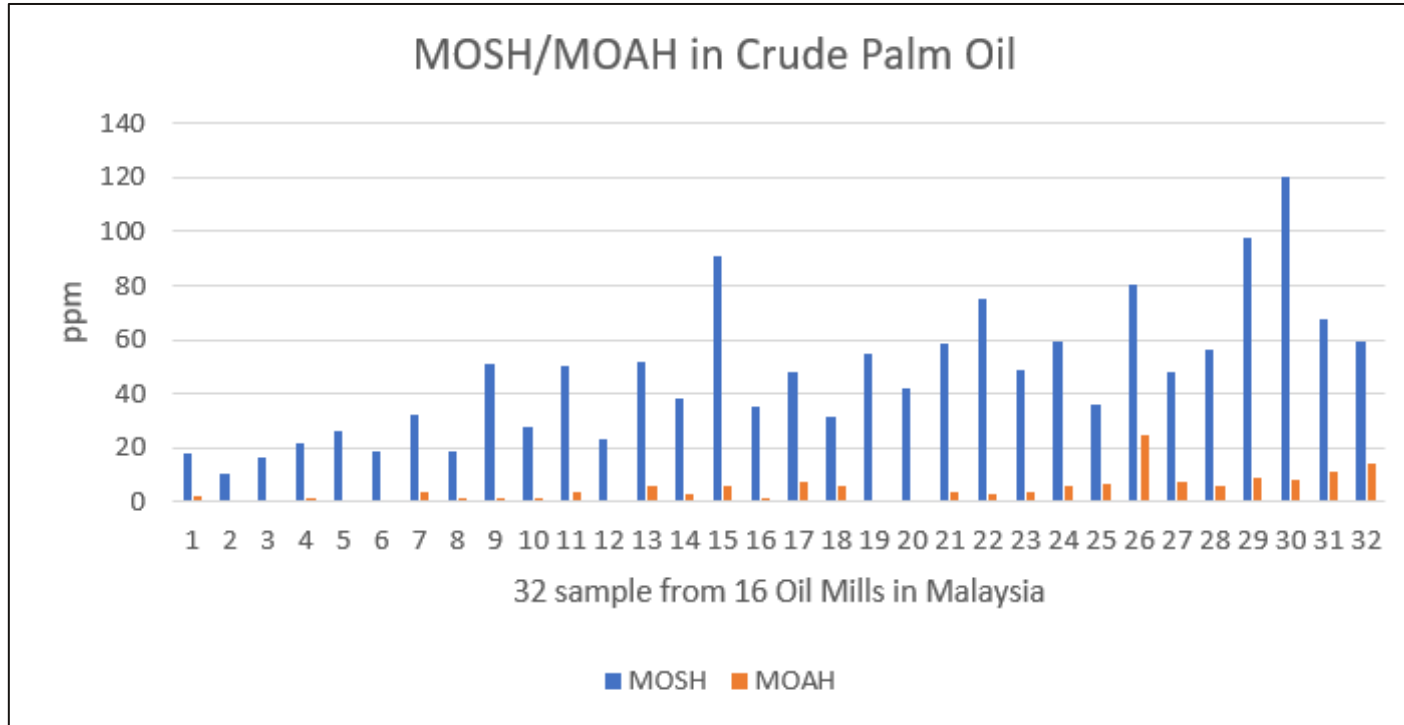
* LOQ : limit of quantification

** ALARA : as low as reasonably achievable



MOSH & MOAH level in crude palm oil

– Samples from oil mills in Malaysia



Observation :

- MOSH are mostly C20 & above (lubricants are mostly long carbon chain for lubricity properties)
- Wide range of MOSH from 10 to 120 ppm; coming from operation malpractices, rather than inherent composition of CPO (CPO usually do not form carbon chain >20)
- MOAH is relatively lower than MOSH (in the ratio of ~1:10)
- With good manufacturing practices, these contaminants can be controlled

MOSH average 47 ppm

MOAH average 4.6 ppm

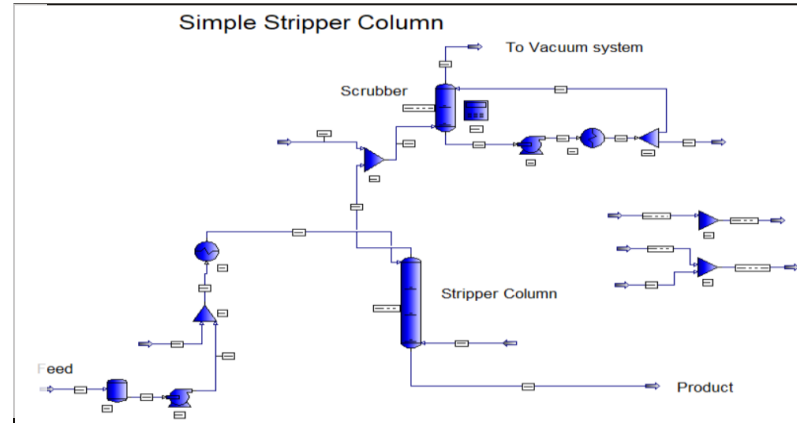


Palm oil MOSH & MOAH reduction – pilot test

– with Alfa Laval PRO II simulation tool and pilot plant

Palm Oil stripping test for MOSH/MOAH removal at :

- Three different temperatures 210°C, 225°C and 240°C
- Analytical results compared with results from simulation tool PROII at same process parameters



based on Alfa Laval's proprietary lipid property library coupled with the process simulator PRO II from SimSci with data provided by customer

Alfa Laval pilot stripping plant in Denmark

Palm Oil			210°C		225°C		240°C	
MOSH		Feed	Pilot Plant	PROII	Pilot Plant	PROII	Pilot Plant	PROII
C10 - C25	ppm	13.9	2.1	0.3	0	0	0	0
C26 - C35	ppm	41	12	16.5	4.7	6	0	3
C36 - C50	ppm	26	33	29.1	26	26.3	17.8	23.3
Sum C10 - C50 (excl. LOQ)	ppm	80.9	47.1	45.9	30.7	32.3	17.8	26.3
Reduction in total MOSH	%		41	43	62	60	77	67
MOAH								
		Feed	Pilot Plant		Pilot Plant		Pilot Plant	
C10 - C25	ppm	2.5	0		0		0	
C26 - C35	ppm	7.6	2.3		0		0	
C36 - C50	ppm	7	6.8		4.9		3.7	
Sum C10 - C50 (excl. LOQ)	ppm	17.1	9.1		4.9		3.7	
Reduction in total MOAH	%		46		71		78	

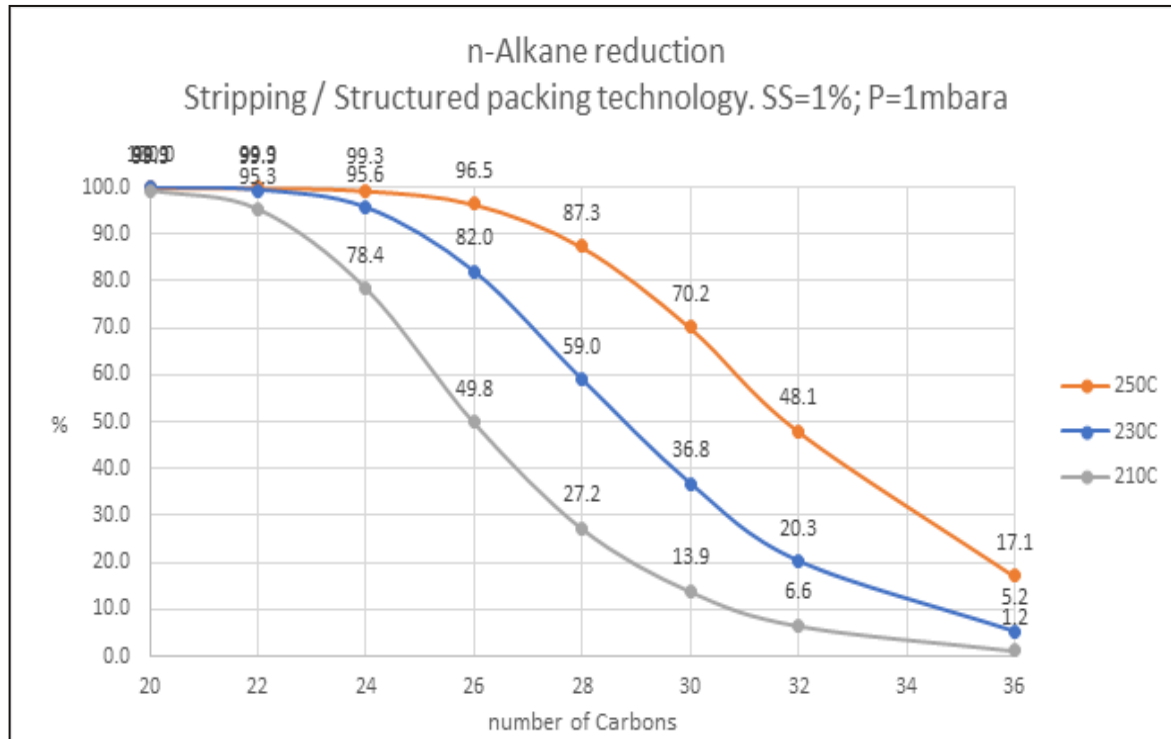


Influence of process parameters on MOSH & MOAH removal

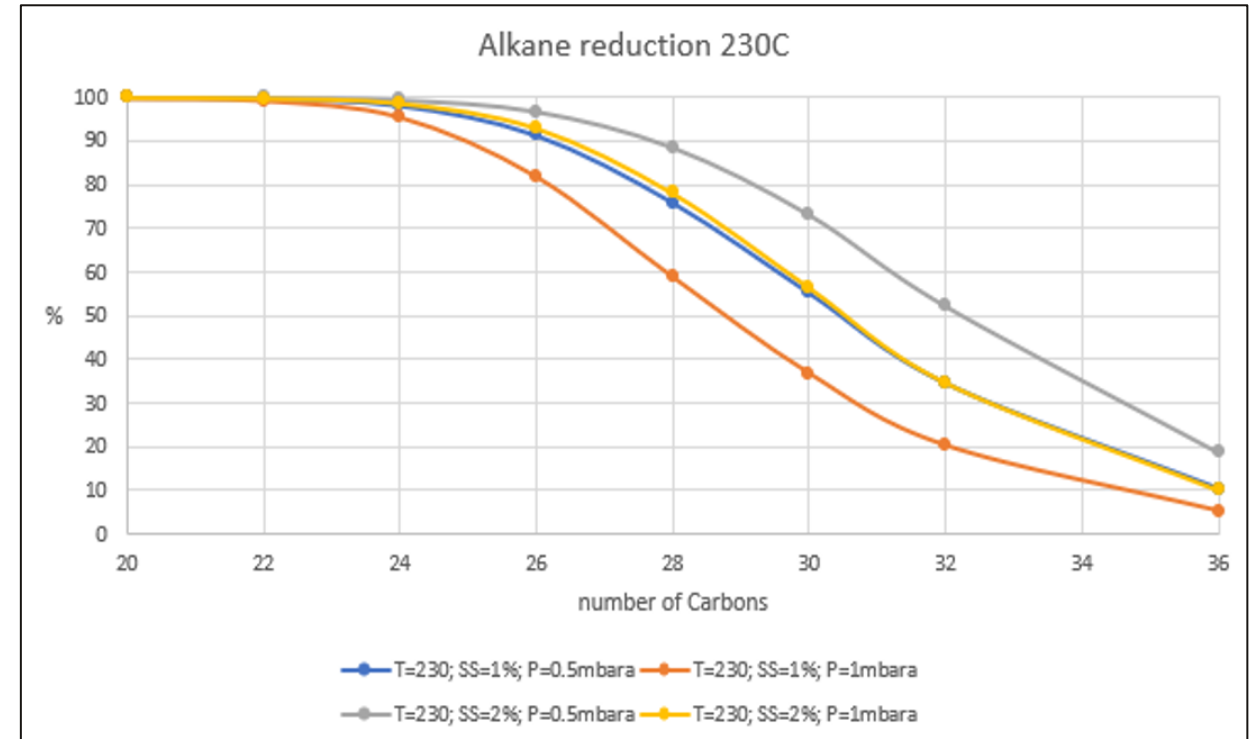


– with Alfa Laval PRO II simulation tool

Temperature influence *



Sparge steam and pressure influence *



- * Data provided by a Malaysian refiner. Result shall vary with other samples. Contact Alfa Laval for personalized simulation
- * Performance based on Alfa Laval's proprietary lipid property library coupled with the process simulator PRO II from SimSci



Conclusion

– Reduction of GE and MOSH with Alfa Laval PalmFlex refining technology

Direct GE stripping can achieve
< 0.5 ppm

Lighter MOSH can be partially
stripped (<C30)

Eliminate the post bleaching
and re-refining steps

In combination with good
manufacturing practices in mill
& refinery

Highest oil quality with low
operating cost

Adoption of food-grade
lubricants is recommended



Alfa Laval PalmFlex refining

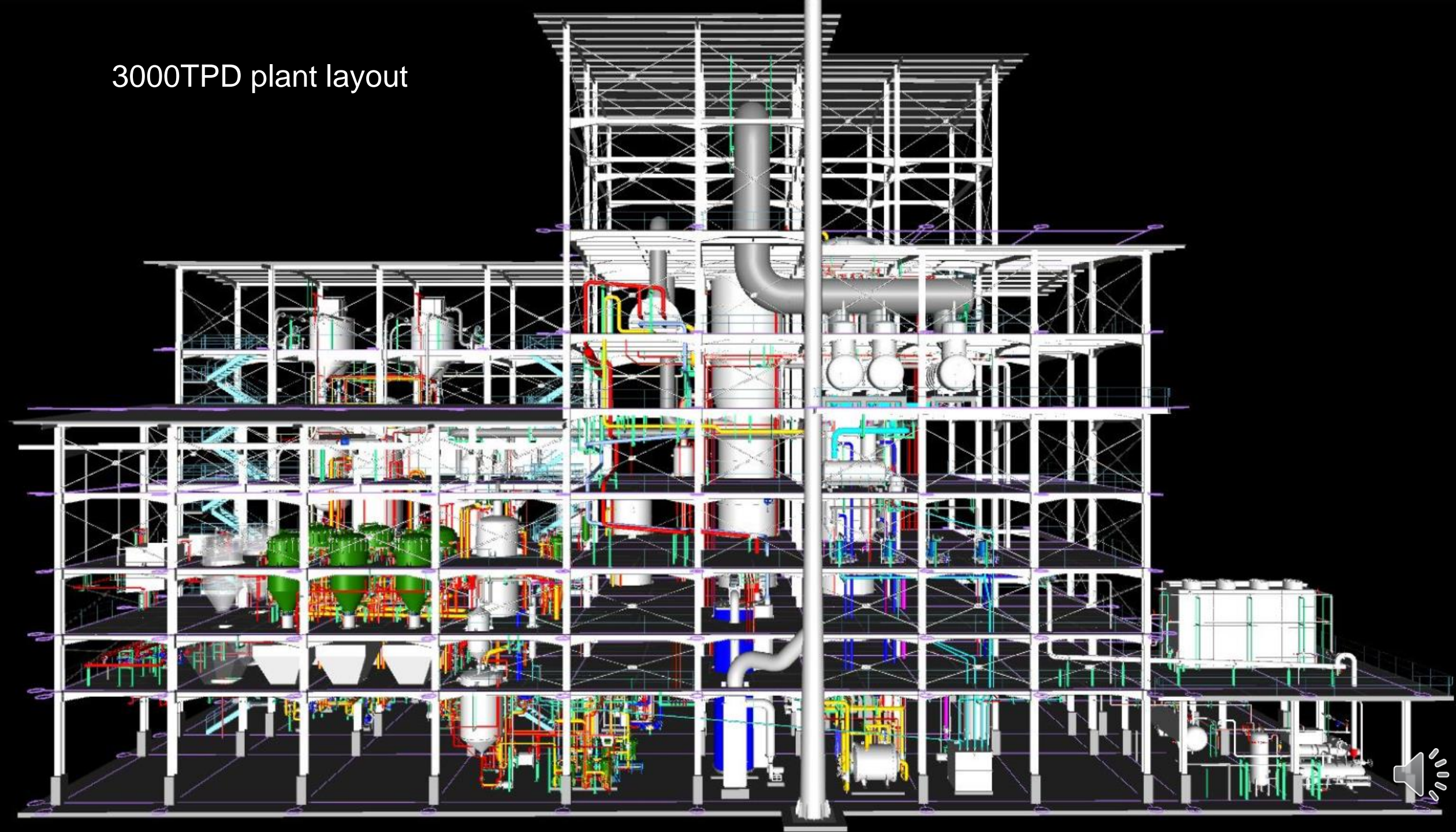
– Highest oil quality with low operating cost



Alfa Laval PalmFlex is a proven refining technology delivering **highest oil quality** to meet stringent demand on **food safety** at **low operating cost**



3000TPD plant layout



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