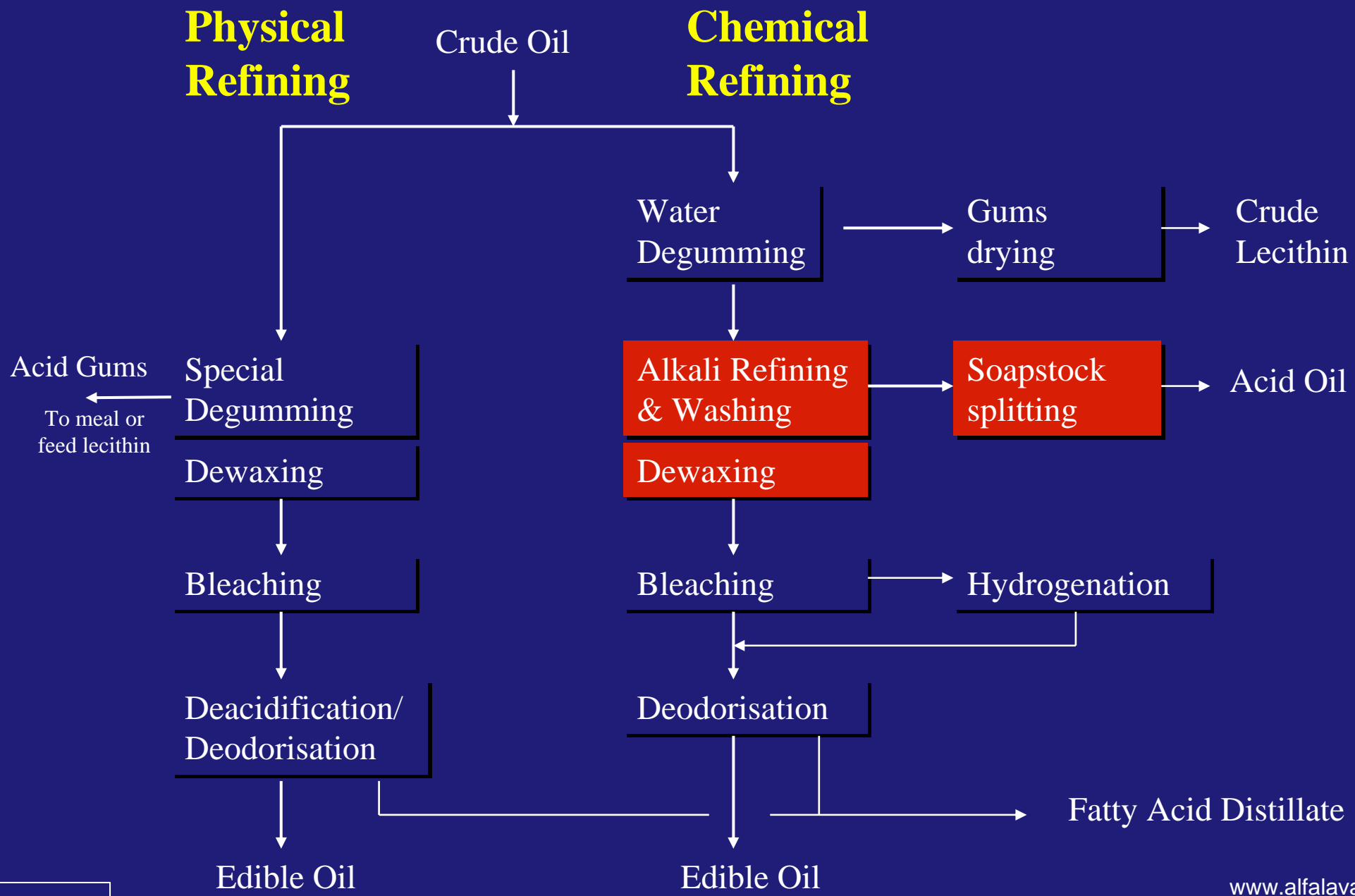


ALFAVAL



Basics of Alkali Refining & Water Washing of Vegetable Oils

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Alfa Laval Copenhagen A/S



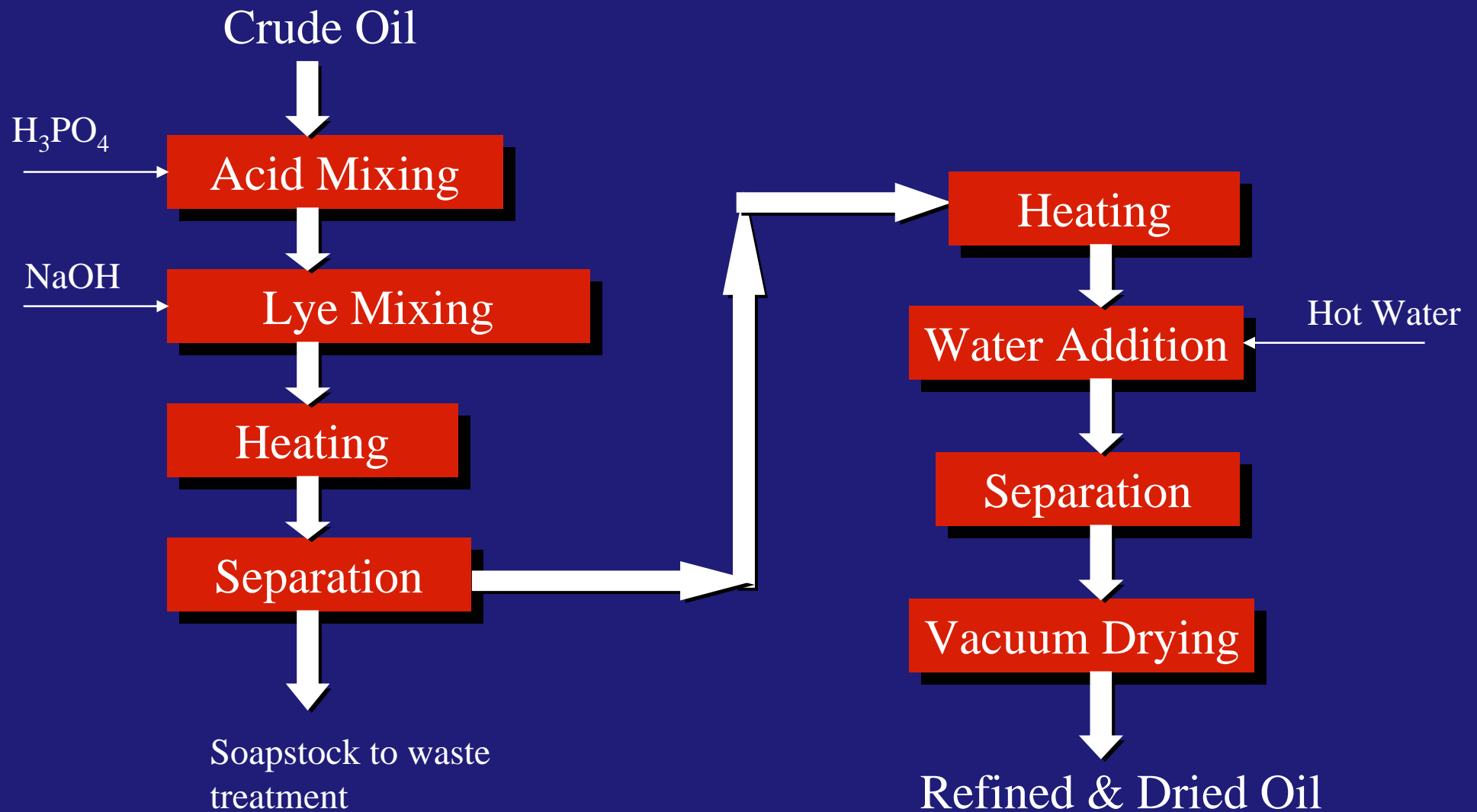
Purpose of Alkali Refining

- Removing of impurities from oil
 - Phospholipids (gums)
 - Colour bodies
 - Metal Ions - Pro-oxidants
 - Iron
 - Copper
 - Free Fatty Acids
 - Solids - meal fines

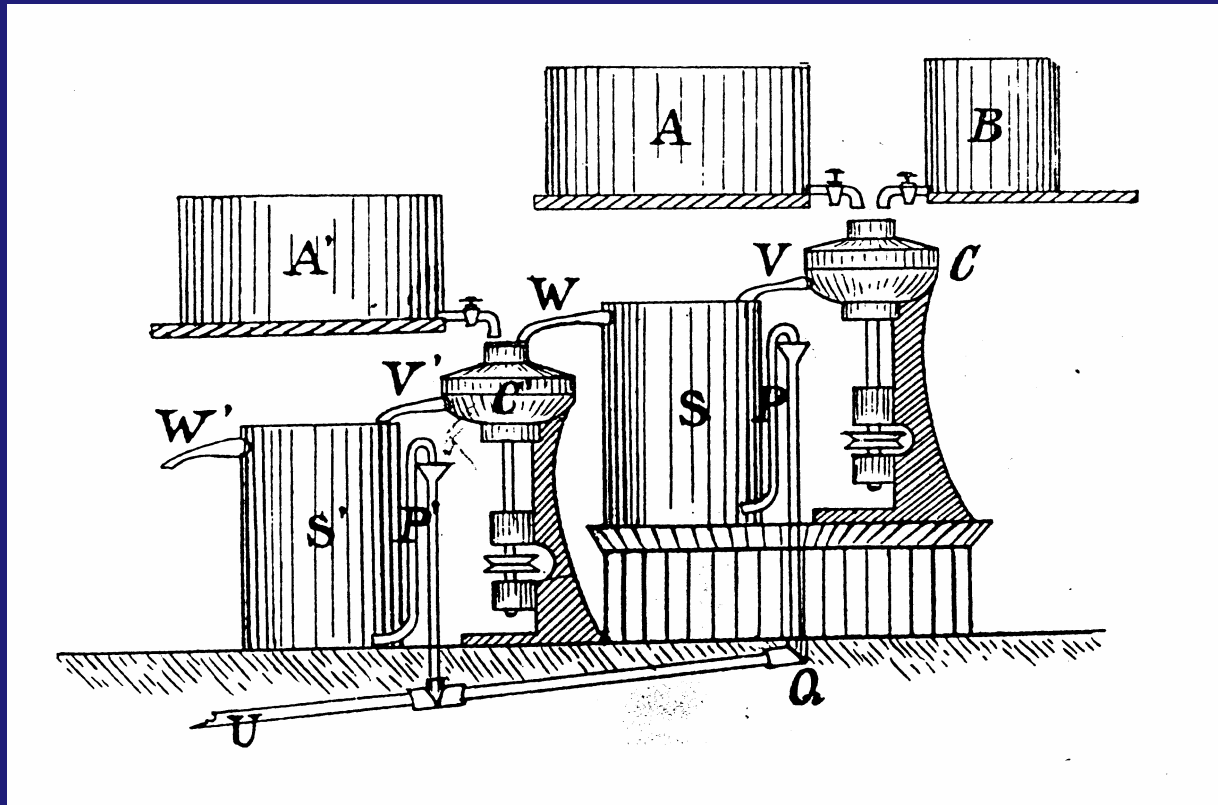
Oil Impurities

- Phospholipids
 - cause emulsions
 - darken oil with heat
 - interfere with crystallization
- Colour Bodies
 - Some have nutritional value
 - Remove to add consumer appeal & functionality in industrial uses (not heat stable)
- Metal Ions
 - act as pro-oxidants degrading the oil quality & stability

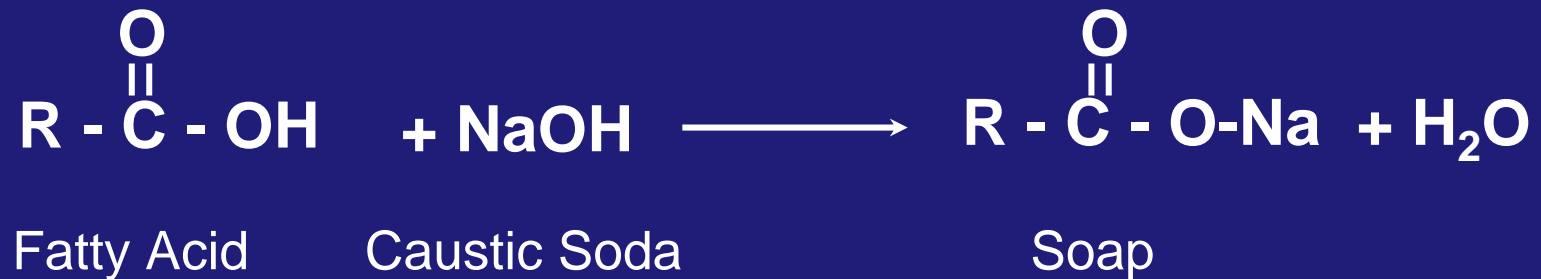
Alkali Refining Process Steps



Alkali Refining Plant - ca. 1892



Neutralization Reaction



Other mechanisms

- colour bodies adsorbed onto soap
- phosphatides hydrated by water in lye
- chelated metal ions removed in soap

Amount of Neutralization Lye

$$\text{Amount of lye} = \frac{A * \text{FFA} * 1000 * k}{100 * M * N} \text{ l/h}$$

where

A = oil flow (kg/h)

FFA = content of free fatty acids (%) *

k = factor for lye excess

M = molecular weight of the fatty acids (kg/mol) **

N = normality of the lye (mol/l)

Amount of Neutralization Lye (cont.)

* Content of free fatty acids has to be adjusted for addition of gum conditioning acid (0,1 % Phosphoric Acid corresponds to approx. 0,8 % FFA)

** Molecular weight of the fatty acids:

- Coconut/Palm kernel	200
- Palm	256
- High Erucic Acid Rapeseed	304
- Most other oils	282

Effect of Lye Excess

- Groundnut oil with 2,5 % FFA refined with 4,25 N lye

Lye excess (%)	FFASS (%)	Refining factor (excl. saponification)	Real refining factor (incl. saponification)
5	55	1,82	1,86
40	75	1,33	1,61
80	80	1,25	1,81

Effect of Acid Conditioning

Oil	Amount of acid % w/w	Soap content (ppm)		P – content (ppm)	
		Neutralised oil	Washed oil	Crude oil	Washed oil
Rapeseed	0	1900	1200	250	180
”	0,15	1500	80	250	5
Sunflower	0	1600	500	320	90
”	0,05	1400	50	320	2
Corn	0	2100	1500	540	120
”	0,10	1100	80	540	4
Soybean	0	700	120	90	20
”	0,10	600	40	90	2

Washing and Drying

- Washing
 - Hot soft process water should be used
 - 5 -10 % of oil flow
- Drying
 - 70 mm Hg vacuum

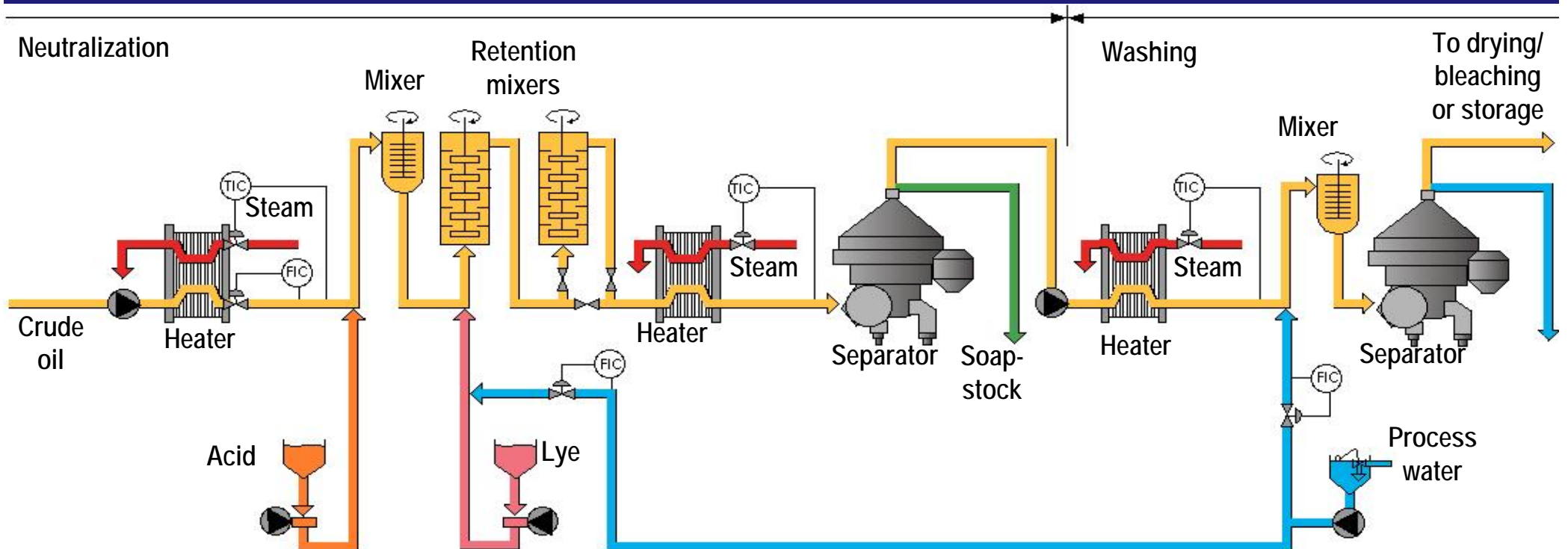
Refining Process - Selection

		P - content	
		< 200 ppm	> 200 ppm
FFA	< 1,5 %	Long-Mix or Multi-Mix	Long-Mix
	1,5 – 3 %	Multi-Mix (2-stage)	Multi-Mix (3-stage)
	> 3 %		

Long-Mix Process Steps

- Acid pre-treatment
- Lye mixing
- Retention mixing
- Emulsion break heating
- Centrifugal separation of soapstock
- Heat
- Water addition and mixing
- Centrifugal separation of wash water
- Vacuum drying of refined and washed oil

Long-Mix Process



Long-Mix – Lye Treat Conditions

	Strength (°Bé)	Excess (%)	Reaction time (min)
Crude seed oils	14 - 22	70 - 100	3 – 6
Degummed seed oils	16 - 26	35 - 70	2 – 5
Cottonseed	18 - 36	70 - 200	6 – 10
Corn	18 - 20	35 - 100	1 - 2

Long-Mix

Target Results

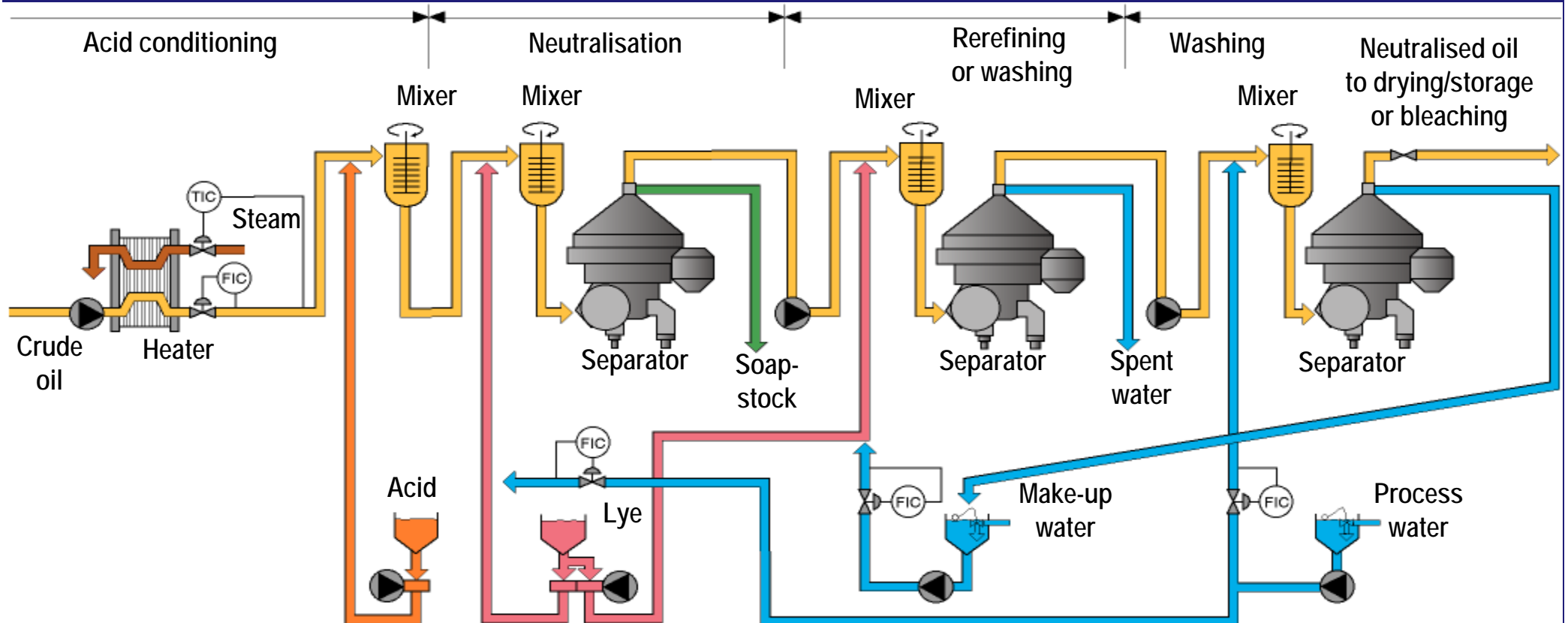
- Phosphorous in oil after S1 - 8 to 12 ppm, 20 ppm max.
- Soap in oil after S1 - 200 to 300 ppm, 400 ppm max.

- Phosphorus in oil after S2 – max. 4 ppm
- Soap in oil after S2 – max. 50 ppm
- FFA in oil – 0,02 to 0,04 %, 0,05 % max.
- Moisture in oil – max. 0,5 % or 0,05% if dried
- Loss = max. $0,8 + 1,25 \times TL$

Multi-Mix Process Steps

- Heat
- Acid pre-treatment
- Lye mixing
- Centrifugal separation of soapstock
- Lye or water mixing
- Centrifugal separator of soapstock or wash water
- Water addition and mixing
- Centrifugal separation of wash water
- Vacuum drying of refined and washed oil

Multi-Mix Process



Multi-Mix – Lye Treat Conditions

	Strength (°Bé)	Excess (%)	Reaction time (sec)
Crude seed oils	20 - 28	30 - 60	15 - 30
Degummed seed oils	20 - 28	10 - 30	1 - 3
Cottonseed	20 - 28	10 - 50	>1
Animal & Fish	20 - 28	10 - 30	1 - 3

Multi-Mix

Target Results

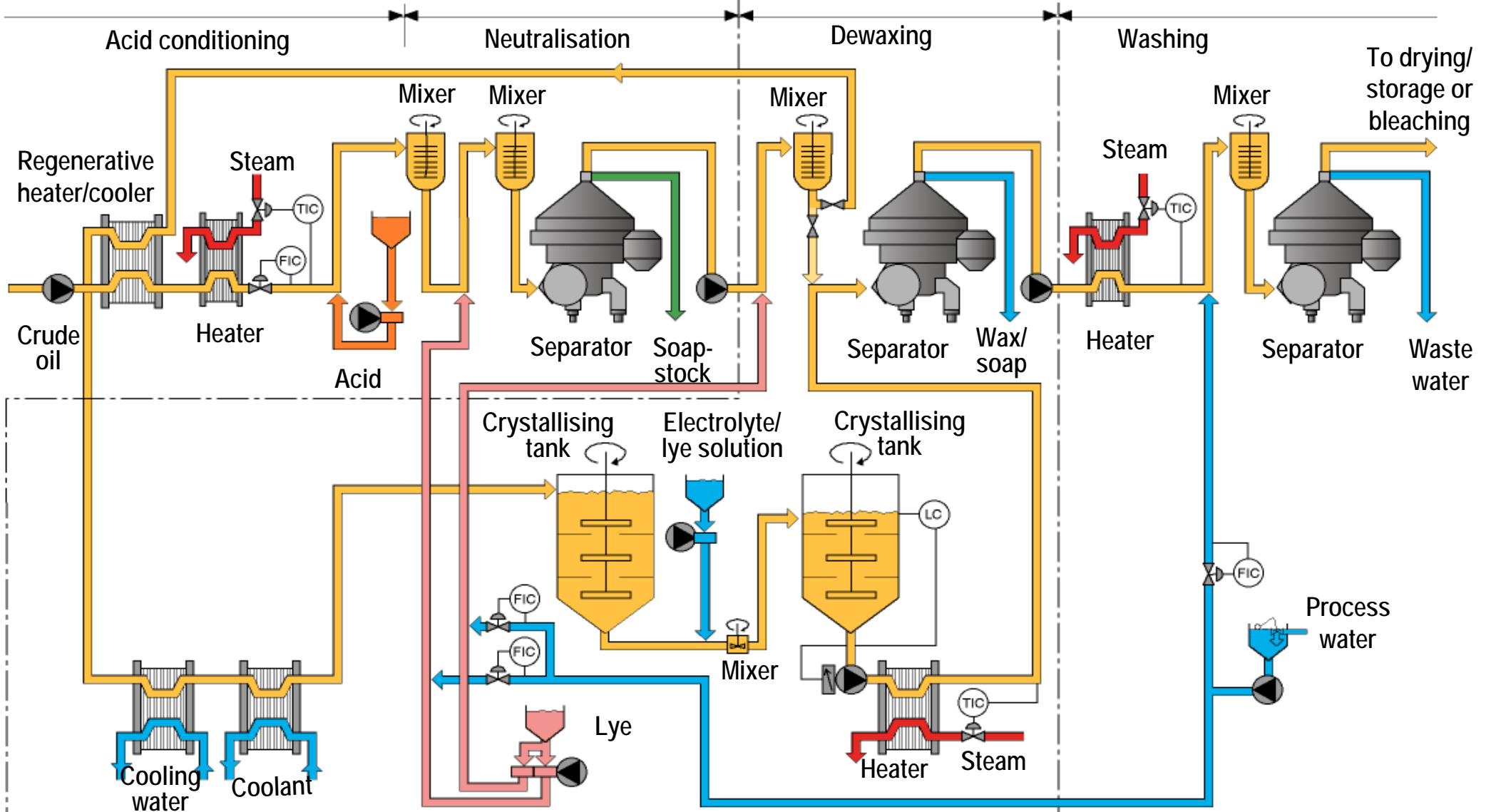
- Phosphorous in oil after S1 - 8 to 12 ppm, 20 ppm max.
- Soap in oil after S1 - 500 to 700 ppm, 1000 ppm max.

- Phosphorus in oil after S3 – max. 4 ppm
- Soap in oil after S3 – max. 30 ppm
- FFA in oil – 0,02 to 0,04 %, 0,05 % max.
- Moisture in oil – max. 0,5 % or 0,05% if dried
- Loss = max. $0,3 + 1,25 \times TL$ (+ 0,3 % if re-refining)

Multi-Wax Process Steps

- Heat
- Acid pre-treatment
- Lye mixing
- Centrifugal separation of soapstock
- Lye mixing
- Cool
- Crystallization
- Heat
- Centrifugal separator of waxes and soapy water
- Heat
- Water addition and mixing
- Centrifugal separation of wash water
- Vacuum drying of refined and washed oil

Multi-Wax Process



Multi-Wax

Target Results

- Soap in oil after S1 - 1500 to 2000 ppm, 2500 ppm max.
- Phosphorus in oil after S3 – max. 4 ppm
- Soap in oil after S3 – max. 50 ppm
- Wax removal – min. 85 %
- FFA in oil – 0,02 to 0,04 %, 0,05 % max.
- Moisture in oil – max. 0,5 % or 0,05% if dried
- Loss = max. $0,7 + 1,25 \times TL$ for 600 ppm wax content or
max. $1,2 + 1,25 \times TL$ for 1500 ppm wax content

Other Refining Process

- Cold neutralization
 - combined neutralization and dewaxing
- Miscella refining
 - neutralization in the miscella phase
- Modified Caustic Refining (MCR)

Dry Refined Oil Quality Targets

- Soap - < 30 ppm
- Phosphorous - < 2 ppm
- Iron - < 0.2 ppm
- Copper - < 0.01 ppm
- FFA - < 0.05%
- Moisture - < 0.05%