Westfalia Separator
Food Tec GmbH

Mechanical Separation
Division

Basics of Alkali Refining of Vegetable Oils

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Objectives of Refining

1. Removal of undesired products from crude oils
   - free fatty acids (FFA)
   - phospholipids (gums)
   - oxidised products
   - metal ions
   - colour pigments
   - others

2. Preservation of valuable vitamínes.
   (vitamina E or tocopherol – natural anti-oxidants)

3. Minimize oil losses

4. Protection of the oil against degradation

Steps of the chemical refining process

1. Degumming: Reduction of phospholipid (gum) content
2. Neutralisation: Removal of free fatty acids and residual gums
3. Bleaching: Removal of colour pigments and metal ions
4. Desodorization: Removal of odours

NEUTRALISATION

Objective:

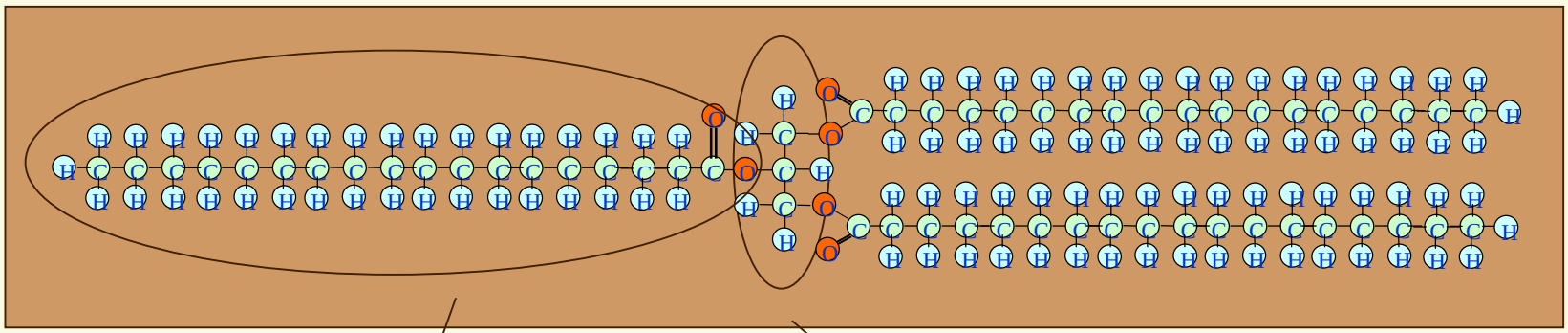
Removal of free fatty acids

Two different refining principles:

1. Chemical Refining: Removal by a chemical reaction with alkali (caustic soda).

2. Physical Refining: Removal by distillation at higher temperature and low vacuum

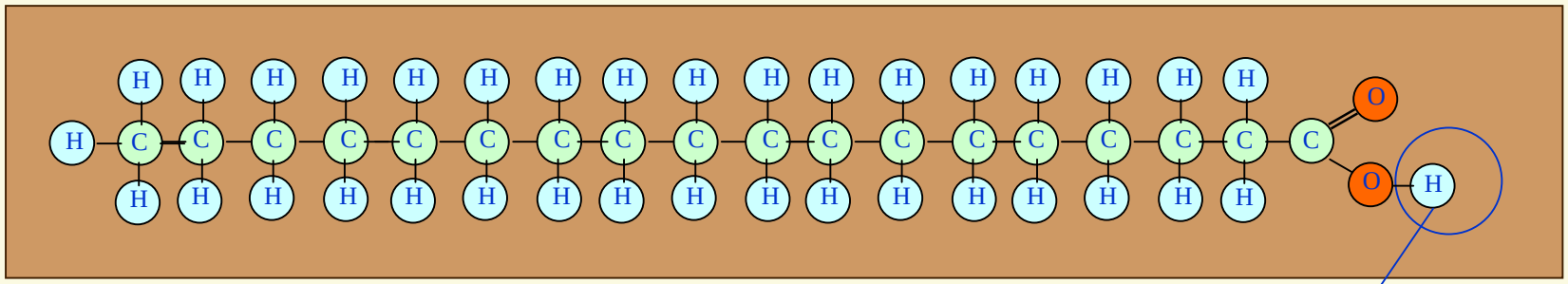
Structure of Triglycerides



Stearic acid

Glycerol

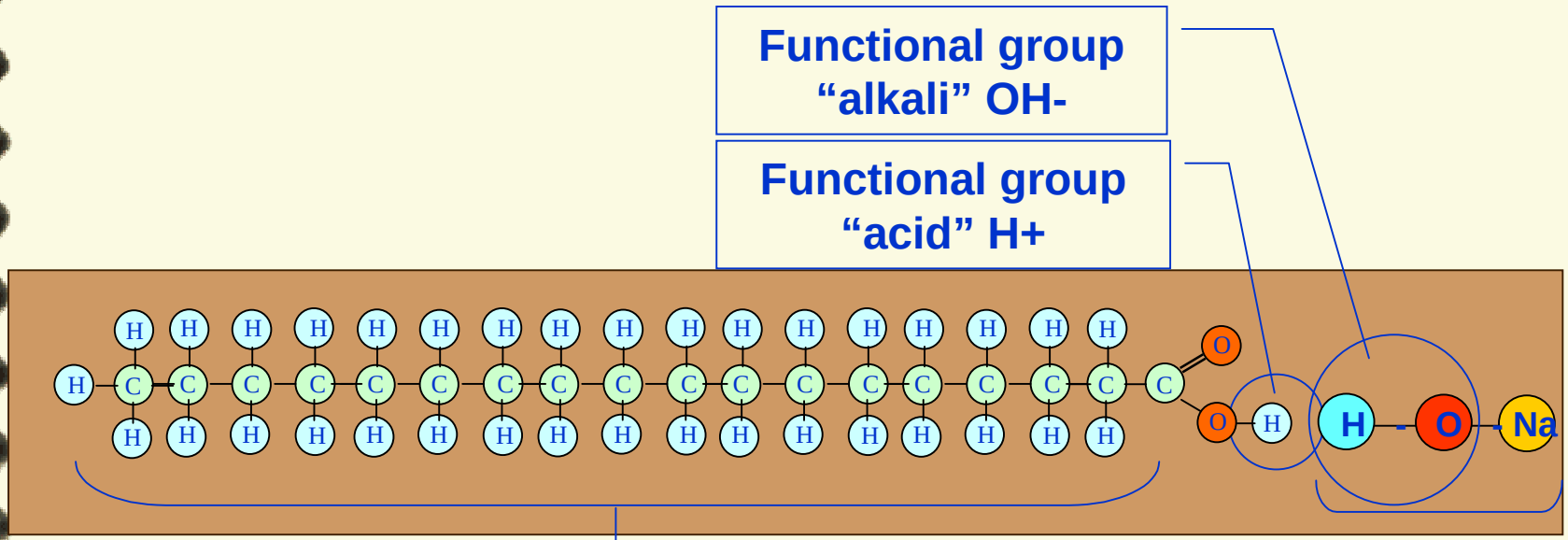
Structure of a free fatty acid molecule



Functional group "acid" H+

Stearic acid ($C_{18}H_{36}O_2$)

Chemical Neutralisation
(after the reaction with caustic soda)



fatty acid + caustic soda

= soap + water

Alkali Refining

Process steps:

1. Conditioning:

Transformation of the non-hydratable phospholipids into their hydratable form by breaking down the metal/ phosphatide complexes with a strong acid.

2. Neutralisation

Saponification of the free fatty acids by alkali (caustic soda).

3. Washing:

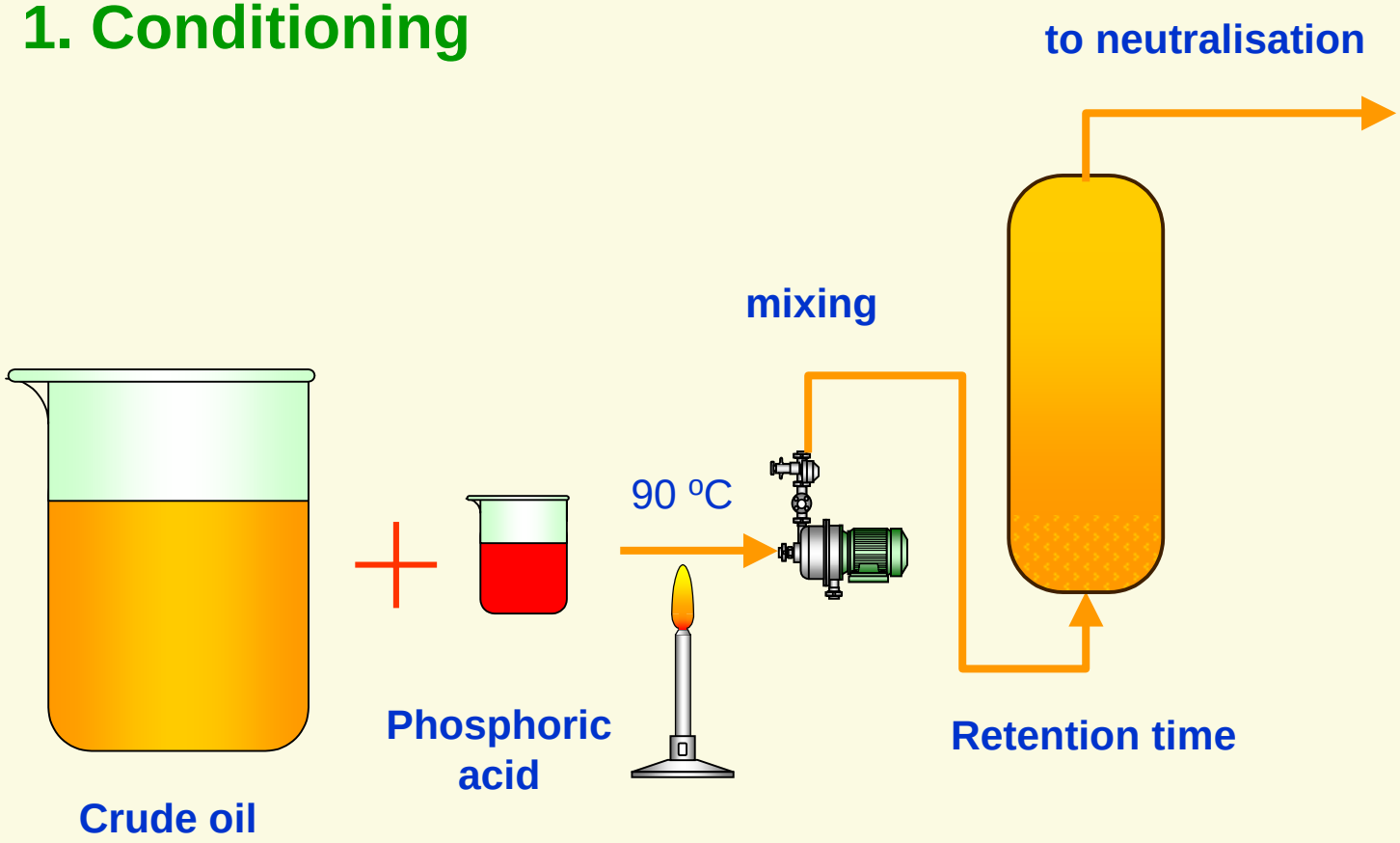
Removal of residual soaps by hot water.

4. Drying:

Removal of moisture under vacuum.

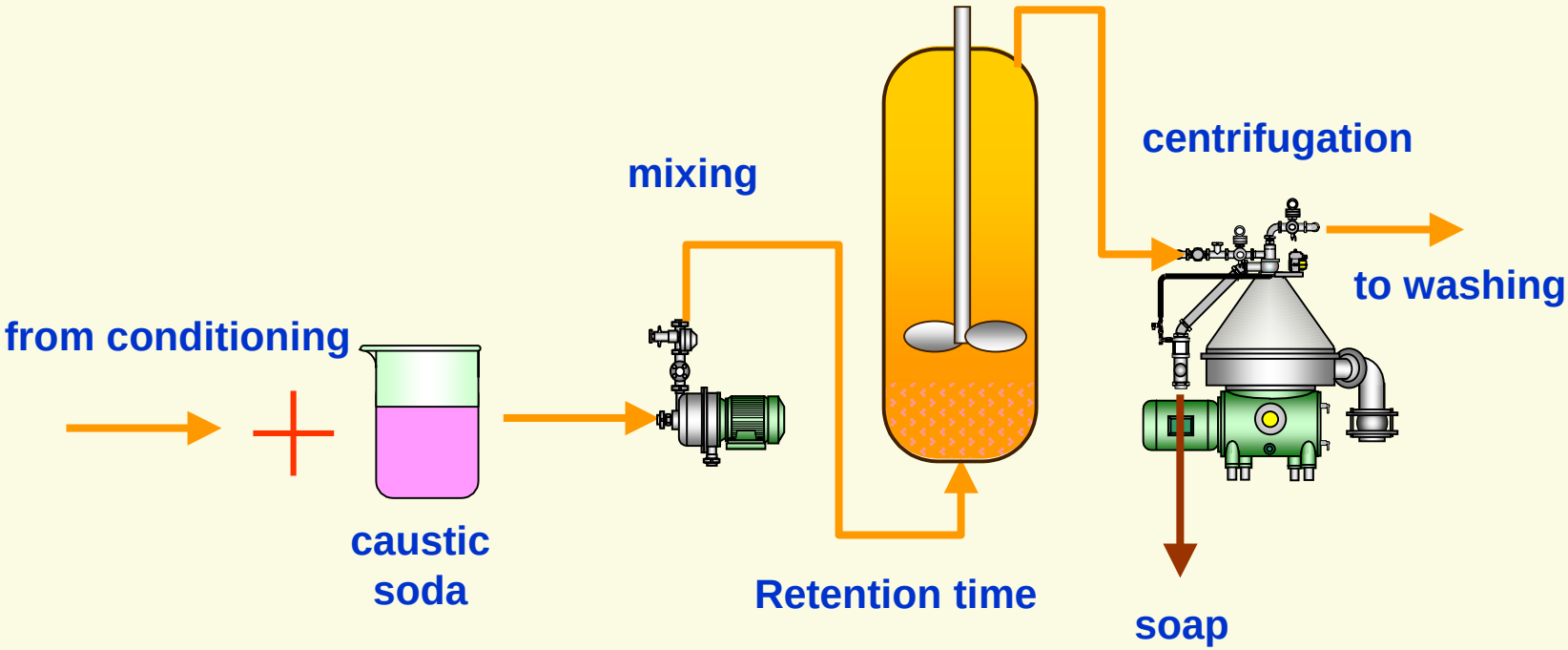
Steps of Alkali Refining

1. Conditioning



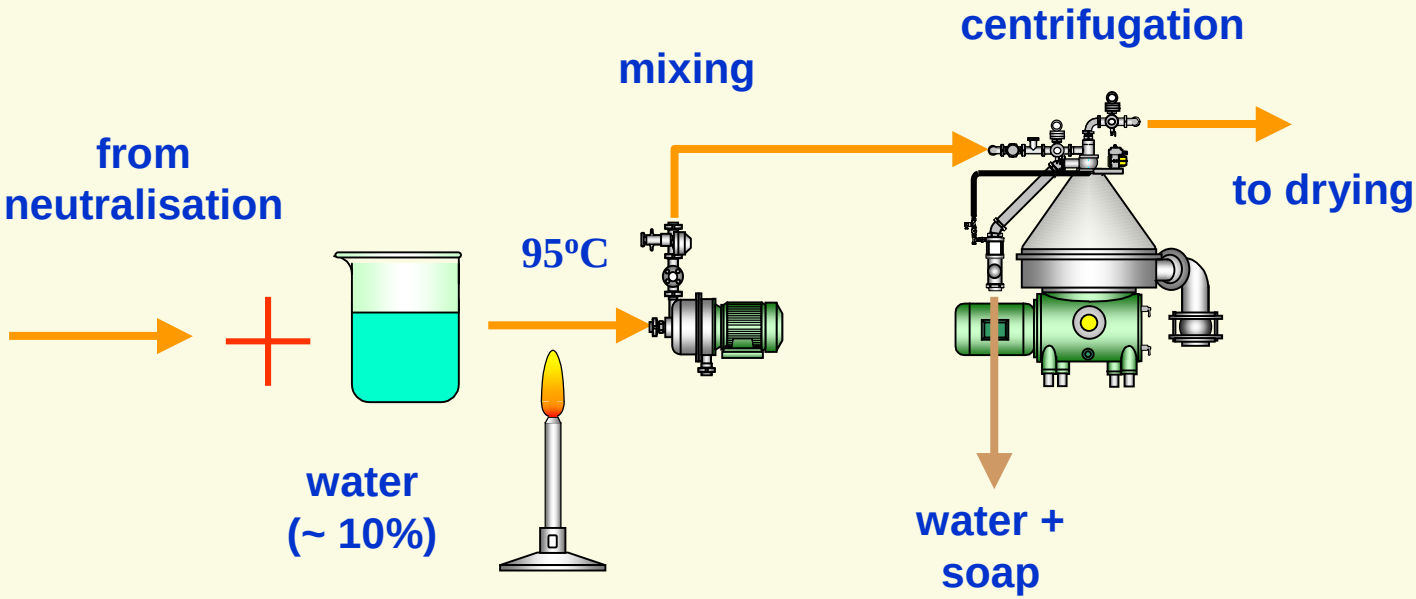
Steps of Alkali Refining

2. Neutralisation



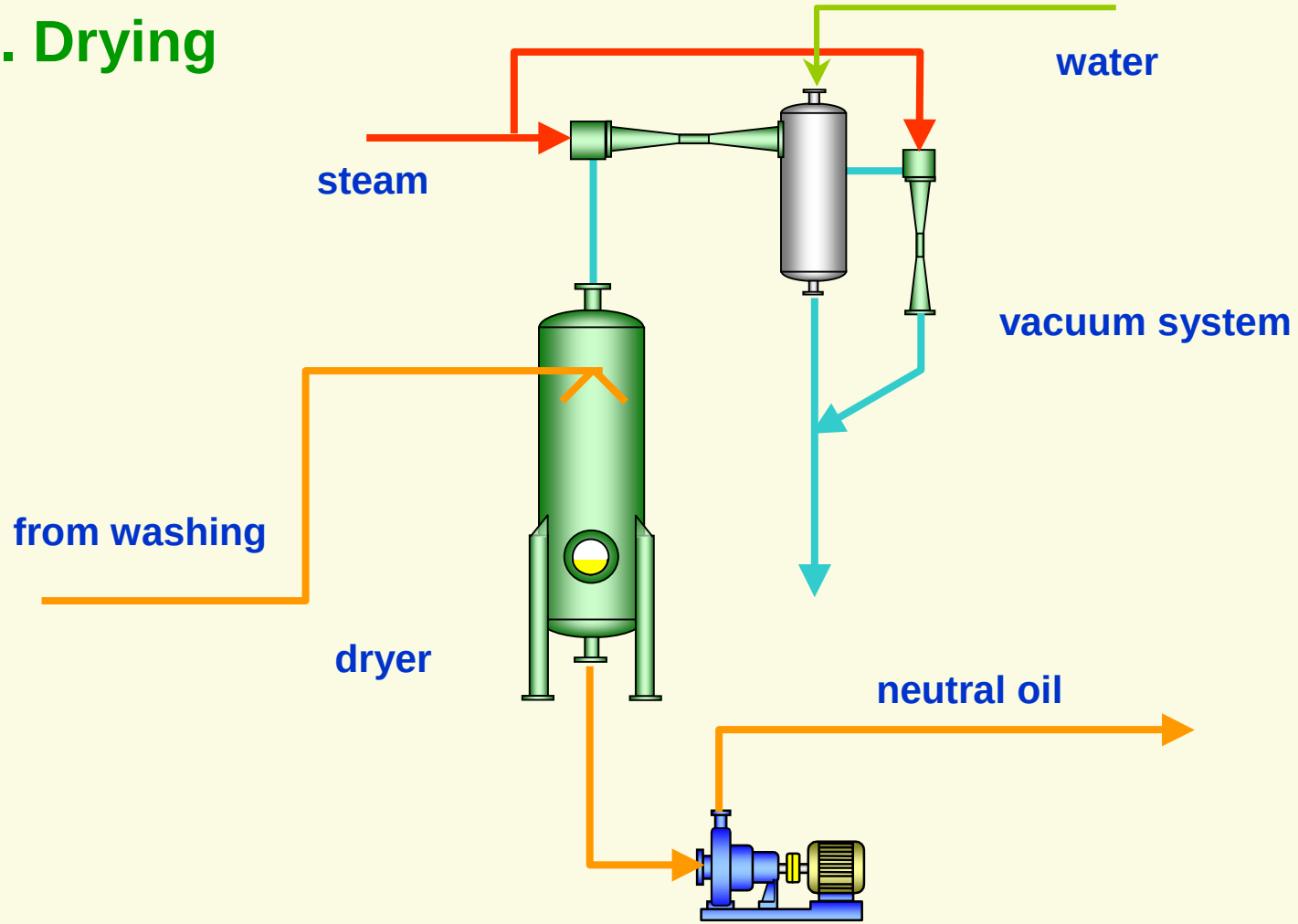
Steps of Alkali Refining

3. Washing



Steps of Alkali Refining

4. Drying

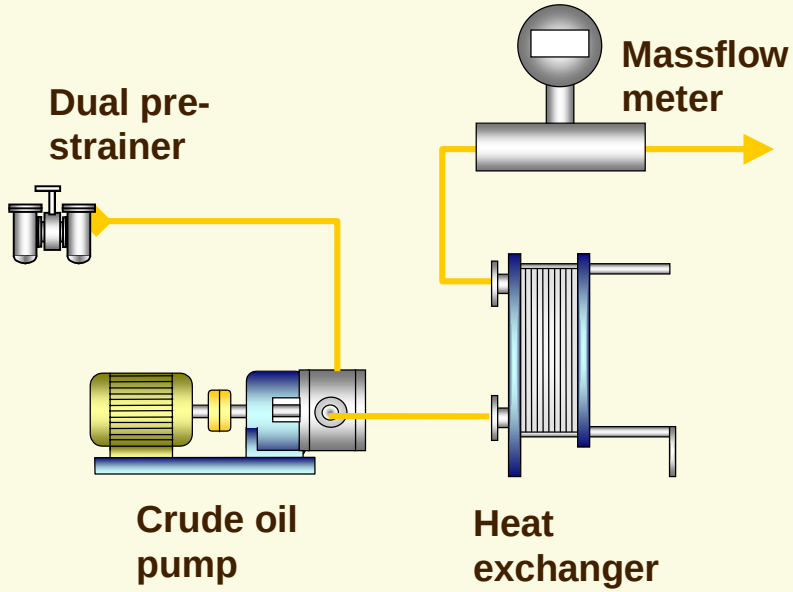


Alkali Refining: Plant Design
Crude oil dosation

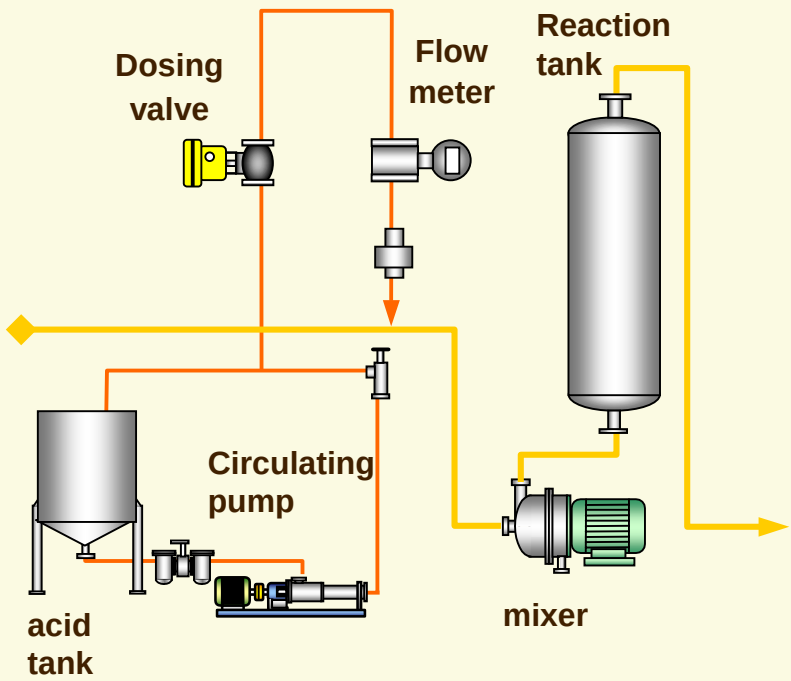
The capacity of the plant is adjusted by a speed controlled crude oil pump in combination with a massflowmeter.

A pre-strainer is installed to protect the pump and following equipment .

The oil temperature is adjusted with a heat exchanger by means of steam.



Alkali Refining: Plant Design
Acid Conditioning



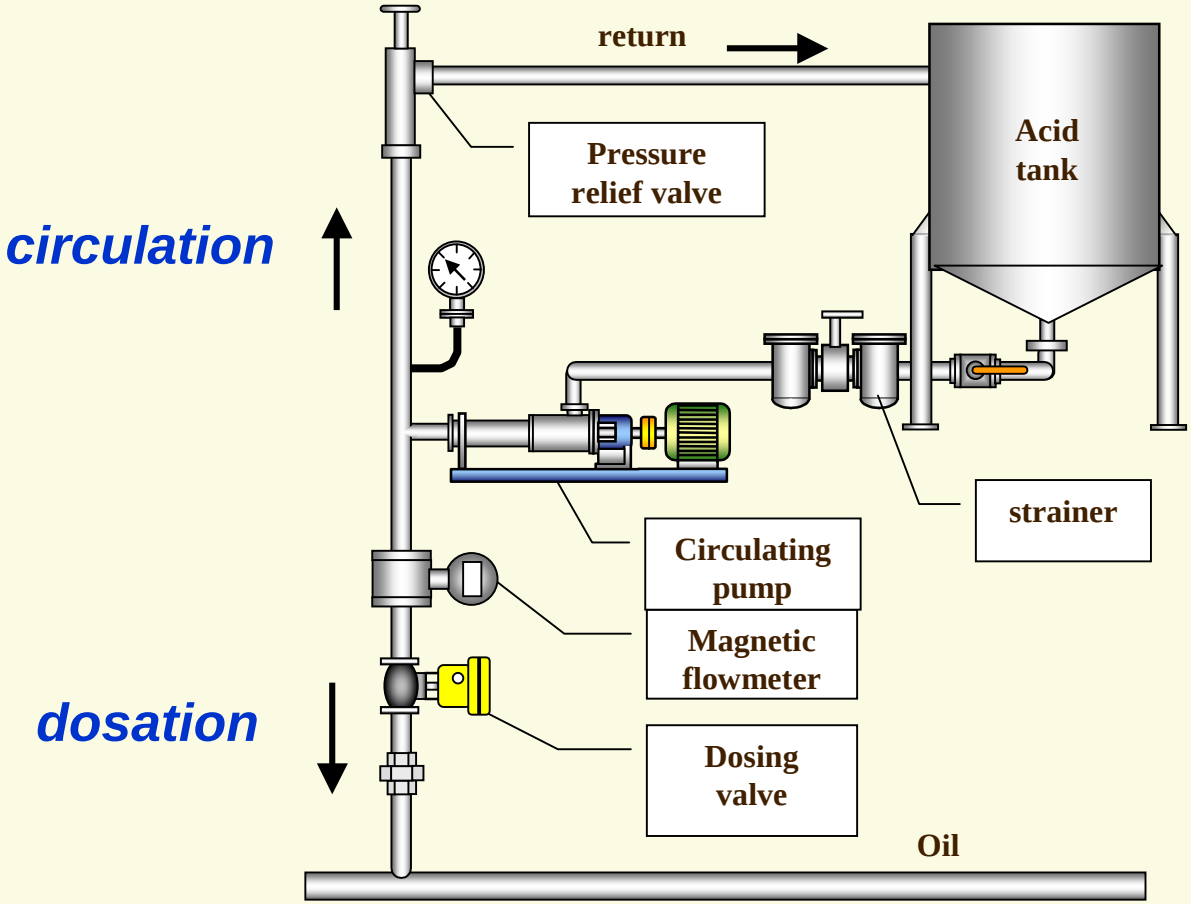
The acid is circulated with a certain pressure by a circulating pump.

The dosing is done by a magnetic flowmeter and a pneumatic dosing valve.

The acid flow is controlled by the PLC in relation to the oil flow.

Acid and oil is mixed intensively by a dynamic mixer followed by a retention time (5min.)

Alkali Refining: Plant Design
Details of the acid dosing system



Alkali Refining: Plant Design
Neutralisation

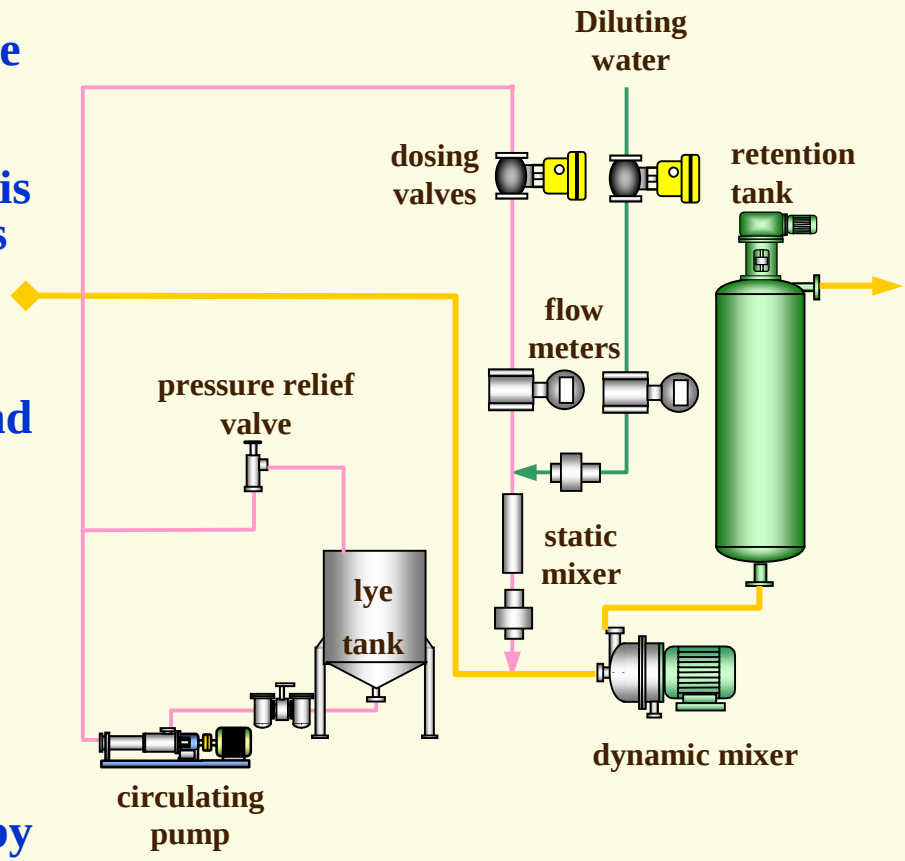
Concentrated caustic soda is circulated with a certain pressure by a circulating pump.

Dosing of lye and diluting water is done with a magnetic flowmeters and a pneumatic dosing valves.

The lye flow is controlled by the PLC in relation to the oil flow and the FFA content.

The diluting water flow is controlled in relation to the lye flow and the lye dilution degree.

Conc. lye and diluting water is mixed by a static mixer, the diluted lye is mixed with the oil by a dynamic mixer, followed by a retention time (approx. 10 min.)



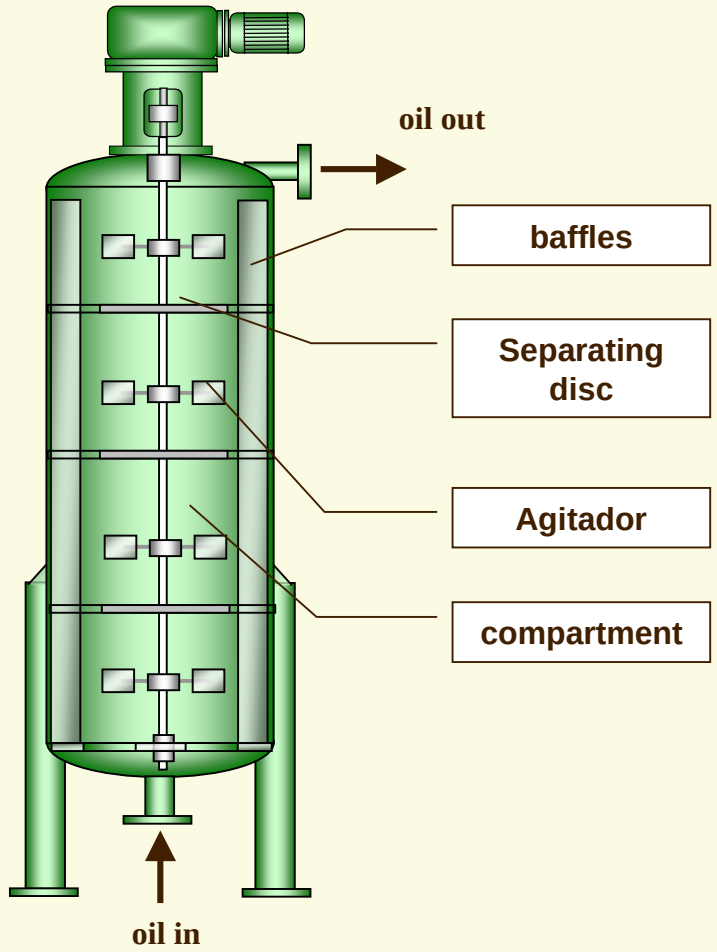
Alkali Refining: Plant Design
Details of caustic soda retention tank

Divided into several compartments to ensure an even retention time.

Smooth agitation to avoid decantation of soap and emulsification.

Soap flocks are agglomerated to larger particles to improves separation efficiency in the centrifuge.

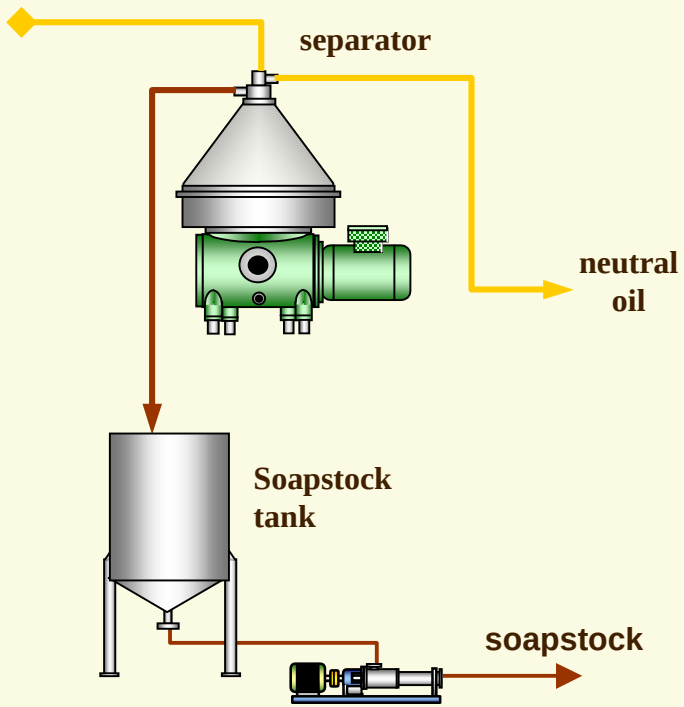
Hydration of phospholipids is improved.



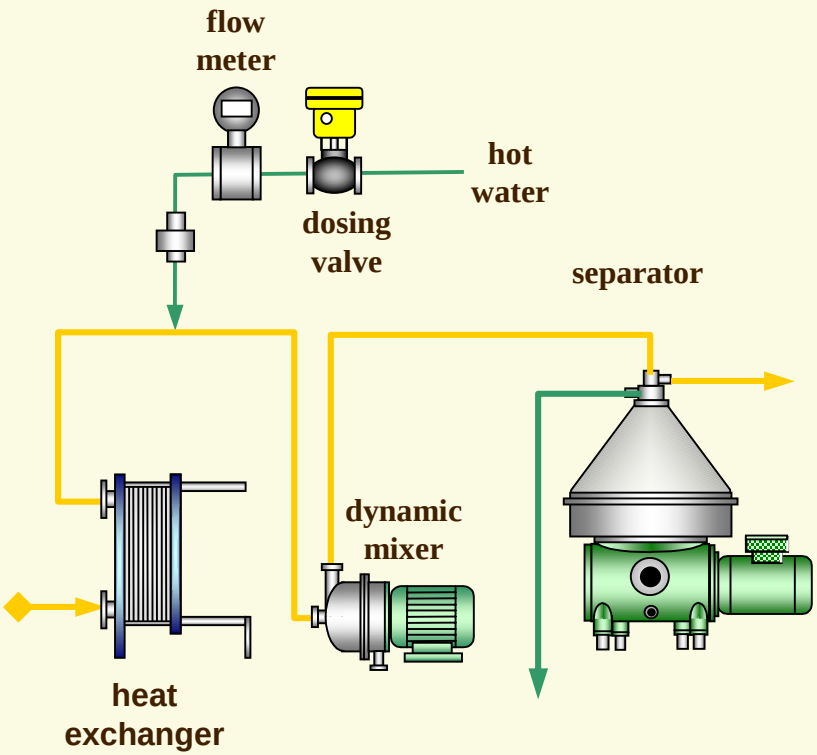
Alkali Refining: Plant Design
Soapstock separation

Soapstock is continuouly discharged by the separator to the soapstock tank.

Residual soap content in neutral oil < 500 ppm.



Alkali Neutralisation: Plant Design
Water washing



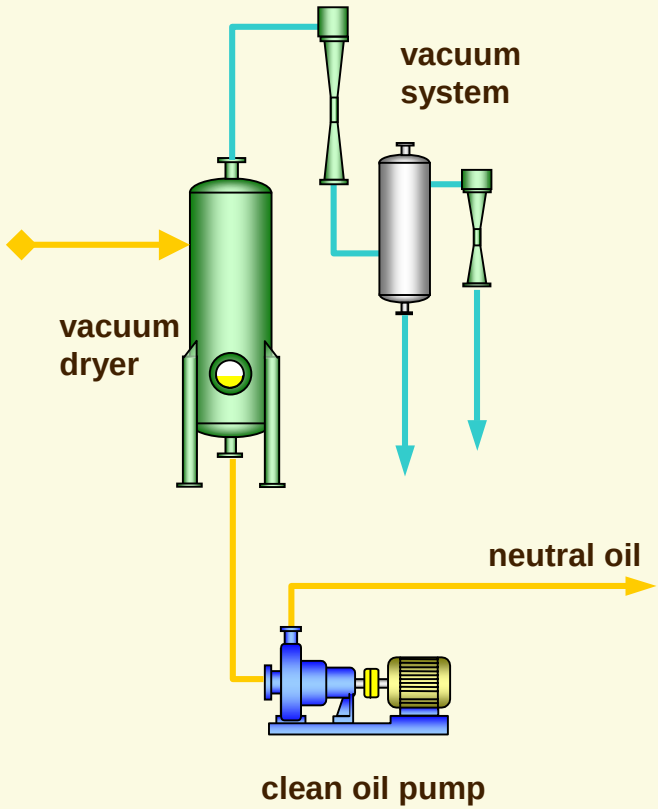
Neutral oil is heated to optimal washing temperature (95 °C).

Hot and soft water ist added to the oil and mixed intensively by a dynamic mixer.

Washing water flow is controlled by the PLC in relation to the oil flow.

Wash water is separated immediately after mixing, no retention time.

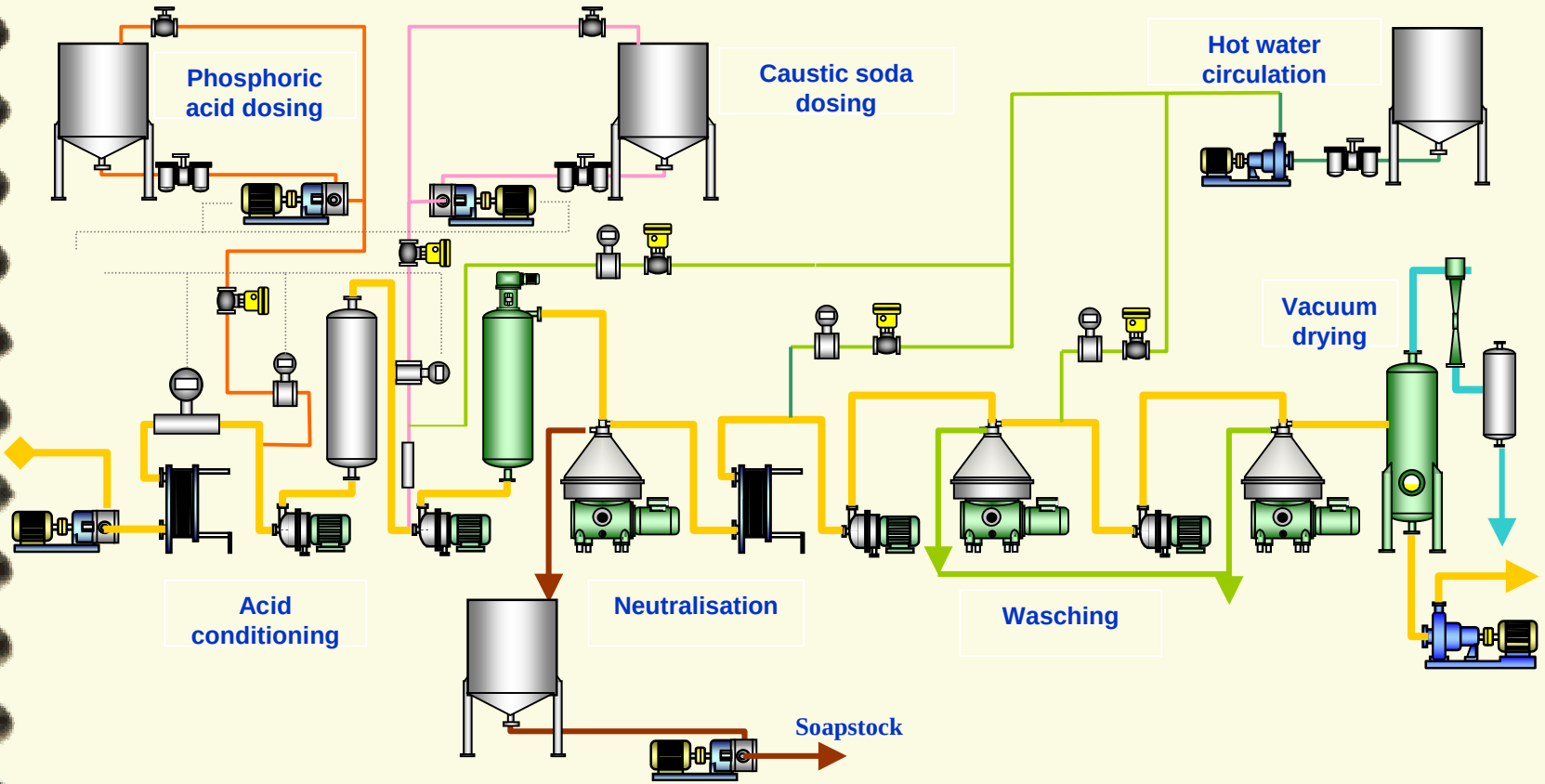
Alkali Refining: Plant Design
Vacuum drying



Residual moisture is removed by a dryer under a vacuum of < 50 mbar.

Final moisture content < 0,1 %.

Alkali Refining: Plant Design
Complete 3-stage plant



Alkali Refining: Chemicals
Phosphoric acid

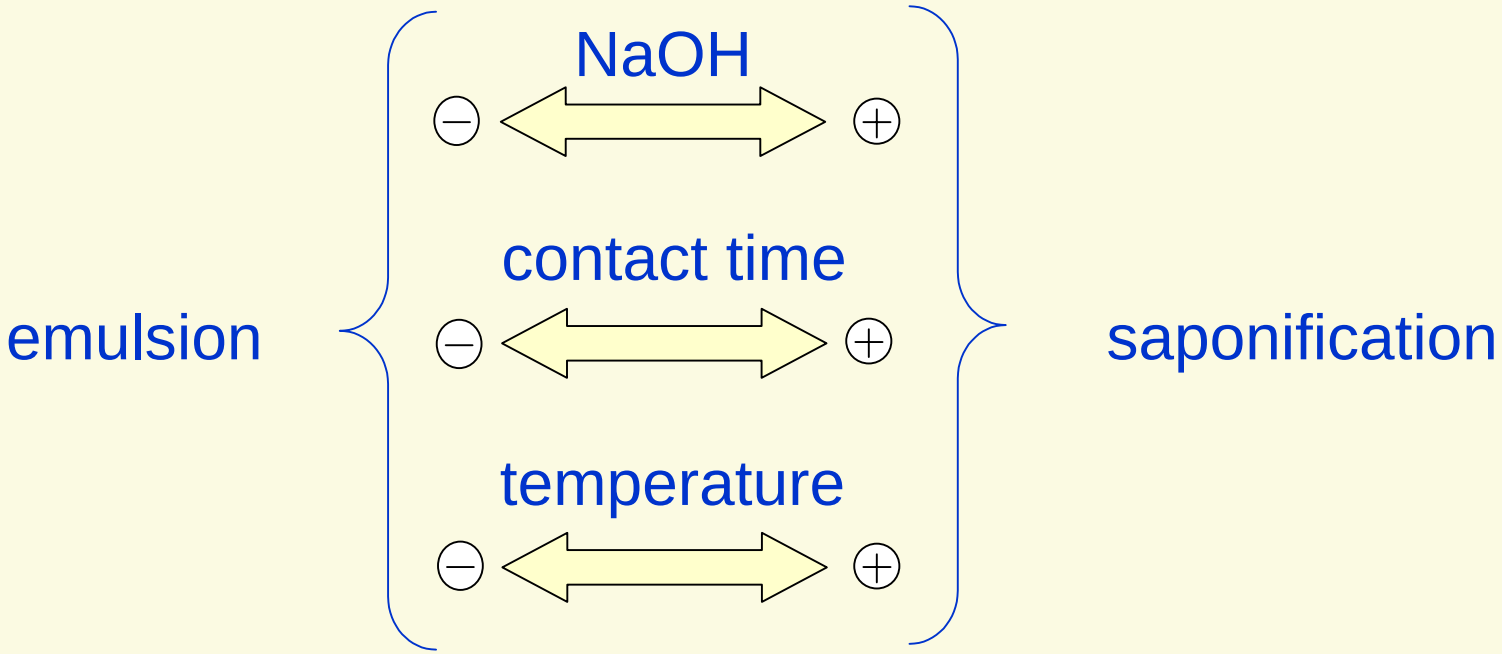
- ✓ **Converts the non-hydratable phospholipids into their hydratable form by breaking up the Ca- and Mg-complexes of phosphatitic acid (PA) and phosphadityl etholamine (PE).**
- ✓ **Concentration: 75 – 85 %**
- ✓ **Addition : 1 – 3 kg / t oil**
- ✓ **Temperature: 80 – 90 °C**

Alkali Refining: Chemicals
Caustic soda

- ✓ **Neutralises the free fatty acids by saponifying them into sodium salts.**
- ✓ **Saponifies and hydrates phospholipids**
- ✓ **Removes colour pigments**
- ✓ **Concentration: 12 – 24 °Bé**
- ✓ **Addition: stochiometric amount to neutralise the phosphoric acid and the free fatty acids plus an excess of 0 – 40 %**
- ✓ **Calculation: 0,142 kg NaOH (100%) per kg FFA + 0,816 kg NaOH (100%) per kg H_3PO_4 (100%)**

Alkali Refining: Chemicals
Caustic soda

- ✓ **Finding the optimal condition between:**
  - **Neutral oil saponification and emulsification**



Alkali Refining: Chemicals
Water

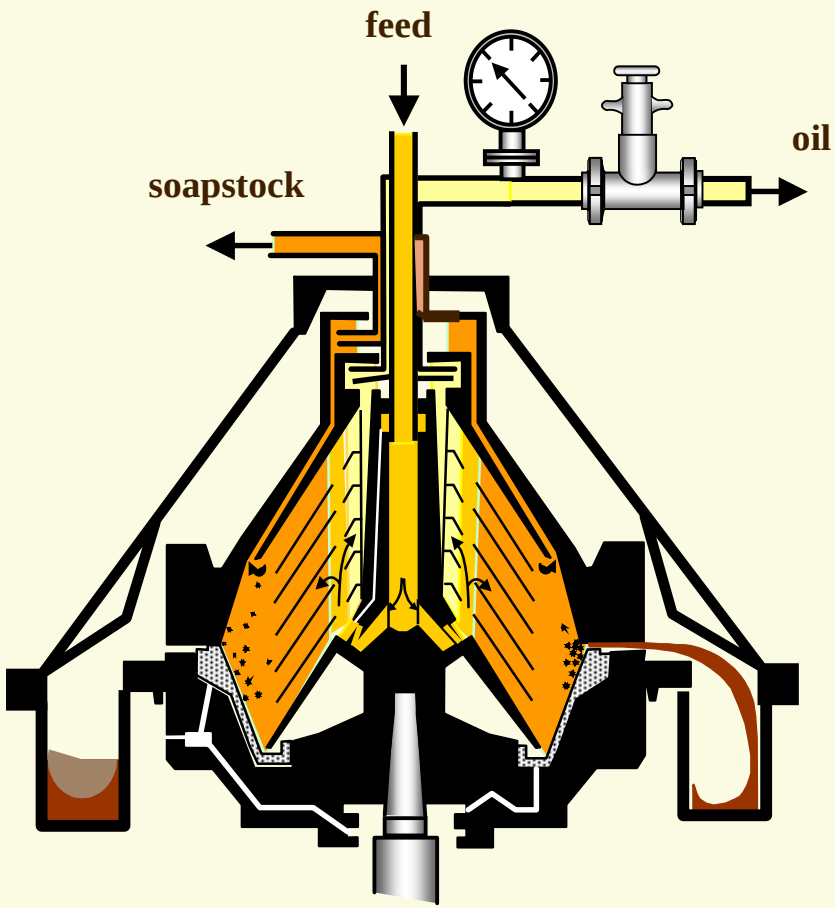
- ✓ To wash out residual soaps and to dilute the caustic soda
- ✓ Quality: soft, demineralised water
- ✓ Temperature: min. 90°C
- ✓ Addition for washing: 5 – 10 %

Alkali Refining: Results

- ✓ **Typical neutral oil quality:**
  - **FFA:** **< 0,1 %**
  - **Phospolipids:** **< 10 ppm**
  - **Soaps:** **< 50 ppm**
  - **Moisture:** **< 0,1 %**
  - **Impurities:** **nil**

- ✓ **Losses:**
  - **According to the Theoretical Loss (TL)**
    - **TL = FFA + Phospholipids + moisture + impurities + 0,3%**
  - **Neutralisation Loss:**
    - **TL < 3 %:** **Loss = 1,25 x TL + 0,3**
    - **TL> 3 %:** **Loss = 1,35 TL**

Alkali Refining: General Comments



- ✓ A centrífuge or separator is an accelerator for the decantation of gums, soapstock or wash water from oil and is not changing anything in the chemical structure of the products. Important for the efficiency of the machines are the process conditions prior and during the separation (dosation of chemicals, mixing, reaction times, temperature).
- ✓ For the optimal operation of the separator the ideal adjustments for the separating zone between the two phases to be separated (Fine Tuner diameter) and the outlet pressure of the oilphase (function of the hydrohermetic feed) have to be found.

Thank you for your attention