SOAP & DETERGENT

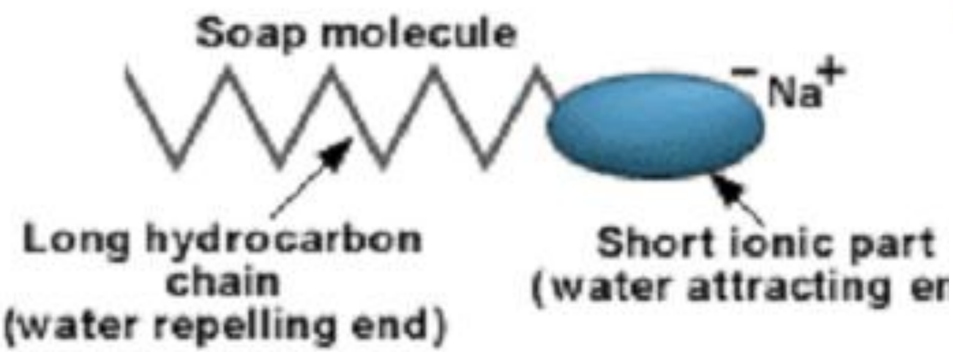
Chemical process technology
CHE F419

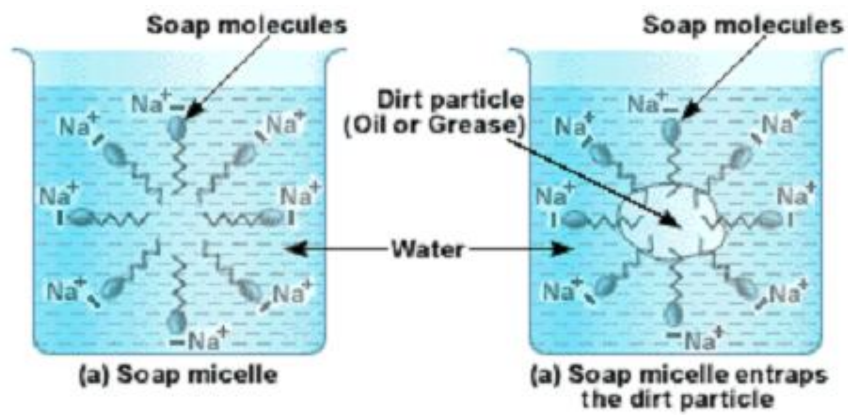
SOAPS

- Soaps are the sodium and potassium salts of the fatty acids (long chain carboxylic acid).
- Common fatty acids used are oleic acid, stearic acid, palmitic acid, lauric acid and myristic acid.
  - ***Sodium stearate*** ($C_{17}H_{35}COO$-Na+)
  - ***Sodium palmitate*** ($C_{15}H_{31}COO$-Na+)
  - ***Sodium oleate*** ($C_{17}H_{33}COO$-Na+)
- Soaps are used for human comfort, cleanliness and for industrial use.

CLEANSING ACTION OF SOAPS

- Soap is a surface active agent or surfactant.
- The soap molecules contain both hydrophilic part and hydrophobic part. The hydrophilic part of soap is carboxylate head group ($COO^{-}Na^{+}$) and hydrophobic part is aliphatic chain. The dirt or grease is cleaned by key mechanism as shown.

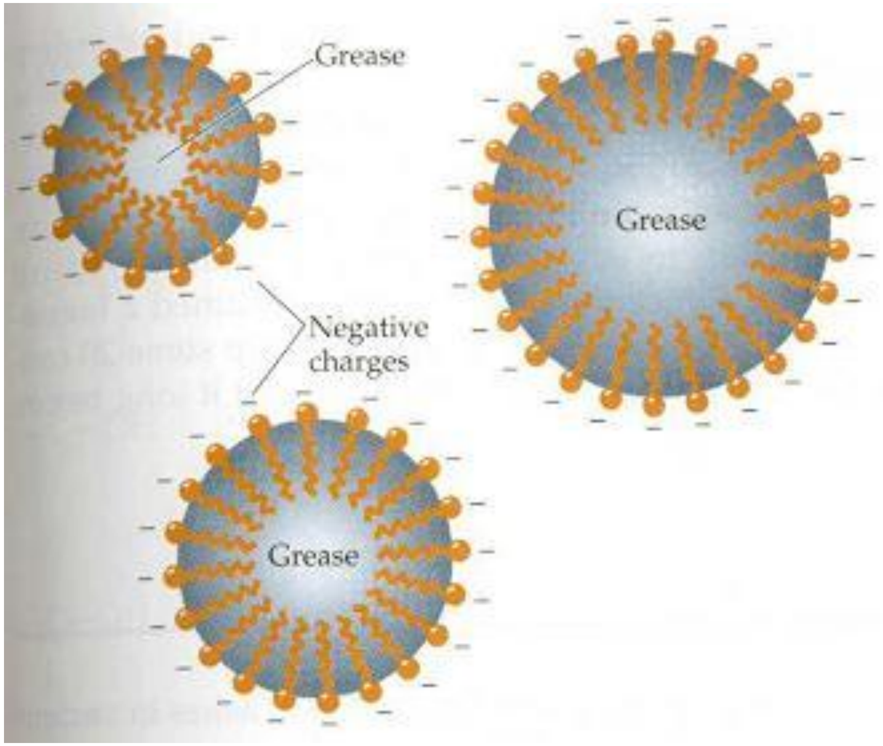




Agitation breaks the grease into *micelles* whose surfaces are covered by the negatively charged *carboxylate* groups, the <u>hydrophilic</u> -COO- groups of the embedded <u>soap molecules</u>.

The grease droplets repel each other and remain suspended in the wash water

In the end, the suspended droplets go down the drain with the wash water.



CHEMICAL RECTIONS

- Fat splitting reaction: (Catalyst : Metal oxide, ZnO)

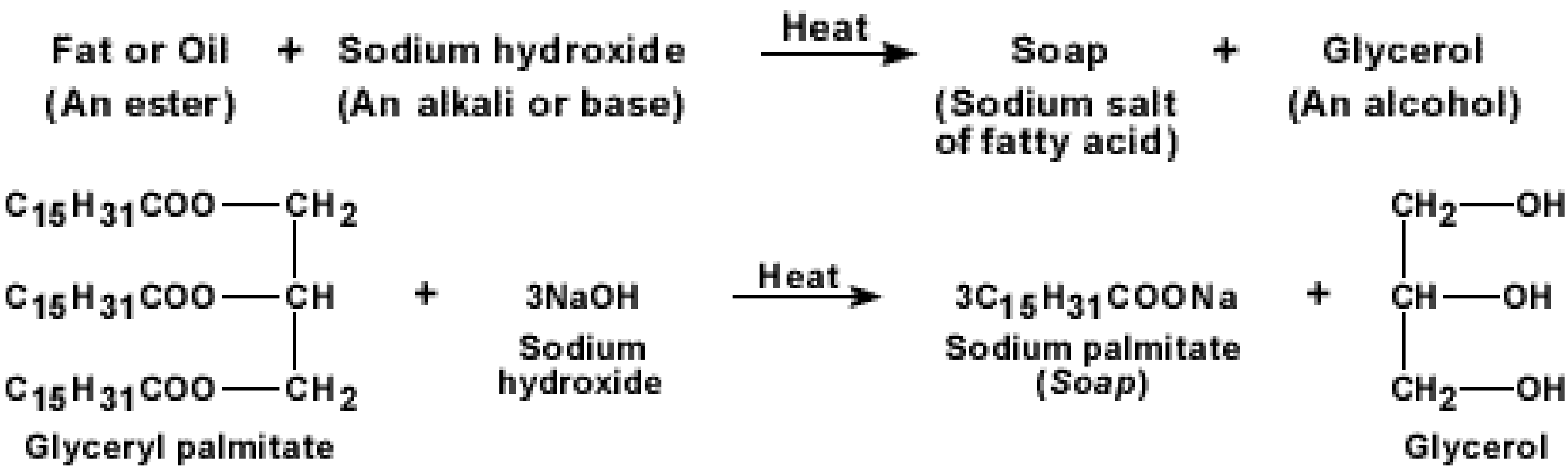
$(RCOO)_3C_3H_5 + 3H_2O \rightarrow 3RCOOH + C_3H_5(OH)_3$

triglycerides water fatty acid glycerin

- Saponification Reaction:

$RCOOH + MOH \rightarrow RCOOM + H_2O$

fatty acid base soap water



METHOD OF SOAP MAKING

- **BATCH SAPONIFICATION**

  This process includes acid hydrolysis of glycerides followed by alkali addition or direct saponification using strong caustic in batch process operation

  Are the oldest types of soap manufacture.

CONTINUOUS HYDROLYSIS AND SAPONIFICATION PROCESS

This method is greatly used

flexibility in control of product distribution

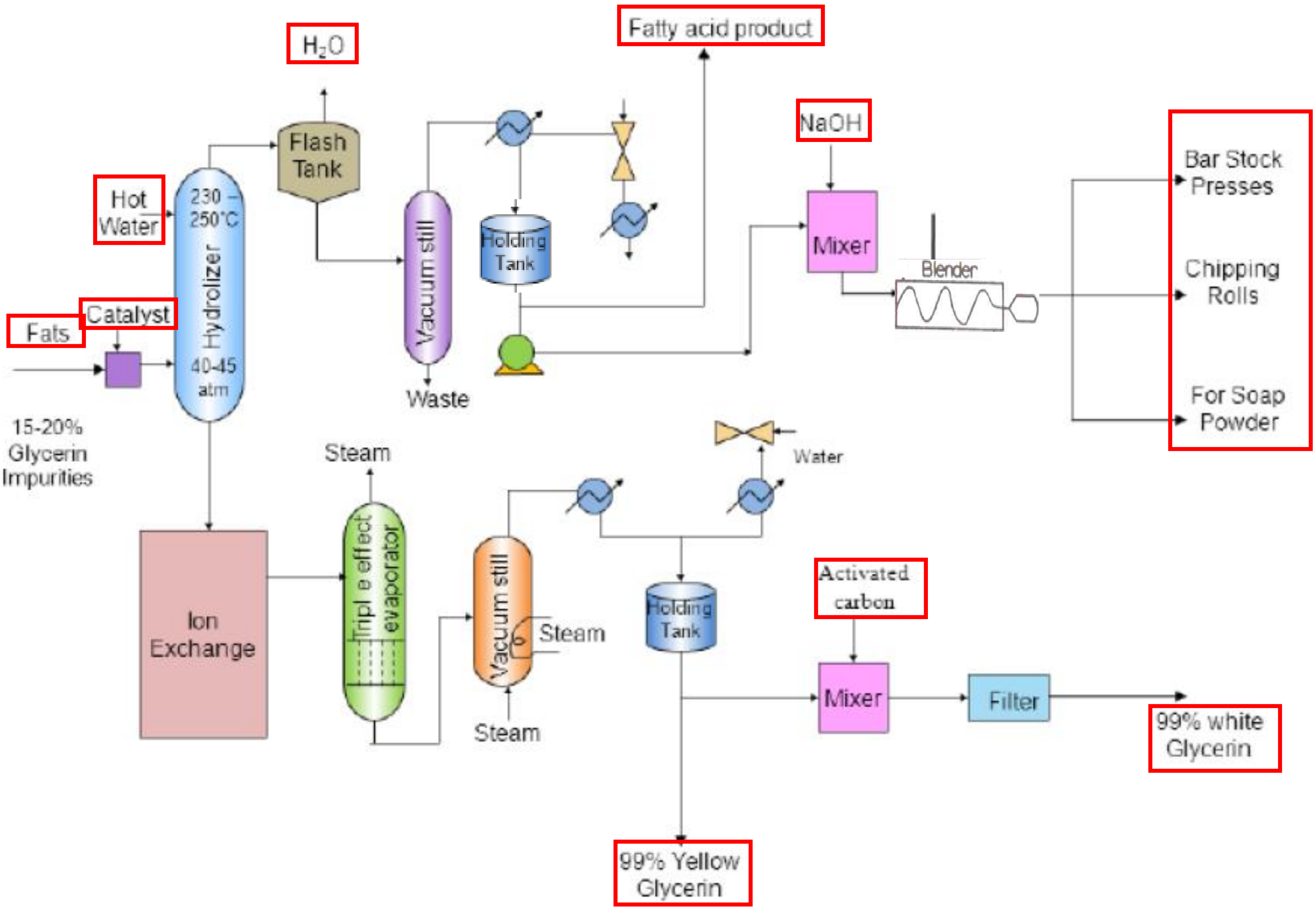
Higher glycerin yield

Less off color production

Requires less space and manpower.

SOAP MANUFACTURING

(Along with Fatty acid and Glycerin)



ADVANTAGES & DISADVANTAGES

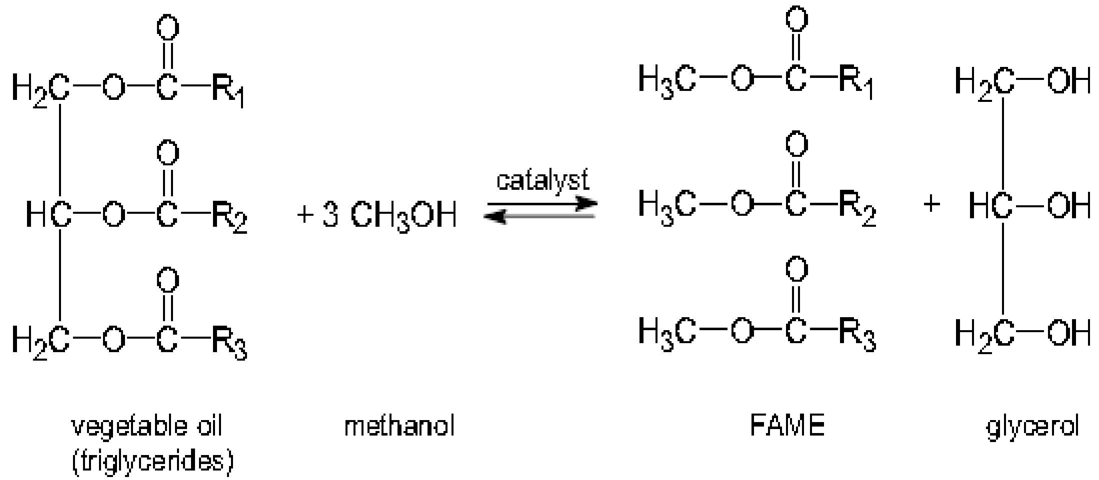
ADVANTAGES

- Soaps are eco-friendly and bio degradable.

DISADVANTAGES

- Soaps are not suitable in the hard water.
- They have weak cleansing properties than detergents.

Biodiesel



Scheme 7.1 *Transesterification of vegetable oil with methanol. FAME = fatty acid methyl esters. R_1, R_2, and R_3 are long-chain hydrocarbons.*

Europe are rapeseed, soya bean, and sunflower oils. On the other hand, palm oil is considered an excellent feedstock for biodiesel production in tropical countries such as Malaysia and Thailand.

The preferred (homogeneous) catalysts are sodium hydroxide (NaOH) and sodium methoxide ($NaOCH_3$).

shows a simplified block diagram for the production of biodiesel using an alkaline catalyst. The triglycerides are first pretreated by "degumming" for removal of phospholipids, drying, and, if necessary, removal of free fatty acids. Phospholipids are triglycerides with two fatty acid chains and one side chain formed by a phosphate ester. If the triglycerides contain too much free fatty acids, these are converted to the corresponding methyl esters in the presence of an acid catalyst. Alternatively, the free fatty acids are separated from the feed for disposal or separate treatment in an acid esterification unit.

After pretreatment, the tryglicerides are subjected to transesterification with methanol in the presence of an alkaline catalyst. The methyl esters are subsequently separated from the heavier glycerol phase by phase separation. The catalyst is then neutralized by adding an acid, for example, hydrochloric acid, after which washing to remove minor amounts of by-products and drying yields a biodiesel ready for use.

Excess methanol is recycled. The resulting crude glycerol (circa 80–85 vol.%) can be used as such or be purified further by chemical treatment, evaporation, distillation, and bleaching to yield glycerol of pharmaceutical quality (>99.5 vol.%). Today, the crude glycerol that is not purified is largely burned, which must be considered as a tragic waste of a potentially very useful organic raw material.

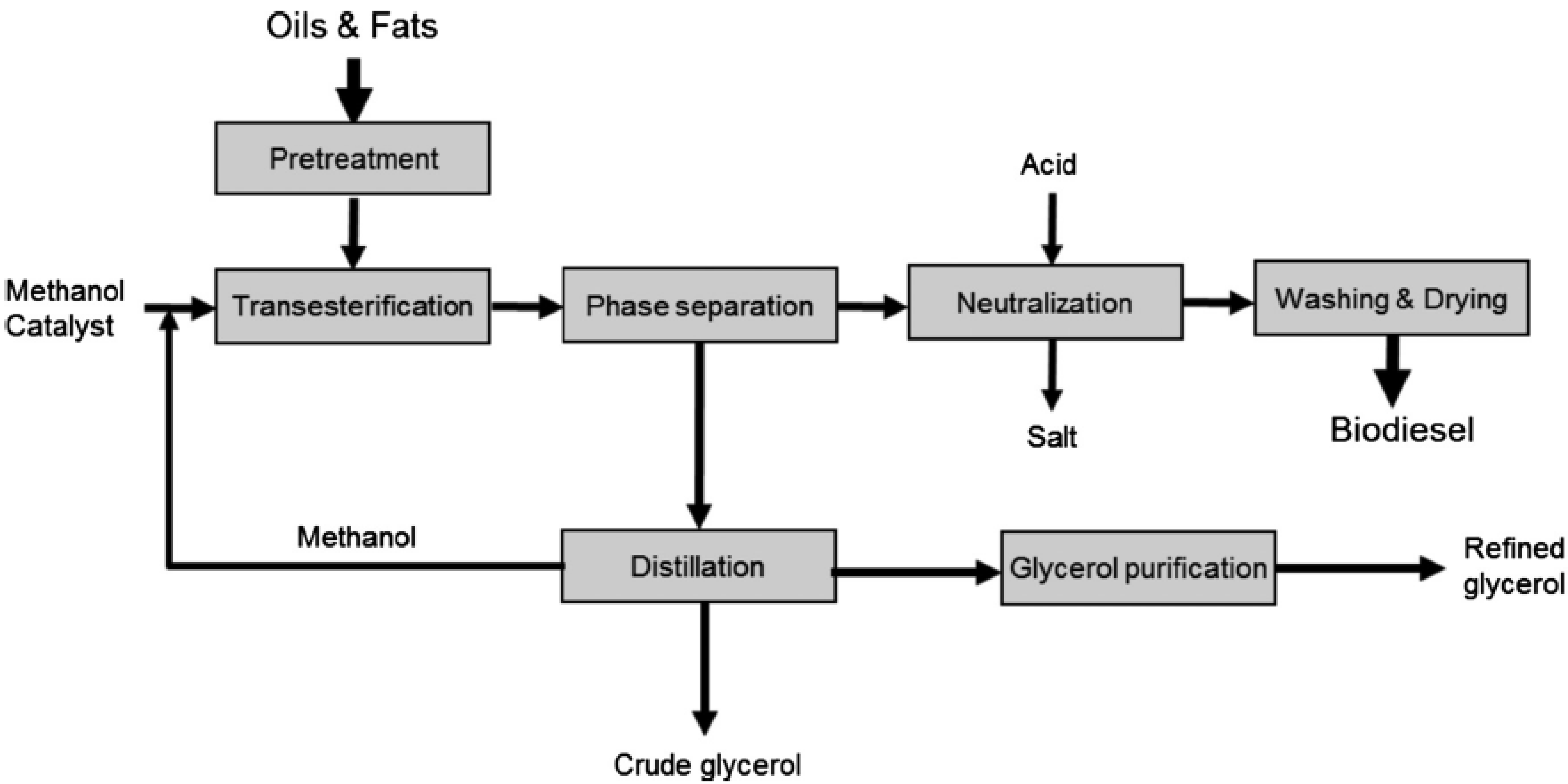


Figure 7.5 *Simplified block diagram for the production of biodiesel using an alkaline catalyst.*

Table 7.2 *Comparison of alkali- and enzyme-catalyzed transesterification processes [13].*

	Alkaline catalyst	Lipase catalyst
Reaction temperature (K)	320–350	305–315
Yield of FAME	Normal	Higher
FFA in feedstock	Saponified	Converted to FAME
Water in feedstock	Interference with reaction	No influence
Recovery of glycerol	Difficult	Easy
Purification of FAME	Repeated washing	None
Production cost of catalyst	Low	High
Catalyst separation	Difficult	Difficult

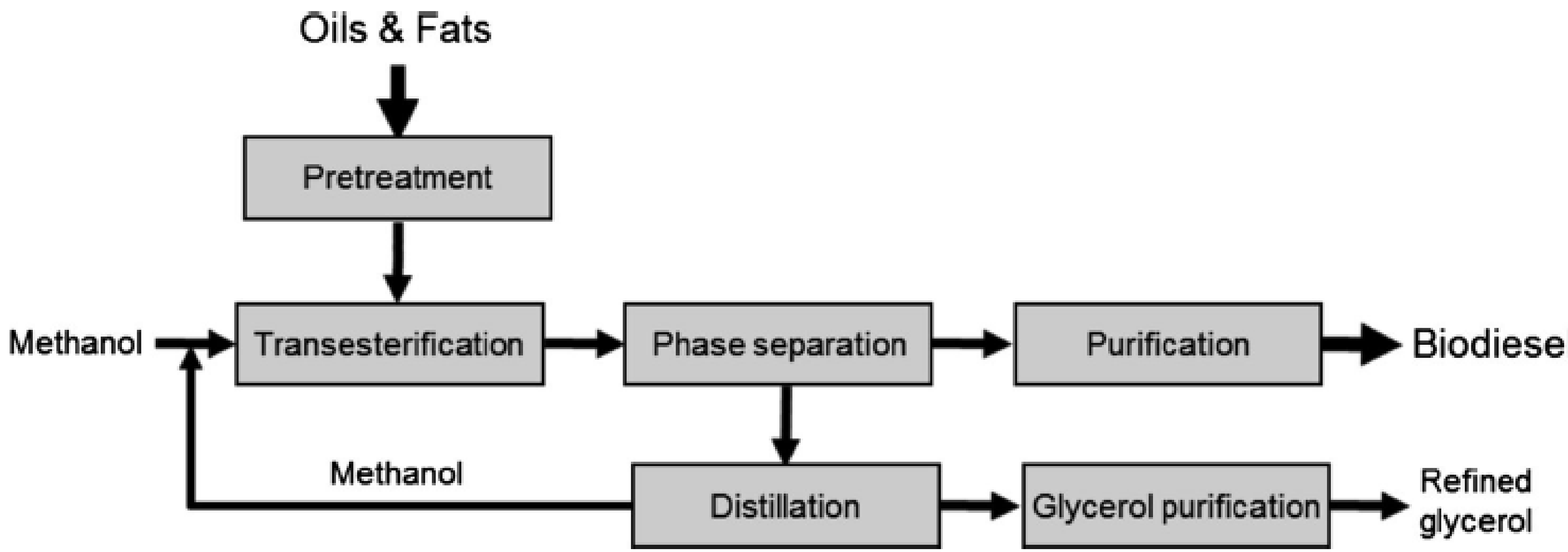


Figure 7.6 Simplified block diagram for the production of biodiesel using a solid acid catalyst.

DETERGENTS

- Detergents have better surface tension lowering action than soaps.
- Due to excessive foaming, it is unable to reduce organic content of sewage effluent.
- Biodegradation of detergent is an important environmental factor.
  - Detergent compounds, which can be oxidized to simple end-products, are known as biologically soft syndets and preferred in detergent compounding.
- Detergents are of four types - anionic, cationic, non- ionic and amphoteric.
  - Most common type is anionic which is generally made up of sodium salts of an organic sulfate or sulfonate.

Detergent Compounding

- Anionic (give R^- in water)
  - Sulfate $RO.SO_3H$ and Sulfonate (aryl benzene sulfonate)
  - Sulfated compounds are quite stable compare to sulfonate
  - The molecular structure of R is important in determining the biological softness. Straight chain normal paraffin structure gives a soft ABS where as branched or isoparaffin structure resists biodegradation.
- Cationic (give R^+ in water)
  - Quaternary ammonium compound : germicidal properties
- Non-Ionic
  - Alkyl-aryl ethylene oxide derivatives, fatty acids amide
  - Produce little foam, but enhance soil removal and grease emulsification
- Detergent Builders
  - Fluorescent dies as brighteners; zeolite/phosphate builders to extend foam; sodium carboxycellulose to improve soil and dirt suspension

General method to make synthetic detergents:

Alkylbenzene + oleum → alkylbenzene sulfonate

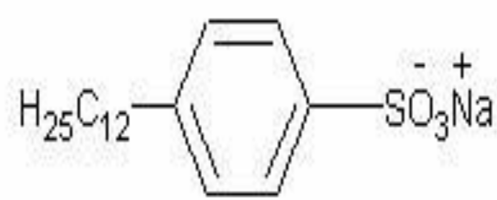
Tallow fatty alcohol + oleum → fatty alcohol sulfate

Sulfonate + sulfate + NaOH → sodium salts

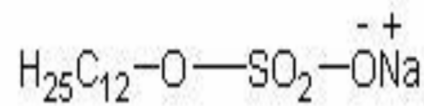
$R.CH_2OH + H_2SO_4 \rightarrow R.CH_2O.SO_3H \xrightarrow{NaOH} R.CH_2O.SO_3Na$

Sodium salts + builders → Detergents

EXAMPLES OF DETERGENTS



Sodium p-dodecyl benzene sulphonate



Sodium lauryl sulphate or

Sodium n-dodecyl sulphate

Comparison of Soaps and Detergents

1. Soaps cannot be used in hard water	1. Synthetic detergents can be used in hard water
2. Soap is made from vegetable oil or edible oils	2. Synthetic detergents made from byproducts of petroleum industry (to conserve edible oil)
3. Soaps cannot be used in acidic medium (otherwise precipitate the fatty acids)	3. Synthetic detergents can be used in any medium including acidic.
4. Soaps have weak cleansing action	4. Synthetic detergents have strong cleansing action.
5. Soaps are not very soluble in water	5. Synthetic detergents are highly soluble
6. Soaps are biodegradable and do not cause pollution	6. Synthetic detergents are not biodegradable and cause water pollution

WASHING POWDERS

- **Washing powders are a combination of soaps, detergents and other chemicals.**
- **washing powders have about 15 to 30% of their weight in synthetic detergents**
  - **Sodium sulphate and sodium silicate - to keep the powder dry.**
  - **Sodium triphosphate or sodium carbonate - to make the solution alkaline. (helps to remove dirt and also soften water.)**
  - **Carboxy methyl cellulose – to keep the dirt particles removed are kept suspended in the solution.**
  - **sodium perborate (bleaching agent) - for obtaining sparkling white clothes,**