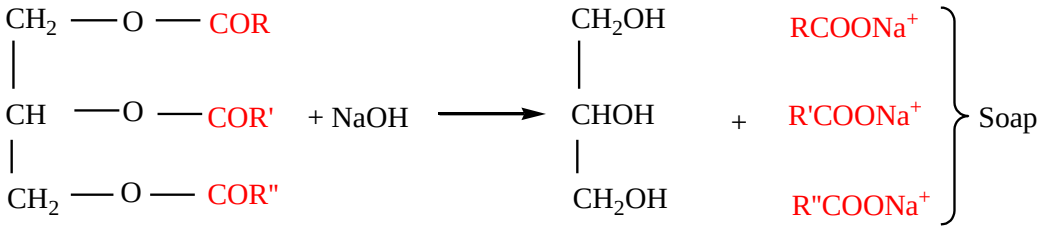
Soap and detergents

Soap is a mixtures of sodium salt of long chain fatty acids. Fatty acids are straight chain carboxylic acid

Saponification: is the process of making soap; soap is prepared by alkaline hydrolysis of glycerides.



Sources of vegetable oils

Sun flower seed

Coconut oil seeds

Sim sim

Castor oil seed

Extraction of oil

Ripe seeds are dried and the oil extracted by application of pressure or by solvent extraction. The residues / husks after extraction of oil are used as fuel, animal feeds or fertilizers.

Process of making soap

Vegetable oil is boiled with sodium hydroxide until all the oil is hydrolyzed; then saturated solution of sodium chloride is added to precipitate soap. Finally, after cooling soap is skimmed off. When potassium hydroxide is used instead of sodium hydroxide, soft soap (usually used as bathing soap) is obtained.

Glycerin the byproduct of making soap is used in cosmetics and pharmaceutics as a humectant.

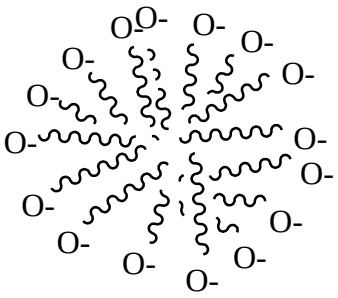
Soap vary in composition and method of processing, if made from olive oil, it's castile soap, alcohol can be added to it to make it transparent, air can be beaten in it to make it float; perfumes, dyes and germicide can be added. If a potassium salt instead of sodium salt, it is soft soap. Chemically, however, soap remain pretty the same, and does its job the same way. Other additives include antiseptics, color, perfumes, chelating agents such as polyphosphates, bleaching agents such as peroxides and per borates and fillers such as titanium dioxide.

Mechanism of soap

A soap molecule has a polar end, $-COO^-Na^+$ and the non-polar end, the long carbon chain of 12 to 18 carbon atoms. The polar end is water soluble and is thus hydrophilic. The non-polar end is water insoluble, thus hydrophobic (or lipophilic, it is soluble in non-polar solvents. Molecules like this are called amphipathic; they have both polar and non-polar end.

When soap is 'dissolved' in water, soap is dispersed in spherical cluster called micelles. The non-polar ends bundle together in the center while the polar ends project outwards in the polar solvent – water.

Soap micelle in water



Negatively charged carboxylate ions stud the surface of the micelle, repulsion between similar charges keeps the micelles dispersed. During the washing fat soluble dirt is removed from the cloth and stabilized inside the micelle while water soluble dirt dissolve in water.

Detergents

These are synthetic cleansing agent other than sodium and potassium salts of carboxylic acids. Although the synthetic detergents vary considerably in their chemical structures, the molecules of all of them are amphipathic, i.e. have a large non-polar hydrocarbon end that is oil soluble and a polar end that is water soluble.

Types of detergents

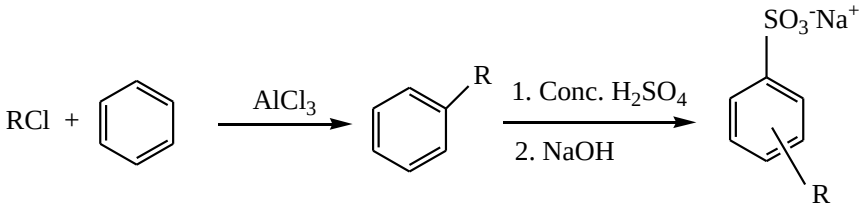
1. Ionic detergents: e.g. salts of alkyl hydrogen sulphates.

   Preparations
   The C12 to C18 alcohols are converted into the salts of alkyl hydrogen sulphates.

$$\underset{\text{Lauryalcohol}}{RC_{11}H_{23}CH_2OH} \xrightarrow{H_2SO_4} \underset{\text{Lauryl hydrogen sulphate}}{RC_{11}H_{23}CH_2OSO_3H} \xrightarrow{NaOH} \underset{\text{Sodiumlaurylsulphate}}{RC_{11}H_{23}CH_2OSO_3^-Na^+}$$

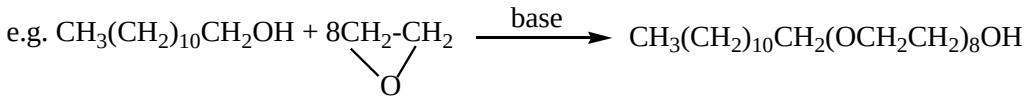
   For this, the non-polar end is the long carbon chain and the polar end is $-OSO_3^-Na^+$.

2. Sodium salts of alkyl benzene sulphonic acids.
   These are the most widely detergent; a long chain alkyl group is attached to benzene ring by the action of aFriedels-Crafts catalyst and alkyl halide, alkene or alcohol. Sulphonation and neutralization yields the detergent.



Sodium salt of alkyl benzene sulphonic acid

3. Nonionic detergents: are prepared by treatment of alcohol with ethylene oxide



Hydrogen bonding to the numerous oxygen atoms makes the polyether end water soluble.

Advantages of detergents over soap

1. The sulphates and sulphonates retain their efficiencies in hard water, since the corresponding calcium and magnesium salts are soluble.
2. They form neutral solutions.

Disadvantages

1. They are non-biodegradable.

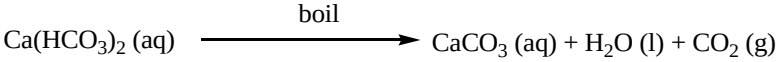
Hard water

This is water that does not form lather easily with soap. Hardness of water is caused by soluble salt of calcium and magnesium. In presence of magnesium or calcium salts soap react to form

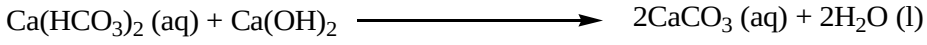
Insoluble salts forming white precipitates called scum.

Types of water hardness.

1. Temporary hardness is a type of hardness that is removed by boiling. It is caused by calcium or magnesium hydrogen carbonates. On boiling, the soluble calcium or magnesium hydrogen carbonates are converted into insoluble carbonates.



It can also be removed by adding slaked lime, $Ca(OH)_2$.



2. Permanent hardness is the type of hardness that cannot be removed by boiling. It is caused by sulphates of calcium and magnesium. It may be removed by:
   (a) Addition of sodium carbonate to precipitate calcium or magnesium ions as carbonates
   $Ca^{2+}(aq) + CO_3^{2-}(aq) \longrightarrow CaCO_3(s)$
   (b) By ion exchange process using permutit process.
   (c) By complexation of calcium and magnesium ions with sodium salts of polyphosphates to prevent them from reacting with soap to form scum.

End