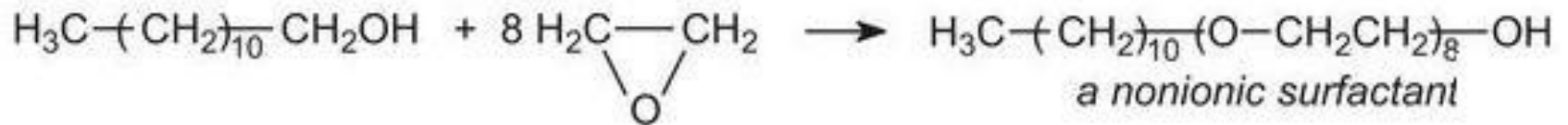


# *Nonionic surfactants*

- These surfactants do not bear an electrical charge and are often used together with anionic surfactants.
- An advantage is that they do not interact with calcium and magnesium ions in hard water.
- They account for nearly 50% of surfactant production (excluding soap).
- The major group of nonionics are the ethoxylates made by condensing long chain alcohols with epoxyethane (ethylene oxide) to form ethers, for example:

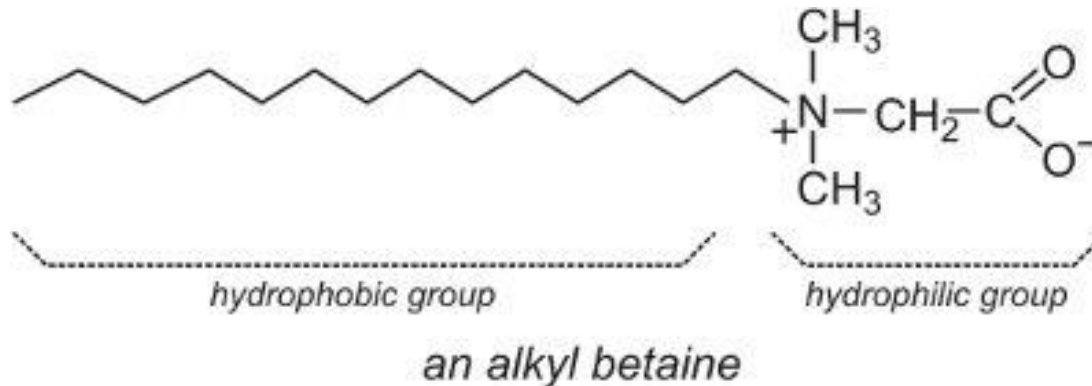


- The long-chain alcohol can come from either a synthetic or natural source.
- Although they do not contain an ionic group as their hydrophilic component, hydrophilic properties are conferred on them by the presence of a number of oxygen atoms in one part of the molecule which are capable of forming hydrogen bonds with molecules of water.

- **As the temperature of the surfactant solution is increased the hydrogen bonds gradually break causing the surfactant to come out of solution. This is commonly referred to as the cloud point and is characteristic for each nonionic surfactant.**
- **Nonionics are more surface active and better emulsifiers than anionics at similar concentrations.**
- **They are less soluble than anionics in hot water and produce less foam.**
- **They are also more efficient in removing oily and organic dirt than anionics.**
- **Depending on the type of fibre, they can be active in cold solution and so are useful in countries which lack hot water supplies and in developed countries where there is a desire to lower the wash temperatures either to save energy or because of the type of fabric being washed.**
- **Nonionics are used in fabric washing detergents (both powders and liquids), in hard surface cleaners and in many industrial processes such as emulsion polymerization and agrochemical formulations.**

# *Amphoteric surfactants*

- Amphoteric (or zwitterionic) surfactants are so called because the head-group carries both a negative and positive charge.
- A range of methods is used to produce such materials, almost all of which contain a quaternary ammonium ion (a cation).
- The negatively charged group can be carboxylate,  $-\text{CO}_2^-$ , sulfate,  $-\text{OSO}_3^-$  or sulfonate,  $-\text{SO}_3^-$ . One such well-used class is the alkyl betaines which have a carboxyl group
- Betaines are neutral compounds with a cationic and an anionic group which are not adjacent to one another.



- Amphoteric surfactants are very mild and are used in shampoos and other cosmetics. They are said to be pH balanced.

# Applications

- *Laundry detergents*
- A detergent is made up of many ingredients, some of which are surfactants. However, there are other ingredients, each with specific functions:
- *Bulking agents*, such as sodium sulfate and water.
- Some detergents need anti-caking agents, for example aluminium silicate, which keep the powder dry and free-flowing.
- *Builders*, usually sodium aluminosilicates, a type of zeolite, remove calcium and magnesium ions and prevent the loss of surfactant through scum formation.
- Stains can be bleached with oxidizing agents such as sodium perborate ( $\text{NaBO}_3 \cdot 4\text{H}_2\text{O}$ ) and sodium percarbonate ( $2\text{Na}_2\text{CO}_3 \cdot 3\text{H}_2\text{O}_2$ ) which react with hot water to form hydrogen peroxide which in turn reacts with the stain.
- *Buffering agents* - to keep the pH at the appropriate value
- *Structurants* - to give shape to the fabric being washed
- *Sequestrants* - to react with free metal ions which might otherwise cause problems with appearance or scum formation
- *Optical brighteners* - to make the fabrics look brighter and whiter

- ***Enzymes*** - to remove specific stains: proteases (to remove proteins), amylases (to remove starches), lipases (to remove fats)
- ***Anti-redeposition agents*** - to prevent dirt being redeposited on fabrics
- ***Skin conditioning agent*** - to help to keep the skin in good condition
- ***Softness extender*** - to help keep the clothes 'soft'
- ***Emulsifier*** - to help keep immiscible liquids as an emulsion
- ***Colorant***
- Domestic automatic machine laundry liquids are formulated using blends of anionic, nonionic and soap surfactants and various other functional substances.
- Bleach systems are not compatible with the higher water temperature and cannot be used above ca 315 K.
- For hand washing (used for delicate fabrics such as wool or silk), foam-stabilisers are included, to maintain foam.
- The customer equates the quantity of foam produced with the detergent cleansing action. For the quantity of foam produced the order is:
- anionics > soap > nonionics > cationics

# ***Machine dishwashing powders and tablets***

- **The products used in dishwashers are usually powders and contain builders (90-95%), a nonionic surfactant (1-5%), bleach agents with an activator and enzymes.**
- **They are formulated with sodium carbonate and sodium silicate to create a very alkaline environment that helps to denature (break down) the fats and proteins left on the used dishes and utensils.**



# *Washing up liquids*

- These formulations contain between 13-40% of surfactants which are predominantly alkyl ether sulfates but also include nonionics and amphoteric (betaines).



# ***Shampoos and shower gels***

- These tend to be based on alkyl ether sulfates and usually contain small amounts of other surfactants (most typically amphoteric) which help protect the skin from irritation and also condition the hair.
- ***Hair conditioners and fabric softeners***
- These products are formulated using cationic surfactants (sometimes combined with small amounts of non-ionic surfactants).
- These are not cleansing products and the cationic surfactant is deposited onto the slightly negatively charged hair or cotton fibre surface, thus giving a lubrication benefit.

# Environmental considerations

- In Western Europe all surfactant components of domestic detergents must be biodegradable.
- The original alkylbenzene sulfonate anionics were based on branched alkenes and these proved resistant to degradation by bacteria at sewage treatment works causing many rivers to suffer from foam.
- There was also a fear that surfactants could be "recycled" into drinking water. Similar concerns were expressed about nonylphenol ethoxylates and so in the 1980s the industry moved to linear alkylbenzene sulfonates and alcohol ethoxylates as the major ingredients of their formulations.
- The development of compact powders and liquids and refillable packages is designed to reduce packaging waste.
- Redesign of washing machines and laundry detergent products (including the addition of bleach activators and enzymes to ensure good stain removal at low temperatures) has resulted in energy savings by reducing water heating and using shorter wash cycles.

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