Role of Wetting Agents and Detergents in Bleaching

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Introduction

WATER, the liquid commonly used for cleaning, has a property called surface tension. In the body of the water, each molecule is surrounded and attracted by other water molecules. However, at the surface, those molecules are surrounded by other water molecules only on the water side. A tension is created as the water molecules at the surface are pulled into the body of the water.

This tension causes water to bead up on surfaces (glass, fabric), which slows wetting of the surface and inhibits the cleaning process. You can see surface tension at work by placing a drop of water on to a counter top. The drop will hold its shape and will not spread.

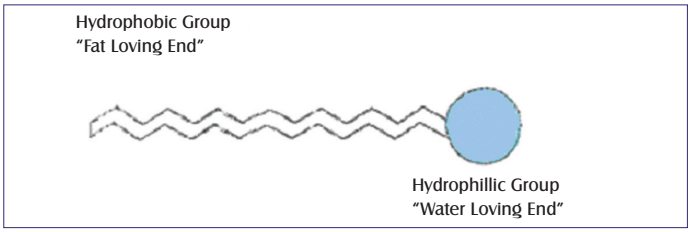
In the cleaning process, surface tension must be reduced so water can spread and wet surfaces. Chemicals that are able to do this effectively are called surface-active agents, or surfactants. They are said to make water 'wetter'.

Surfactants perform other important functions in cleaning, such as loosening, emulsifying (dispersing in water) and holding soil in suspension until it can be rinsed away. Surfactants can also provide alkalinity, which is useful in removing acidic soils.

What Are Surfactants?

Generally, surfactants or detergents are substances that, when dissolved in water, give a product the ability to remove dirt from surfaces such as the human skin, textiles and other solids.

Each surfactant molecule has a hydrophilic (water-loving) head, which is attracted to water molecules, and a hydrophobic (water-hating) tail, which repels water and simultaneously attaches itself to oil and grease in dirt. These opposing forces loosen the dirt and suspend it in the water. The mechanical agitation of the washing machine helps pull the dirt free.



Mechanism of Dirt Removal

- Surfactants enable the cleaning solution to fully wet the surface being cleaned, so that dirt can be readily loosened and removed.
- They clean greasy, oily, particulate, protein, and carbohydrate based stains.
- They are instrumental in removing dirt and in keeping them emulsified, suspended and dispersed, so they do not settle back onto the surface being cleaned.

Thus, for a good cleaning, three types of energy are required:

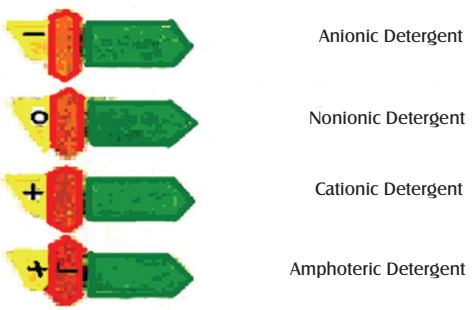
- Chemical energy, provided by the surfactant or detergent
- Thermal energy, provided by warm or hot water
- Mechanical energy, provided by a machine

Types of Surfactants

There are different types of surfactant types, each with unique properties and characteristics: the type of dirt and fabric on which they work best and how they can cope with water hardness. Detergents use a combination of various surfactants to provide the best possible cleaning results.

There are four main types of surfactants, depending on the type of the charge of the head:

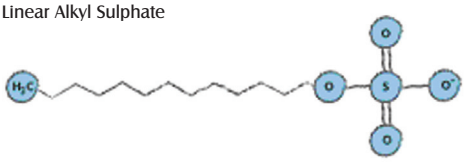
- Anionic surfactants
- Cationic surfactants
- Non-ionic surfactants
- Amphoteric/zwitterionic surfactants



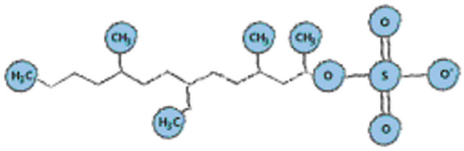
Anionic Surfactants

The chemical reacts with hydrocarbons derived from petroleum or fats and oils to produce new acids, similar to fatty acids. In solution, the head is negatively charged. The surfactant is particularly good at

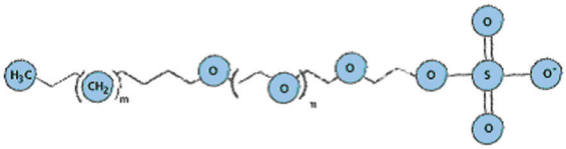
Linear Alkyl Sulphate



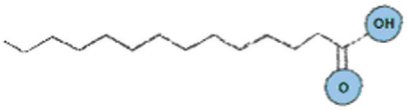
Branched Alkyl Sulphate



Alkyl Ether Sulphate



Fatty Acids/Soaps



keeping the dirt away from fabrics and removing residues of fabric softener from fabrics.

Anionic surfactants are particularly effective at oily-soil cleaning and oil/clay soil suspension. Still, they can react in the wash water with the positively charged water-hardness ions (calcium and magnesium), which can lead to partial deactivation. The more calcium and magnesium molecules in the water, the more the anionic surfactant system suffers from deactivation. To prevent this, the anionic surfactants need help from other ingredients such as builders (Ca/Mg sequestrants) and more detergent should be dosed in hard water.

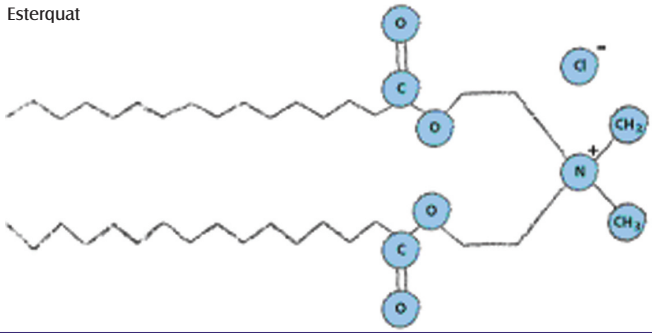
The most commonly used anionic surfactants are alkyl sulphates. Others are 'surfactants' (from surface-active agents) which are generally known as alkyl benzene sulphonates.

Cationic Surfactants

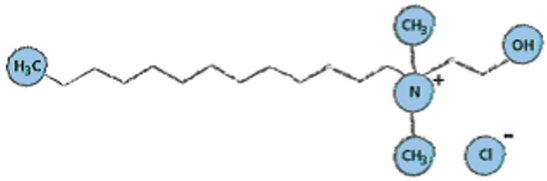
Another class of detergents has a positive ionic charge; these products are called 'cationic' detergents. There are different categories of cationics, each with their specific application:

- In fabric softeners and in detergents with built-in fabric softener, cationic surfactants provide softness. Their main use in laundry products is in rinse-added fabric softeners, such as esterquats, one of the most widely used cationic surfactants in rinse added fabric softeners.

Esterquat

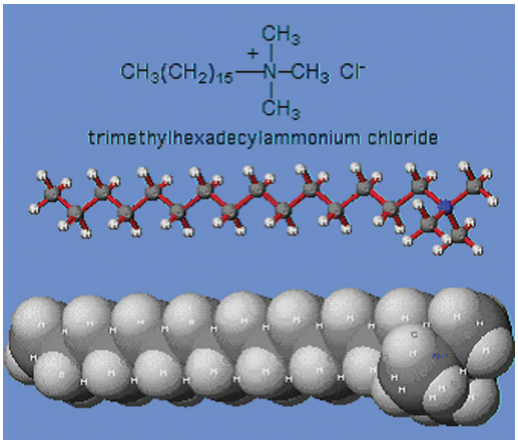


Mono Alkyl Quaternary System



- In laundry detergents, cationic surfactants (positive charge) improve the packing of anionic-surfactant molecules (negative charge) at the stain/water interface. This helps to reduce the dirt/water interfacial tension in a very efficient way, leading to a more robust dirt-removal system. They are especially efficient at removing greasy stains.
  An example of a cationic surfactant used in this category is the mono alkyl quaternary system.

- In addition to being good cleansing agents, they also possess germicidal properties, which makes them useful in hospitals. Most of these detergents are derivatives of ammonia. It may be surprising that it even works because the ammonium (+1) nitrogen is buried under the methyl groups, as can be seen in the space-filling model.



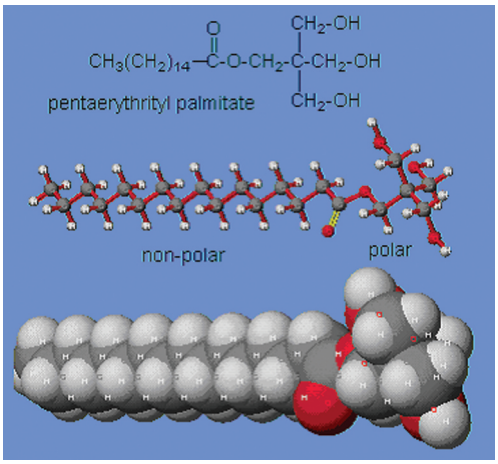
Non-Ionic Surfactants

Non-ionic surfactants such as alcohol ethoxylates also adsorb on the dirt. Their long ethoxylated chains extend in the water phase and prevent the dirt droplets or particles from uniting and from depositing on to the fabric surface.

Most laundry detergents contain both non-ionic and anionic surfactants, as they complement each other's cleaning action. Non-ionic surfactants contribute to making the surfactant system less hardness sensitive.

The most commonly used non-ionic surfactants are ethers of fatty alcohols.

Non Ionic Surfactants



Since the detergent does not have any ionic groups, it does not react with hard-water ions. In addition, non-ionic detergents foam less than ionic detergents. The detergent molecules must have some polar parts to provide the necessary water solubility.

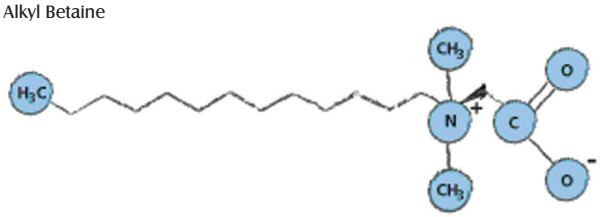
Amphoteric/Zwitterionic Surfactants

These surfactants are very mild, making them particularly suited for use in personal care and household cleaning products. They can be anionic (negatively charged), cationic (positively charged) or non-ionic (no charge) in solution, depending on the pH of the water.

They are compatible with all other classes of surfactants and are soluble and effective in the presence of high concentrations of electrolytes, acids and alkalis.

These surfactants may contain two charged groups of different sign. Whereas the positive charge is almost always ammonium, the source of the negative charge may vary (carboxylate, sulphate, sulphonate). These surfactants have excellent dermatological properties. They are frequently used in shampoos and other cosmetic products, and also in hand-dishwashing liquids, because of their high foaming properties.

An example of an amphoteric/zwitterionic surfactant is alkyl betaine.



New Development at Sarex

We at the Sarex have a wetting-cum-detergent product, Celldet R, with low foaming, for bleaching of cellulosic yarn or fabrics. A study of Celldet R was carried out against other competitors' wetting-cum-detergent agents – Comp A and Comp B – available in the market. Bleaching was carried out on grey single-jersey cotton-knit fabric by using the above wetting-cum-detergent and scouring agents.

Bleaching was carried out at a liquor ratio of M:L = 1:10, Temp 98°C, for 45 min.

Drain → Hot wash (80°C) → Neutralise and dry

The bleached fabric was evaluated for different performance properties, such as wetting efficiency, absorbency, rewetting and foaming tests.

Foam Test:
Foaming characteristics were measured at 1g/l concentration and in presence of 2g/l caustic in soft water as follows:

400ml of solution was taken in a glass cylinder and solution was stirred at 200rpm for 5 minutes. Foam height was measured immediately and after 2 minutes.

Wetting Efficiency by Draves Test:
Wetting efficiency was tested by AATCC Test Method 17–1989. In this method, 5gm of 2/40s (30-tex) yarn is folded to two folds (9' x 2'). One end of the loop is attached to a hook (3gm) and a 40gm weight is attached to the hook. The other end is cut loose with scissors and entered into a measuring cylinder containing 500ml of 1g/l wetting agent. The time taken to sink the yarn is noted.

Absorbency Test:
Absorbency of the bleached fabric was tested by AATCC Test Method 79-1986. In this test, the fabric is mounted on an embroidery loop (6" diameter) and a drop of the water is allowed to fall from a distance of 2cm on to the taut surface of a test specimen. The time required for the specular reflection of the water drop to disappear is measured and recorded as wetting time.

Rewetting Property:
In this test a 1" x 1" fabric sample was added in 200ml of distilled water. The time taken to sink the bleached fabric was noted.

Results and Discussion

From the results, it is clear that the wetting efficiency of Celldet R is more or less comparable with Product B, followed by Product A. The results are given in Table 2 and Figure 1.

In addition, the foaming behaviour of Celldet R, Product A and Product B are comparable, showing much less foam (see Table 2 and Figure 2).

The fabric bleached with Celldet R and Product B shows comparable absorbency at 0.7% concentration, while Product A shows slightly poorer absorbency than Celldet R and Product B. The results of the whiteness, absorbency and rewetting time are expressed in Table 3 and Figures 3-4.

At 0.7% concentration, fabric bleached with Celldet R shows better rewetting properties than Product B, followed by product A, and at 1% concentration, all the products shows more or less similar absorbency.

Whiteness of bleached fabric is more or less the same, irrespective of the product and concentration used in bleaching.

Conclusion

Celldet R is a cost-effective and economical low-foaming, APEO and NPEO free wetting-cum-detergent agent.

It shows better absorbency and rewetting properties than competitors' wetting-cum-detergent agents. ID

Table 1: Recipe for Bleaching with Celldet R and Competitors products

Sr.No.	Samples	Recipe %						
		I	II	III	IV	V	VI	Blank
1	Caustic flakes	2	2	2	2	2	2	2
2	Soda ash	1	1	1	1	1	1	1
3	H2O2 (50%)	3	3	3	3	3	3	3
4	Sarastabil MRS	0.3	0.3	0.3	0.3	0.3	0.3	0.3
5	Celldet R	0.7	1	-	-	-	-	-
6	Comp A	-	-	0.7	1	-	-	-
7	Comp B	-	-	-	-	0.7	1	-

Table 2: Wetting Efficiency and Foaming of wetting-cum detergent agents

Sample	Wetting efficiency, 1g/l (Drave's Test Method), Sec.	Foam height, mm			
		1g/l sample		1g/l sample + 2g/l caustic	
		I mm	2 min	I mm	2 min
Celldet R	30	5	5	5	5
Comp A	80	10	10	10	10
Comp B	66	30	20	30	20

Table 3: Effect of wetting-cum detergent agents on whiteness, absorbency and rewetting time of Bleached Fabric

Product	Conc., %	Whiteness Index(CIE)	Absorbency, Sec	Rewetting time, Sec
Blank	nil	80	180	180
Celldet R	0.7	80	1	9
Comp A	1.0	80	1	10
Comp B	1.0	80	1	6

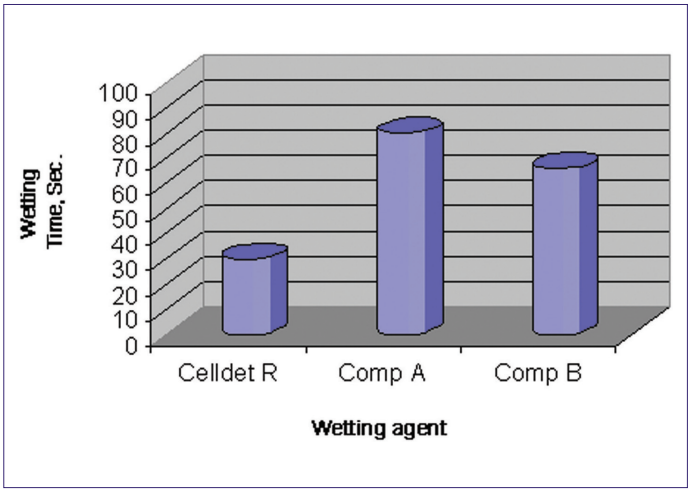


Figure 1: Wetting Efficiency of Celldet R and Competitors' Samples

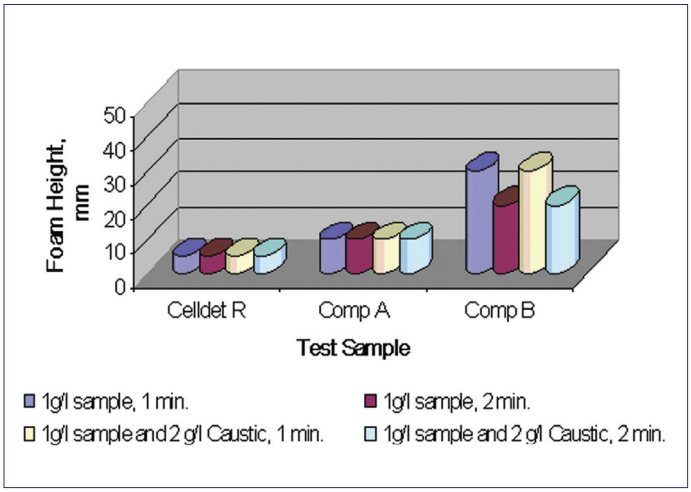


Figure 2: Foaming of Celldet R and Competitors' Samples

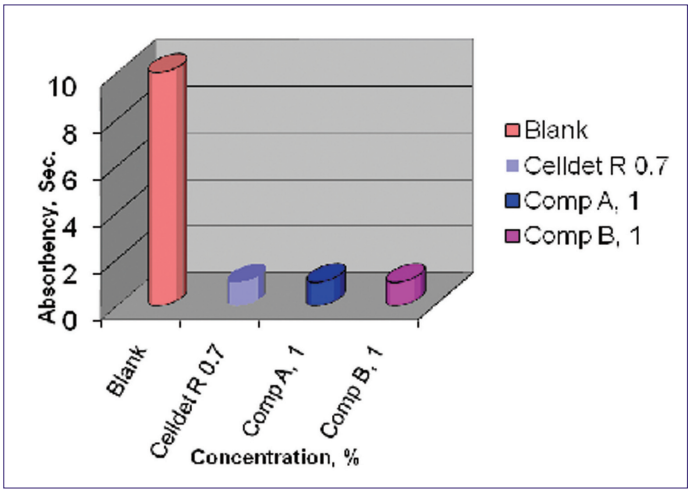


Figure 3: Effect of Celldet R and Competitors' Samples on Absorbency of Bleached Fabric

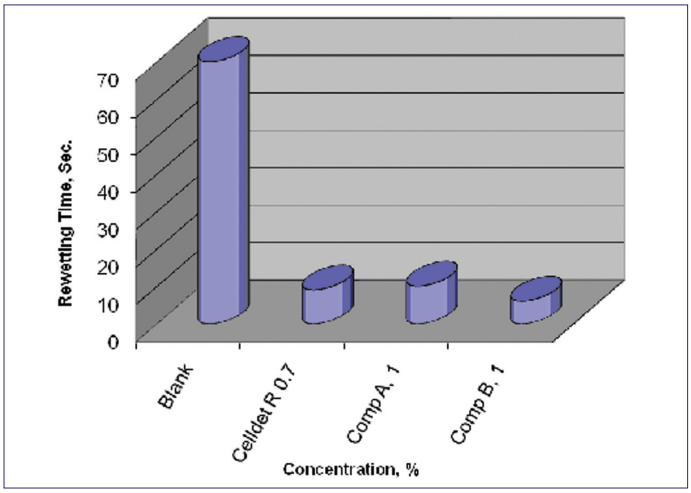


Figure 4: Effect of Celldet R and Competitors' Samples on Rewetting Time