Module 6: Household Products - Study Materials

Soaps, Detergents and our Health

Soaps and detergents play a very important role in our lives. These chemicals help us in making our surroundings cleaner (i.e., by removing soil and grease), healthier (i.e., by reducing the germs), and pleasant.

In order to make it more effective in the process of cleaning, the water must be made to spread and thus wet surfaces effectively, i.e., its surface tension must be reduced.

This is achieved by using compounds called **surfactants**.

Soaps and Detergents

What are Surfactants?

- Soaps and detergents are composed of surfactants.
- Surfactants are water-soluble and surface-active agents.

Surfactants are composed of a hydrophilic (water-soluble) head and a hydrophobic (fat-soluble, water-hating) tail. The hydrophilic end is stable when solubilized in water and the hydrophobic end consists of a long chain hydrocarbon that is more stable when surrounded by other organic groups.

Classes of Surfactants

There are different classes of surfactants categorized by the charge of the hydrophilic component of the surfactant molecule after dissociation in water:

- Anionic surfactants have a negative charge.
- Cationic surfactants have a positive charge.
- Non-ionic surfactants have no charge.
- Amphoteric surfactants have both positive and negative charges.

Soaps and Detergents

All About Soap

Advantages

- Soaps are manufactured from combinations of natural and renewable resources.
- Soaps are biodegradable and thus do not pollute bodies of water.

Disadvantages

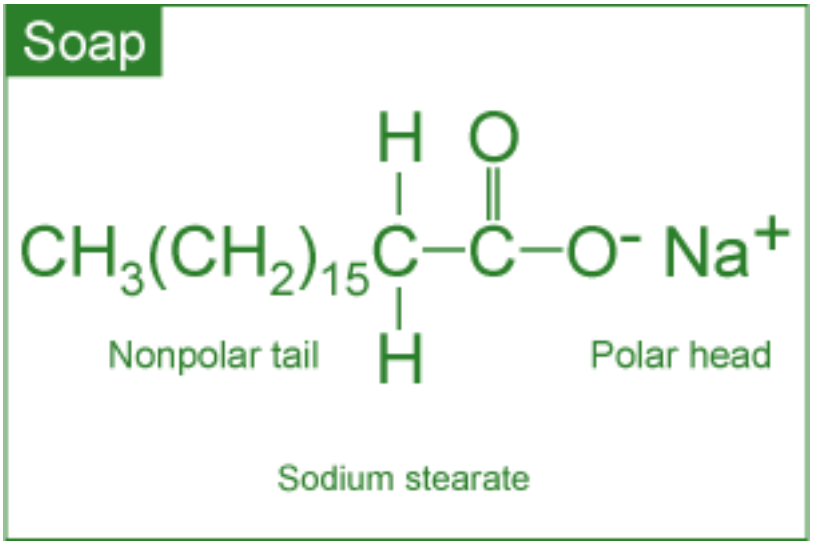
- Formation of soap film (or scum) in water containing Ca^{2+} and Mg^{2+} ions (hard water).

  The calcium and magnesium ions react with soap molecules to produce calcium and magnesium salts of fatty acids. These salts are insoluble in water and impair the surfactant properties of soap because the amount of soap available for cleaning is reduced. Soap scum is difficult to rinse away and can be visible, i.e., on fabrics, bathtubs and sinks.
- Poor adaptability to diversity of fibers, washing temperatures and water conditions.
- Tendency to clog sewage systems due to their gelling properties.

Composition and Limitations of Soap

Soaps (anionic surfactants) consist of the long hydrocarbon tails of fatty acids and the polar heads of sodium or potassium salts of fatty acids (found in fats and oils of animals and plants).

Traditionally, soap was made from animal fat and wood ash (composed of potassium hydroxide and potassium carbonate).



Soaps and Detergents

All About Detergent

Advantages

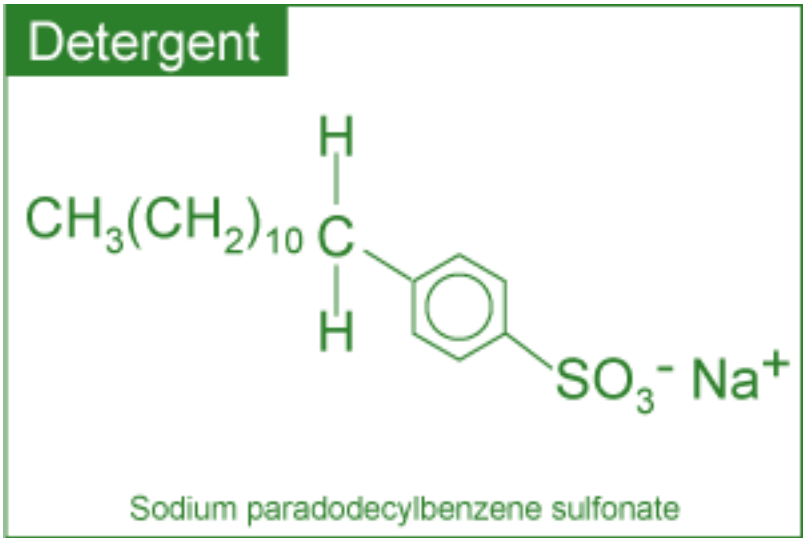
- Detergents are less affected by calcium and magnesium ions in water, thus acting as better cleaning agents and almost eliminating the film formation.
- Detergents perform well under diverse conditions such as adaptability to diversity of fibers, washing temperatures and water conditions.

Disadvantages

- Detergents are made from non-renewable petroleum-based oils.
- Majority of detergents are not biodegradable.

Composition and Limitations of Detergents

Detergents (containing a variety of engineered anionic or non-ionic surfactants) are made from petrochemicals.



Soaps and Detergents

The Cleaning Process

Introduction: In the cleaning process, the polar end of the surfactant molecule interacts with water (a polar molecule) and the non-polar end is attracted to oil or grease (non-polar molecules)

- **Step 1:** Chemical interaction (with soap or detergent) traps the oily and greasy soil molecules. In aqueous solution, surfactants cluster near the surface
- **Step 2:** The hydrophobic tails are attracted to grease and the hydrophilic heads to the water, thereby forcing the grease away from the soiled surface
- **Step 3:** The grease is then surrounded by the individual surfactant molecules and removed from the soiled surface
- **Finally:**
  - Thermal interaction (with hot water) helps dissolve oil and grease molecules
  - Mechanical interaction (machine agitation or hand rubbing) releases oily and greasy soil from the fabric

Soaps and Detergents

Classifications

Depending upon the function, household soaps and detergents can be classified as those used for:

Personal hygiene

Laundry

Dishwashing

Household cleaning

It is important to note that in view of the functional diversity, these products are usually formulated by mixing many ingredients. For example, laundry detergents are formulated from the following groups of chemicals:

- Surfactants to bind and suspend grease and dirt in the washing water
- Builders to remove Ca^{2+} and Mg^{2+} from hard water and soil
- Bleaching agents to remove stains and kill bacteria
- Enzymes to catalyze the degradation and elimination of some stains
- Miscellaneous chemicals such as foam stabilizers, fabric brighteners, fragrances, corrosion inhibitors etc. are added in small quantities.

Soaps and Detergents
Environmental Impact

Developing Products that are Safe for all of Us

As cleaning products are an integral part of our lives, it is very important to be aware of their impact on our health as well as the impact on the environment once discharged.

Health risks are very real, particularly in the case of some specialty household cleaners. Drain openers, oven cleaners and toilet bowl cleaners may contain reactive and/or corrosive chemicals. It is imperative that adequate safety precautions are taken while using such products.

The manufacturers are obliged by law to evaluate the environmental safety of the ingredients. Most of these products are formulated to work with water and end up in wastewater treatment plants, thus impact on the environment is minimized.

The **Safer Detergent Stewardship Initiative (SDSI)** program of the U.S. Environmental Protection Agency (EPA) recognizes corporate environmental leaders using safer surfactants which break down quickly into non-polluting chemicals and thus protect aquatic life.

In an effort to handle these products in an environmentally wise way, we as consumers should buy them in usable amounts and dispose of them (if required) properly.

Soaps and Detergents
Recent Trends

In keeping with consumer demand for more efficient and environmentally friendly products, the present trend is to develop home and fabric care products that:

- Contain surface protectors or modifiers that repel soil and stains more effectively.
- Deliver active ingredients in a controlled way.
- Are effective in cold water.
- Contain natural or naturally derived ingredient(s).
- Do not contain chemicals of concern with respect to toxicity.
- Generate less carbon dioxide during production (smaller environmental footprint)

Keyterms
Use the Glossary (top menu bar) to check out these terms

Reducing agent: A substance that reduces (i.e.,

Oxidizing agent: A substance that oxidizes (i.e.,

donates electrons) another substance and in turn gets oxidized (i.e., accepts electrons).

accepts electrons) another substance in a chemical reaction and in turn gets reduced (i.e., donates electrons).

Personal Care Products

Influencing Factors

Nearly all of us use personal care products for one or more reasons: to make our hair clean and colorful, skin free of wrinkles or to delight the senses. This is an expanding and dynamic field primarily because such products must be developed to take care of the changing needs of society.

Some influencing factors include:

- Aging population
- Changing attitudes of men
- More women in the workplace
- Concerns about exposure to ultraviolet radiation

The chemical ingredients in these products are thus changing at a remarkably fast pace. The availability of biotech products and processes to produce new ingredients is going to revolutionize the development of personal care products in the future.

In addition to rapidly changing chemical ingredients, more efficient delivery systems are being introduced. These include a variety of encapsulation systems to deliver the active ingredients in cosmetics.

Many shampoos, lipsticks, face creams and toothpastes contain these microcapsules. The active ingredient is delivered when the microcapsules rupture on the applied surface (e.g., skin) due to rubbing, presence of moisture, change in pH or the presence of naturally occurring bacteria.

Personal Care Products

Hair Care Products: Shampoos, conditioners, styling agents and colorants

Overview: These products are used for a variety of purposes such as to wash, condition, color or curl hair

- Includes: Shampoos, Conditioners, Styling agents, colorants

Shampoos: Shampoos are cleansing agents containing anionic surfactants to remove oil and dirt from the hair and scalp – Anionic Surfactant (Sodium Dodecylsulfate)

- Surfactants produce foam, lifting oil and dirt from the hair. In addition, fragrances, thickneners, foam boosters and other agents may also be added

Conditioners: Usually contains cationic surfactants : Hexadecyltimenthylammonium chloride

- Helps in rising out any residual shampoo and at the same time provide softer and easy to manage hair

Styling agents: The curling of hair is carried out in 3 steps

- Treatment of hair with a reducing agent (an electron donor) that breaks certain covalent bonds
- Setting hair in the desired shape
- Treating hair with an oxidizing agent (an electron acceptor) such as dilute solution of hydrogen peroxide to reform the previously broken covalent bonds in the new shape

Colorants:

- **Hair coloring is a 2 step process involving:**
    - Oxidation of natural hair pigments to colorless products using a bleaching agent
    - Application of an organic, synthetic dye to obtain the desired color
    - In addition to the dye (or its precursor), the formulation contain ammonia, hydrogen peroxide and a surfactant. In order to reduce the damage to hair during the coloring process and reduce the smell of ammonia, the chemistry has been modified by replacing ammonia with ammonium carbonate.
- **Major developments in the field of hair coloring include the availability of:**
    - A large variety of colors
    - Improved delivery systems to enhance the adhesion of colors to the hair
    - More effective conditioners to neutralize the harsh effects of dye chemicals

Personal Care Products

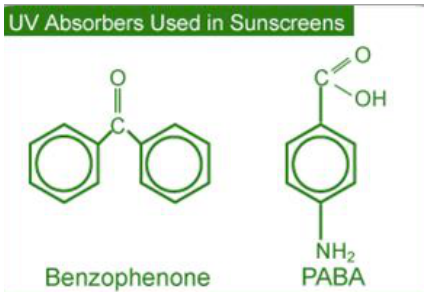
Skin Care Products

Skin care products can be classified as:

- **Moisturizers**
    - Used to increase the water content of the skin.
    - They perform a number of functions such as:
        - Prevent and treat dry skin
        - Protect the skin and make it appear smooth by encouraging an orderly shedding process.
        - Improve skin tone and texture
        - Protect sensitive skin and mask imperfections
    - Active ingredients in skin moisturizers include:
        - **Humectants:** Absorb moisture and hold it in the skin.
            - Glycerin, urea
        - **Emollients:** Lubricate and smooth the skin.
            - Lanolin, mineral oil
        - **Miscellaneous:** Antioxidants, fragrances, minerals, plant extracts, vitamins
    - Skin care products (creams, lotions, shampoos and sun care products) containing plant-derived chemicals are being developed at a very fast rate.
- **Sunscreens** (sunblock)
    - Used to protect the skin against the harmful effects of ultraviolet (UV) radiation. Ultraviolet radiation emitted by the sun consists of UV-A and UV-B.
    - Although stratospheric ozone layer destroys most of this radiation, the UV light that gets through can cause problems. In addition, the depletion of ozone layer due to a variety of natural and human made chemicals may increase the amo0unt of UV radiation reaching us. It is believed that exposure to UV radiation can cause painful sunburn, damage the skin, and lead to skin cancer.
    - Sunscreen products (sold as lotions, ointments, creams and gels) are formulated with addition chemical ingredients that absorb UV radiation.
    - Active ingredients commonly used in sunscreens can be classified as:

        - **Inorganic:** Approved for use are titanium dioxide and zinc oxide. These work primarily by reflecting and scattering UV light.
        - **Organic**: Wide varieties are approved for use. These work primarily by absorbing UV light and dissipating it as heat.
    - The effectiveness of a sunscreen in a formulation is rated by its ability to block the UV-B rays that cause skin burns. It is called Sunburn Protect Factor (SPF). The higher the SPF, the better its protection against UV-B rays.

UV absorbers used in sunscreens: Benzophenone PABA



Protection Factors:

- Protection from a particular sunscreens depends on the following factors:
    - Activities (e.g., swimming leads to a loss of sunscreen from the body)
    - Amount applied and frequency of reapplication
    - Solar intensity
    - Type of skin
    - Amount of sunscreen absorbed by the skin
- In order to achieve a high SPF, formulations generally contain a combination of inorganic and organic ingredients.

Some misconceptions: There is a misconception that a user can determine the duration of effectiveness of a sunscreen by multiplying the SPF by the time it takes for him of her to suffer a burn without sunscreen.

- Ex: Someone who would sunburn after 15 minutes (without any sunscreen protection) in the sun would expect to burn after 150 minutes if protected by a sunscreen with SPF 10

Personal Care Products

Safety in the Sun

In an attempt to inform the consumers the level of UV-A protection in sunscreens, the US Food and Drug Administration (US FDA) is proposing a four star rating system to be displayed near the SPF rating on the label. According to this system, one star will represent low UV-A protection and four stars the highest UV-A protection.

Personal Care Products

Cosmeceuticals

Whereas *pharmaceuticals* are defined as products that may affect the structure or any function of the body, cosmetics are something superficial to cover a deficiency or defect.

The term **cosmeceuticals** is used to describe cosmetics containing ingredients which may affect the structure or any function of the body like pharmaceutical ingredients.

During the late 1980s, *alpha hydroxy acids* (AHAs) became important ingredients in many cosmetic formulations claiming to reduce signs of aging, sun-damaged skin and wrinkles. These work by breaking down and lifting off part of the top layer of dead skin cells in order to get rid of some surface damage and accelerate growth of living cells. The cosmetic industry believed the ingredients to be more than simple cosmetics and hence called them cosmeceuticals.

Some of these products are only available with a doctor's prescription and supervision. They include, among others, Botox (for a more youthful look), Vaniqa (to eliminate unwanted facial hair) and Propecia (for bald men).

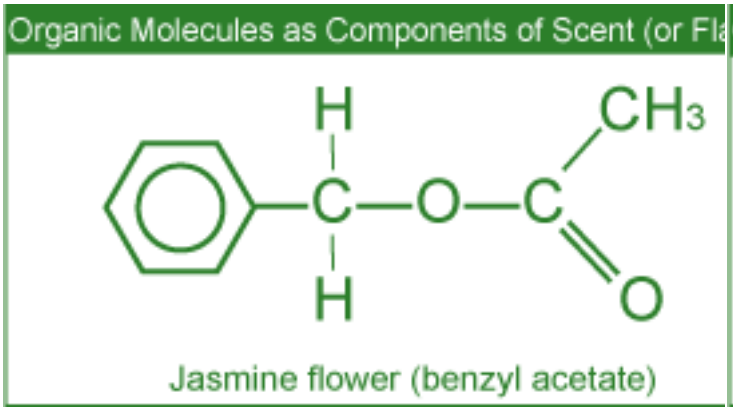
Personal Care Products

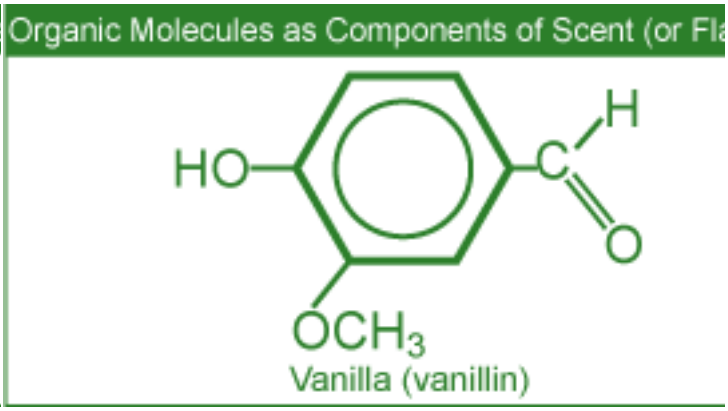
Perfumes

Perfumes are alcoholic solutions of organic compounds with pleasant odors (fragrant compounds). Today, a large variety of natural and synthetic compounds are available to create fragrances for perfumes. In creating perfumes, the ingredients are blended based on their molecular size and volatility.

For this reason, the fragrances in perfumes are generally experienced in three different stages referred to as top, middle and base notes. The top notes are the most volatile components and hence experienced immediately after the opening of the package. The middle notes are experienced next followed by the base notes which last longest.

A recent trend has been to develop more intense and long-lasting alternatives to the known fragrant compounds. Such low-volume production means less impact on energy, health and the environment.





Personal Care Products

Miscellaneous Products

Deodorants

Body odors are reduced or masked by the use of deodorants. Such odors may originate from the conversion of certain compounds (present in the perspiration) to unpleasant odors by bacteria. Thus the effective chemical ingredients in such products are antibacterial agents and perfumes.

Cosmetics

Facial cosmetics such as lipstick and mascara generally contain oils, waxes, pigments and perfumes. Lipstick manufacturers blend various proportions of oils, waxes and emollients (to soothe the skin) to formulate the base for their unique brand. Fragrances, pigments, preservatives, antioxidants and a variety of other ingredients are then added.

In recent years there has been a concern regarding the presence of low levels of lead in certain cosmetics. A recent testing of a number of brands of lipstick by the US FDA (United States Food and Drug Administration) has shown the presence of low levels of lead. According to the US FDA, the levels observed do not pose a safety concern.