Soaps, Detergents, and Other Ambiphiles

Introduction

A. General Purpose/ Uses/ Functions of Detergent

  - A surfactant is identified as a material that can greatly reduce the surface tension of water when used in very low concentrations.
  - What they all have in common is a polar hydrophilic head with at least one long-chain hydrophobic tail.
  - Uses of Detergents:
    - Shampoos
    - Laundry Detergents
    - Stain, odor, and rust remover

  - “For most of American history bath soap was a luxury product. Its eventual transformation into a ubiquitous and well-used commodity required a confluence of cultural and technological changes.”

  - “Two clearly differentiated regions are found in a surfactant, a lyophilic region (in those cases in which the bath is water it is called hydrophilic) and a lyophobic region (in this case it is called hydrophobic).
  - An emulsion consists of a dispersion of droplets (usually from 1 to 100 µm in diameter) in a liquid in which it is immiscible. An emulsion is a metastable system; that is, one that is not thermodynamically favored but lasts long enough (from a few minutes to a few years) to serve a purpose, in this case, to keep liquid dirt in suspension avoiding redeposition.”
  - Micelle- “A structure that can adopt different shapes (spherical, cylindrical, laminar, etc.) with sizes less than 10 nm, in which the surrounding water is orientated by the hydrophilic region of each monomer, leaving an internal region where the hydrophobic tails interact with each other.”
“The main contribution of micelles to detergency is their ability to **spontaneously solubilize immiscible materials** by means of a reversible interaction with their internal hydrophobic tails, a process called **solubilization.”**


“Over just a few nanoseconds, individual detergent molecules rapidly fuse to form small **micelle-like aggregates.”**


A **wetting agent** is “a substance that by becoming adsorbed prevents a surface from being repellent to a wetting liquid and is used especially in mixing solids with liquids or spreading liquids on surfaces.”


Soaps are useful **cleaning agents** because of the different affinities of a soap molecule’s two ends.

The resulting mixture of two insoluble phases is called an **emulsion**. We say the grease has been emulsified by the soapy solution. When the wash water is rinsed away, the grease goes with it.

**B. General Types of Detergents**


**Cationic-**“Adsorbs orienting the hydrophobic tail towards the bath producing a “**greasy**” monolayer that provides the substrate with a soft feel and prevents the damage caused by friction.”

- “The di-n-alkyldimethylammonium chloride is a cationic surfactant traditionally used as fabric softener.”

**Anionic-**“Show a strong tendency to adsorb particularly onto the surface of particles and substrates causing repulsive forces that offset attractive forces which leads to the favoring of the removal of dirt and avoids **particle aggregation**”

- A common anionic detergent is sodium dodecyl sulfate (sodium lauryl sulfate)

**Neutral-** Also called “nonionic”; “Effective for the production of **steric barriers** for the prevention of soil redeposition.”

- A common nonionic detergent is polyoxyethylene alcohols

**Enzymatic-**a detergent that contains a specific class of **enzyme** to help aid in breakdown and cleaning

- A common enzymatic detergent is a protease named subtilisin.

  o **Protease**—“Proteolytic enzymes degrade proteins by cleaving the peptide bonds, thus assisting in the removal of protein-based stains such as blood and many types of food.”
  o **Enzymatic Activity** of an enzymatic detergent is based on pH and temperature and can increase or decrease its effectiveness.
  o Enzymes convert substrates into small, readily soluble fragments that can easily be removed from fabrics by detergents.


  o **Amylases** “act on stains containing starch by degrading starch to short-chain sugars. Typical stains are sauces, gravy, and ice-creams.”
  o **Lipases** “act on soil containing oil and grease from food and body.”
  o **Cellulases** “act on stains from dust and mud. They are especially good for cleaning clothes made from cellulosic fibers.”

C. **Statement of Need and Outline of Approach**

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Introduction

A. General Purpose/ Uses/ Functions of Detergent

A surfactant is identified as a material that can greatly reduce the surface tension of water when used in very low concentrations.\(^1\) Two clearly differentiated regions are found in a surfactant, a lyophilic region (in those cases in which the bath is water it is called hydrophilic) and a lyophobic region (in this case it is called hydrophobic).\(^3\) Soaps are useful cleaning agents because of the different affinities of a soap molecule’s two ends. Greasy dirt is not easily removed by pure water because grease is hydrophobic and insoluble in water. The long hydrocarbon chain of a soap molecule dissolves in the grease, with the hydrophilic head at the surface of the grease droplet.\(^6\) Once the surface of the grease droplet is covered by many soap molecules, a micelle can form around it with a tiny grease droplet at the center.\(^6\) Over just a few nanoseconds, individual detergent molecules rapidly fuse to form small micelle-like aggregates.\(^4\) A micelle is a structure that can adopt different shapes (spherical, cylindrical, laminar, etc.) with sizes less than 10 nm, in which the surrounding water is orientated by the hydrophilic region of each monomer, leaving an internal region where the hydrophobic tails interact with each other.\(^3\) The main contribution of micelles to detergency is their ability to spontaneously solubilize immiscible materials by means of a reversible interaction with their internal hydrophobic tails, in a process called solubilization.\(^3\) A wetting agent is “a substance that by becoming adsorbed prevents a surface from being repellent to a wetting liquid and is used especially in mixing solids with liquids or spreading liquids on surfaces.\(^5\) The resulting mixture of two insoluble phases is called an emulsion. We say the grease has been emulsified by the soapy solution. When the wash water is rinsed away, the grease goes with it.\(^6\) Soap is an article whose commonplace presence and obvious necessity we take for granted.\(^2\) Soaps are used in products such as shampoos, laundry detergents, and rust removers.\(^1\)
B. General Types of Detergents

There are four main types of detergents that are commonly used in most household products. They are cationic, anionic, neutral, and enzymatic detergents. Cationic detergents work by adsorbs orienting the hydrophobic tail towards the bath producing a “greasy” monolayer that provides the substrate with a soft feel and prevents the damage caused by friction. The di-n-alkyldimethylammonium chloride is a cationic surfactant traditionally used as fabric softener.³ A anionic detergent shows a strong tendency to adsorb particularly onto the surface of particles and substrates causing repulsive forces that offset attractive forces which leads to the favoring of the removal of dirt and avoids particle aggregation. A common anionic detergent is sodium lauryl sulfate found in shampoos.³ A neutral detergent, also called a “nonionic”, is effective for the production of steric barriers for the prevention of redisposition. A common nonionic detergent is polyoxyethylene alcohols.³ An enzymatic detergent is a detergent that contains a specific class of enzyme to help aid in breakdown and cleaning. A common enzymatic detergent is a protease named subtilisin.³ The four specific classes of enzymatic detergents are protease, amylase, lipase, and cellulose. Proteolytic enzymes degrade proteins by cleaving the peptide bonds, thus assisting in the removal of protein-based stains such as blood and many types of food.⁷ Amylases act on stains containing starch by degrading the starch to short-chain sugars. Typical stains are sauces, gravy, and ice creams.⁸ Lipases act on soil containing oil and grease from food and the body.⁸ Cellulases act on stains from dust and mud.⁸ They are especially good for cleaning clothes made from cellulosic fibers.⁸ Enzymes convert substrates into small, readily soluble fragments that can easily be removed from fabrics while used in combination with detergents.⁷

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