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Soaps, Detergents, and Other Ambiphiles

Introduction

A. General Purpose/ Uses/ Functions of Detergent

- Ref 1: News from Online: Cleaning Up- Soap, Detergent, and More. Sweeney-Judd,Carolyn. "*Journal of Chemical Education,* Vol. 79 No. 10 October 2002. Pages 1179-1181

    - 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

- Ref 2: Chemists Clean Up: A History and Exploration of the Craft. Kostka, Kimberly L. and David D. McKay. *Journal of Chemical Education,* Volume 79 No. 10. October 2002. Pages 1172-1175.

    - "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."

- Ref 3: Superficial Overview of Detergency. Poce-Fatou, J.A. *Journal of Chemical Education*, Vol. 83 No.8 August 2006. Pages 1147-1151.

    - "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 (usuallyfrom 1 to 100 μm in diameter) in a liquid in which it isimmiscible. 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, inthis 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."

- Ref 4: MD Simulations of Spontaneous Membrane Protein/ Detergent Micelle Formation. Bond, Peter J., Johnathan M. Cuthbertson, Sundeep S. Deol, and Mark S.P. Sansom. *Journal of the American Chemical Society.* Vol. 126. 2004. Pages: 15948- 15949.

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

- Ref 5: Merriam-Webster, Inc., Encyclopedia Britannica Company, 2011. http://www.merriamwebster.com/dictionary. Accessed on 1/30/12.

  - 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."

- Ref 6: Organic Chemistry. Wade, L.G. Jr., Pearson Prentice Hall. 7th edition. 2010.

  - 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

- Ref 3: Superficial Overview of Detergency. Poce-Fatou, J.A. *Journal of Chemical Education*, Vol. 83 No.8 August 2006. Pages 1147-1151.

  - 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.

- Ref 7: Proteolytic Enzymes in Detergents: Evidence of Their Presence Through Activity Measurement Based on Electrophoresis. Fonfria- Subiros, Elsa and Saperas, Nuria. *Journal of Chemical Education*. Vol. 88. September 2011. Pages: 1702-1706.

    - 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."
    - Enzymatic Activity of an enzymatic detergent is based on pH and temperature and can increase or decrease its effectiveness.
    - Enzymes convert substrates into small, readily soluble fragments that can easily be removed from fabrics by detergents.

- Ref 8: Amylase Activity in Detergents, phadebas.com, 2006. http://www.phadebas.com/areas_of_use/chemistry_and_research/amylase_in_detergents. Accessed on 1/31/12.

    - Amylases "act on stains containing starch by degrading starch to short-chain sugars. Typical stains are sauces, gravy, and ice-creams."
    - Lipases "act on soil containing oil and grease from food and body."
    - 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**

Materials and Methods

Results

Discussion

Conclusion

References

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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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[3] Superficial Overview of Detergency. Poce-Fatou, J.A. *Journal of Chemical Education*, Vol. 83 No.8 August 2006. Pages 1147-1151.
[4] MD Simulations of Spontaneous Membrane Protein/ Detergent Micelle Formation. Bond, Peter J., Johnathan M. Cuthbertson, Sundeep S. Deol, and Mark S.P. Sansom. *Journal of the American Chemical Society.* Vol. 126. 2004. Pages: 15948- 15949.
[5] Merriam-Webster, Inc., Encyclopedia Britannica Company, 2011. http://www.merriamwebster.com/dictionary. Accessed on 1/30/12.
[6] Organic Chemistry. Wade, L.G. Jr., Pearson Prentice Hall. 7th edition. 2010.
[7] Proteolytic Enzymes in Detergents: Evidence of Their Presence Through Activity Measurement Based on Electrophoresis. Fonfria- Subiros, Elsa and Saperas, Nuria. *Journal of Chemical Education*. Vol. 88. September 2011. Pages: 1702-1706.
[8] Amylase Activity in Detergents, phadebas.com, 2006. http://www.phadebas.com/areas_of_use/chemistry_and_research/amylase_in_detergents. Accessed on 1/31/12.