Chapter 20: Surfactants, Micelles & Emulsions

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Abstract
The chapter is devoted to surfactants, the formation of micelles and emulsions where the main principles of these processes and their industrial use are put forward. Amphiphilic molecules that occur in both hydrophilic and hydrophobic forms, these molecules are termed as surfactants that reduce the surface and interfacial tension that allow a process like detergency, emulsification and solubilization to happen. The chapter classifies surfactants as anionic, cationic, non-ionic, and zwitterionic surfactants and has discussed their structural characteristics, critical micelle concentration (CMC), and micelle formation. In the interpretation of the stability factors and industrial significance, emulsions are mixtures of immiscible liquids, and their formulation is represented by the oil-in-water (O/W) and water-in-oil (W/O) systems. Its use in detergents, cosmetics, pharmaceuticals, food processing and drug delivery systems are also shown to depict the practical importance. The difficulties in figuring out the stability of formulations, ecological effects and efficiency of the surfactant utilization are also discussed in the chapter. Combining both theoretical knowledge and mathematical modeling and practical examples, students can learn about the development of efficient systems and emulsions based on surfactants. A background on surfactants and micelles is essential to the field of chemical engineering, material science, pharmaceuticals, and consumer product industries, and offers mechanisms to create new solutions to industrial and environmental problems.

Keywords: Surfactants, Micelles, Emulsions, Critical micelle concentration, Detergents, Drug delivery, Industrial applications.

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20.1.Introduction

Surface-active agents can also be called surfactants, and they are substances that can change the properties of the surfaces and interfaces of liquids. Surfactant molecules are amphiphilic chemically and made up of two distinct sections a hydrophilic (water loving) head and a hydrophobic (water repelling) tail. This dual affinity helps the surfactants to align themselves at the interfaces e.g. air-water, oil-water or solid-liquid interfaces to decrease the surface or interfacial tension. Consequently, otherwise energetically unfavorable processes, e.g. mixing of immiscible liquids, can occur.

Historical Background

The application of surfactants dates back to ancient times. In 2800 BCE, Babylonians made early soaps by mixing alkaline ash and animal fat. The same was practised in ancient Egypt and Rome where soap-like substances were used to clean textile and as medicine. Scientific knowledge on surfactants and their behavior at the interface was however developed at a later date. During the 18 th and 19 th centuries, physical chemistry was invented. Theory of surface tension Scientists like Thomas Young and Pierre-Simon Laplace established the basis of surface tension theory, and J. Willard Gibbs came up with the notion of adsorption at interfaces. The early 20 th century experienced a revolution with the systematic classification of surfactants as anionic, cationic, nonionic and zwitterionic, and the creation of synthetic detergents during World War I and II because of the shortages of natural fats and oils. The second part of the 20th century saw a booming science of surfactants that was spurred by industrialization and progress in colloidal and interface chemistry. Radicals like critical micelle concentration (CMC), micellization and interfacial film formation became the key factors

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