Sustainability in commercial laundering processes

Module 4
Usage of Energy and Detergents

Chapter 2

Effect of composition and dosage of detergents on washing performance

Content

Education and Culture

Leonardo da Vinci

- Composition of detergents
- Surfactants, micelle formation, critical micelle concentration
- Alkalis
- Sequestrants
- Enzymes
- Consequences of dosage
- Under-dosage
- Over-dosage

Learning targets

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- After finishing this chapter, you will

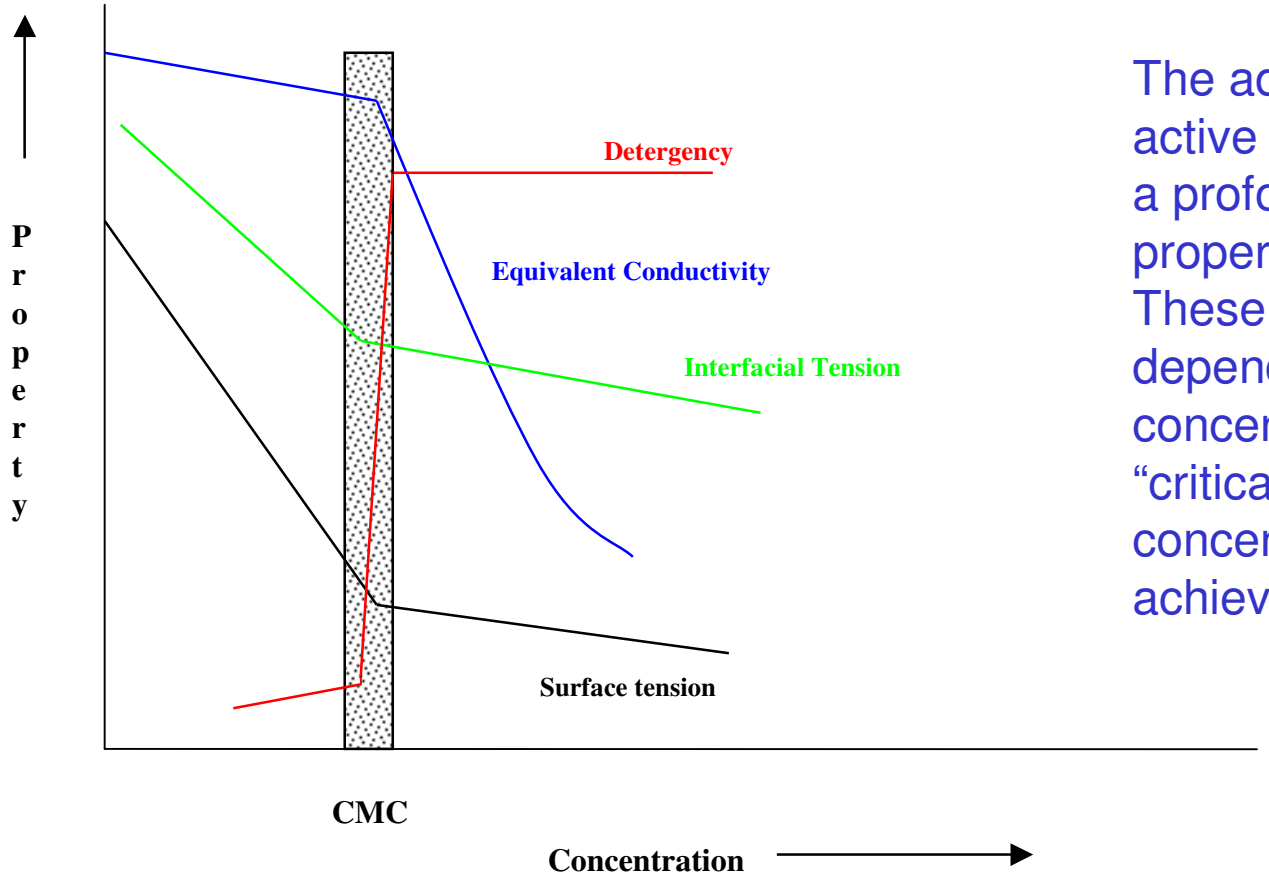
- Know the most important components of washing powders for industrial laundries
- Know the most important properties of surfactants, alkalis, sequestrants and enzymes as well as their role in washing process
- Know the consequences of different washing powders composition
- Know and be able to explain consequences of under-dosage as well as over-dosage

Composition of Detergents

The composition of a detergent will directly affect washing performance.

In many cases, the components are specifically selected to provide performance benefits for a particular soiling type or fabric type

Surfactants



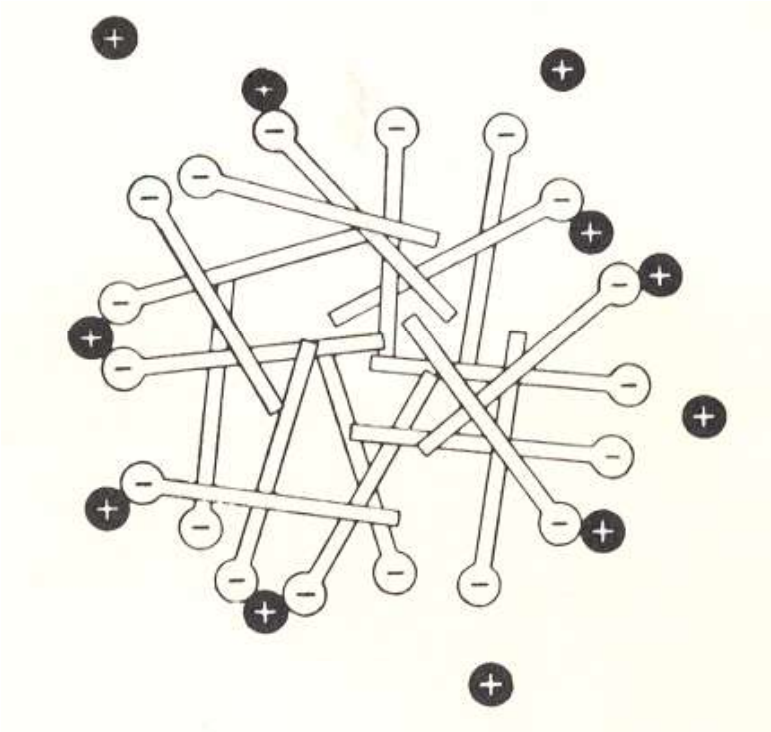
The addition of surface active agents to water has a profound effect upon the properties of the solution. These effects also change depending upon surfactant concentration until the "critical micelle concentration" is achieved.

Surfactants

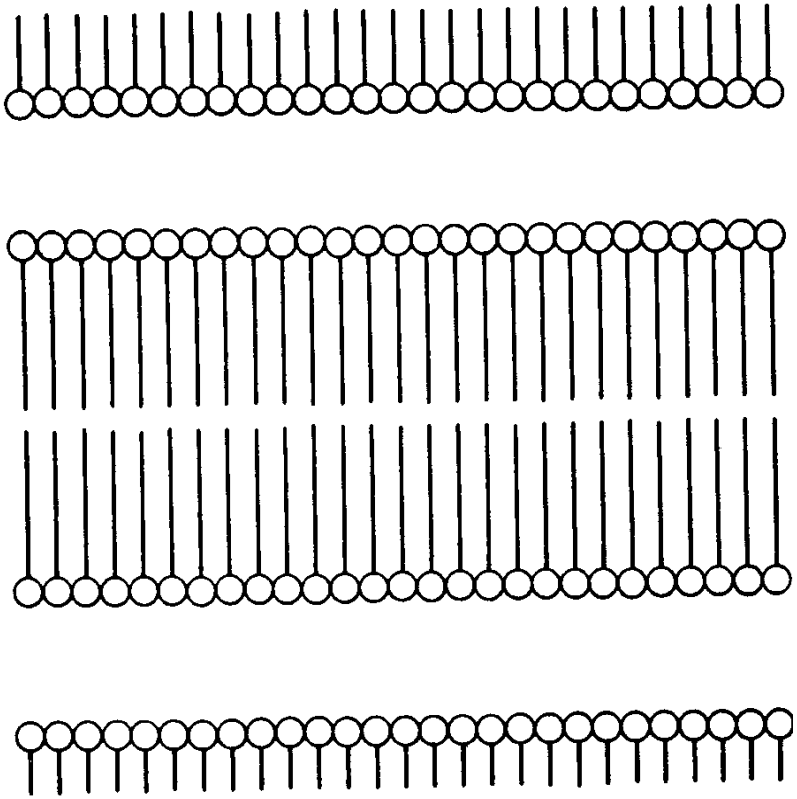
The critical micelle concentration is the point at which surfactant molecules aggregate together in the liquid to form groups known as micelles.

The critical micelle concentration of a surfactant indicates the point at which surface active properties are at an optimum and performance is maximised.

Typical Micelle Formation



The Hartley spherical micelle



The McBain lamellar micelle

CMC

The critical micelle concentration of a surfactant is decreased by other components in a detergent, in particular, electrolytes such as inorganic builders and alkalis.

This reduction affects the adsorption, wetting and emulsifying properties of surfactants.

Alkalis

The type of alkali builders contained in a detergent will affect the washing performance with different alkalis being suited for different textile fibre type and nature of soiling.

Caustic alkalis can be very effective in saponifying natural fatty and oily soiling.

Silicate alkalis are effective in emulsifying and suspending mineral oily soiling.

Alkalis such as bicarbonate and some phosphates can provide buffered pH conditions suitable for washing of woollens and delicate fabrics.

Sequestrants

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Sequestrants such as condensed phosphates, organic chelating agents and zeolites are components which have a significant effect upon washing performance.

The primary function is normally to remove hard water ions (Calcium and Magnesium) from the wash liquor.

These ions adversely affect detergent performance.

In addition, the removal of other multivalent ions, such as Iron and Manganese, by sequestration provides additional performance benefits.

Enzymes

Enzymes are important components of some detergents which are designed to efficiently remove particular soiling/staining types.

Enzymes can enhance detergent performance for the removal of proteinaceaous, fatty and starchy soiling.

Effect of Composition of Detergent on Washing Performance

- Critical micelle concentration (cmc) of surfactants appears to be the most important factor affecting the washing performance of textiles.
- Salts (builders) decrease the cmc value of surfactants thus affecting adsorption, wetting, emulsifying power, suspending power, electrostatic repulsion forces between the particulate soil and fibre, washing power.
- The maximum in the plot of surfactant adsorption on fibre and particulate soil observed and the washing performance versus surfactant concentration coincide very well with the changes in suspending power, emulsifying power or soil charge within the cmc range caused both by electrolyte addition and temperature.

Consequences:

- Lower adsorption of surfactants on fibre and soil,
- Prolonged time of wetting,
- Lower removal of oily and greasy matter (emulsions),
- Lower alkalinity of detergent solution,
- Lower bleaching action,
- Lower electrostatic repulsion forces (charge) between fibre and particulate soil,
- Lower suspending power,
- Higher greying and redeposition of textiles,
- Lower costs of detergent used,
- Lower consumption of water for rinsing,
- Diminished total washing effectiveness

High Dosage of Detergents and Washing Performance

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- Longer and more rinsing
- Higher use of water
- Longer total washing time (wash + rinsing)
- Higher costs for detergents
- Decreased washing performance due to:
  - lower adsorption of detergents on fibre and soil,
  - lower electrostatic repulsion forces between fibre and
  - particulate soil
  - decreased suspending power
  - increased redeposition of textiles (washed fabrics become harsh, grey, and wear out more quickly)

High Dosage of Detergents and Washing Performance (continued)

- Increased alkalinity of the detergent solution
- Significantly increase in biological oxygen demand (BOD) in water
- Significantly increase load on sewage works and on the environment (ecotoxicity)
- Higher concentration of detergents (higher concentration of bleaching agent) can cause the depolymerization of cotton textiles, and shorten their life time