

Formulation 4 chemists

Optimising product stability

This module considers the factors affecting the long-term stability of dispersions and emulsions, and what methods exist to influence them. It looks at techniques to identify or predict systems that are unstable and gives examples of how to control the behaviour to improve shelf life. In colloidal systems sedimentation and creaming of dispersed material is a recurring problem, however it is not the only cause of ageing in formulations. Aggregation, dissolution, hydration, oxidation, microbial attack and polymerisation are all important effects that are covered in this module, which will have broad appeal across many sectors.

Content

Factors affecting shelf life stability

- Some examples of shelf life issues

Aggregation, coalescence and ripening

- Combating particle aggregation
- Combating coalescence

Sedimentation and creaming

- Critical particle size
- Creaming or sedimenting?
- Combating sedimentation and creaming

Chemical degradation

- Oxidation, hydrolysis and hydration
- Microbial attack
- Polymerisation/cross-linking
- Preventing chemical degradation

Predicting shelf life

- Accelerated testing
- Non-invasive early detection

Shelf life optimisation

- Options for optimising formulations

Learning objectives

- Identify the factors that may cause formulations to fail
- Understand how to combat those causes
- Identify a range of tests and equipment that can predict long term shelf life stability
- Make key changes in your formulation design or processing application to improve shelf life

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Introduction to practical rheology

Rheology, the study of the *flow and deformation of materials*, is likely to be of importance in the processing or application of a complex fluid. This module considers the link between performance and rheology and the ways in which these can be measured and influenced. The use of rheometers is described in a basic way to then help focus on the information that can be collected from rheological experiments. This is then related to the performance of materials and how this can be improved by the addition of additives. The way in which additives affect the rheology is also introduced.

Content

Rheological terms

- Flow regimes
- Deformation rates in real applications
- Rheology and microstructure

Rheological measurements

- Controlled stress instruments
- Controlled strain instruments
- Large strain, steady shear measurements
- Small strain measurements

Applications

- Case studies
- Summary of applications

Additives and rheology control

- Rheology of dispersions
- Rheology of polymer solutions

Putting it into practice

- Polymeric rheology modifiers
- Particulate rheology modifiers

Learning objectives

- Identify rheological measurements that relate to processing conditions and performance characteristics
- Make measurements that are fit for purpose
- Understand the link between the microstructure of a formulation and its bulk flow properties
- Understand how polymers and particles affect the rheology of fluids
- Identify rheology modifiers that might be used to improve performance characteristics

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Emulsion and microemulsion technologies

This module provides an introduction to some of the important concepts related to the formation, stabilisation and destabilisation of emulsions and microemulsions, and looks at the similarities and differences between the two types of system. The importance of surfactant structure is highlighted, as is the use of phase diagrams to map the behaviour of the systems.

Content

- Emulsion formation
- Emulsion break-up
- Surfactants and emulsifiers
- Phase inversion
- HLB scale
- Microemulsion formation
- Tertiary phase diagrams
- Quaternary phase diagrams
- Surfactant structure
- Surface curvature

Learning objectives

- Understand the fundamental difference between emulsions and microemulsions
- Predict likely routes to emulsion destabilisation
- Understand the role of surfactants in the stabilisation of emulsions and be able to determine the phase behaviour from the surfactant structure.
- Identify microemulsions and where they fit into the spectrum of surfactant phases through to macroemulsions
- Interpret tertiary and quaternary phase diagrams of microemulsions
- Relate the stability of emulsions to the structure and curvature of droplets

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Using dispersants in formulations

This module investigates the use of polymeric dispersants to stabilise dispersions and emulsions. It examines the subject from the point of view of a formulator who needs to understand why dispersants are used, how they work, what types are available and how to optimise their use. Some general groups of dispersants are described and the implications of how and when they are incorporated into the formulation are examined, as well as giving help in determining the optimum dose of a dispersant.

Content

What are dispersants?

- What options exist for controlling aggregation?
- When to use a dispersant

Categorising dispersants

- Polymer characterisation
- Some common dispersant types
- Block co-polymers

Choosing a dispersant

- What solvent to use
- What information is needed about the particles?
- What molecular weight of dispersant do I need?

Using dispersants

- When to add a dispersant
- How much dispersant to use
- Implications of using the wrong dose

Learning objectives

- Decide when it is appropriate to use a dispersant
- Make informed choices about suitable dispersants
- Identify material changes due to the use of a dispersant
- Design relevant experiments to optimise the use of a dispersant
- Make changes in your formulation design to incorporate a dispersant

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Surfactant chemistry and architecture

This module highlights the important aspects of surfactants in colloid science, including surfactant structures, adsorption at interfaces, aggregation structures, micelle formation and phase diagrams. It covers all aspects from the basic types of surfactant, through to their adsorption at interfaces and the effect on surface and interfacial tension, their self-assembly into structures and their phase behaviour through to liquid crystals.

Content

- Air-water interface
- Surface tension
- Surfactant adsorption
- Aggregation structures
- Thermodynamics of micelle formation
- Aggregate formation
- Packing parameters
- Phase behaviour
- Liquid crystals

Learning objectives

- Appreciate the importance of surfactants in the chemical and related industries
- Identify a number of different surfactant types from ionic through zwitterionic and non-ionic
- Describe surface tension, what its origins are and how it is defined in terms of force and distance
- Develop an understanding of the effect of surfactants at liquid interfaces
- Identify a number of different aggregation structures of surfactants and place them appropriately on a phase diagram
- Predict structures that might form depending on the shape of the molecule as defined by the packing parameter
- Construct phase diagrams of liquid crystal surfactants by polarising light microscopy