Using the Turbiscan Stability Index (TSI) to determine surfactant efficiency on emulsions stabilisation

Application

Liquid dispersions
(Particles and droplets tend to flocculate / coalesce).

Objective

Analyse influence of various parameters on the stability of emulsions:

- Surfactant ;
- Concentration ;
- Temperature.

Device

Turbiscan® AGS
Turbiscan® TOWER

Introduction

Emulsions are unstable colloidal systems that undergo many destabilization phenomena (coalescence, flocculation, creaming, etc.) that can be due to various causes (lack of surfactant to cover the interface, attractive forces, etc.). Therefore, it is very important for the formulator to know the origins of these processes to be able to overcome them to get a stable product.

For many reasons (coexistence of small and big droplets, chemical interactions, etc.) droplets tend to flocculate. The addition of surfactants may minimize these problems. In this study we have investigated how different surfactants influence flocculation of droplets, as well as the effect of surfactant concentration and the temperature of storage.

Measurement Protocol

An O/W emulsion was formulated using oil (triglyceride) and 1% of xanthan, and one of the 2 additional surfactants below. The reference emulsion was also studied, without any addition of surfactant.

The surfactant was chosen between these two non-ionic surfactants with different lipophilic chains:

- Tween® 80 (HLB = 15)
- Tween® 65 (HLB = 10.5)

Identification of phenomena

Thanks to the Turbiscan device, destabilization phenomena were identified in these formulations, showing evidence of pure coalescence in the samples, without any particles migration.

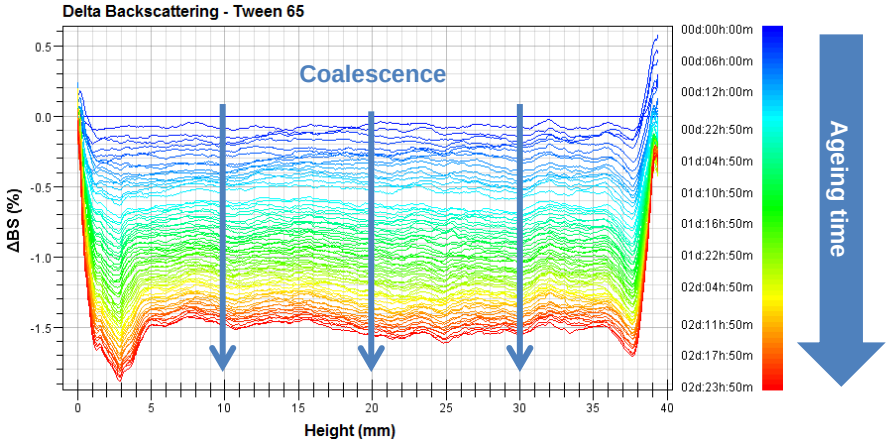


Figure 1. Delta Backscattering, reference emulsion

Quantification of phenomena

It is possible to monitor the coalescence kinetics in the samples versus ageing time, thanks to the Turbiscan Stability Index. It sums all the variations detected in the sample (size and/or concentration). At a given ageing time, the higher is the TSI, the worse is the stability of the sample.

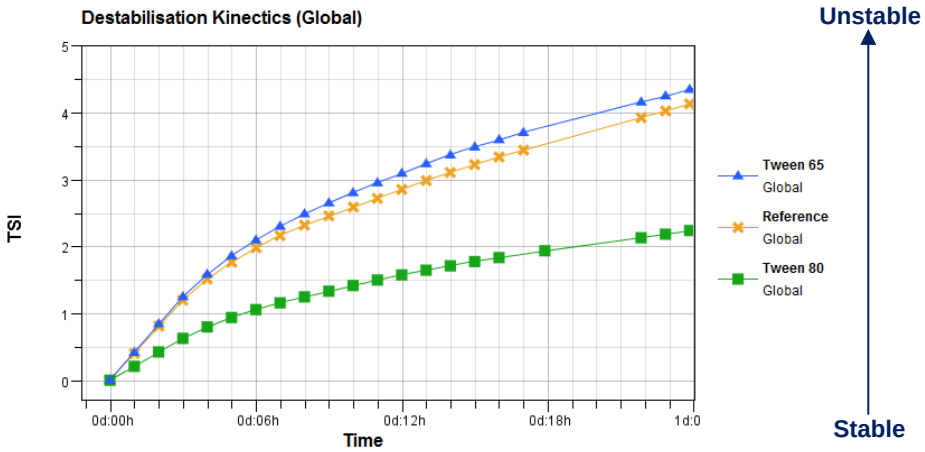
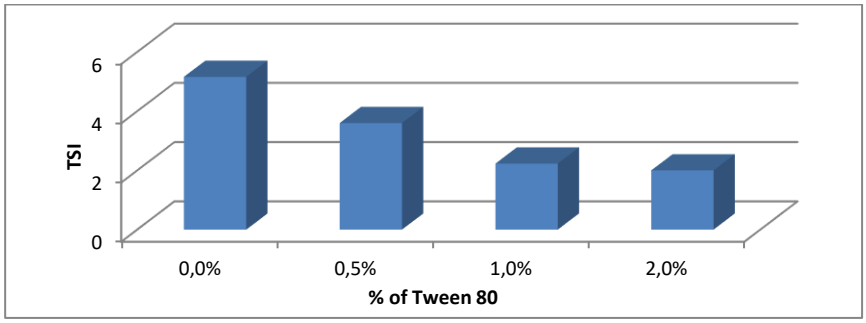


Figure 2. TSI for the reference emulsion and the 2 emulsions with surfactant

Thanks to the previous graph, effect of both surfactants can be compared to the reference. Tween 65 has no influence on the stabilization of the coalescence in this sample, as its HLB is not high enough to play a stabilising role, compared to Tween 80 which decreases significantly the kinetics of coalescence.
In order to increase the stability of the emulsion, surfactant Tween 80 must be added to this formulation.

However, surfactant is still an expensive part on the final formulation and the global stability is not proportional to the amount of surfactant. The second step is then to identify the optimal amount of surfactant in order to have the best stability for the lower price. Analysis was made with 0%, 0.5%, 1%, and 2% of surfactant. The TSI (Turbiscan Stability Index) was computed for each formulation after 1 day of ageing.



Thanks to the previous graph, the optimum amount of surfactant for this formulation is 1%. The TSI is similar with 1% and 2% and so, increase the concentration upper than this 1% value is useless for the stability, and increase the cost of the formulation for no reason.

Summary

The Turbiscan enables to qualify the best surfactant for a given emulsion in order to reduce coalescence rate. This is possible in every kind of concentrated dispersions without any dilution, by comparison of different formulations and then by optimizing the best one.

The Turbiscan is also a unique tool for monitoring the kinetics of destabilization of the system, and quantify it precisely after identifying the phenomena.