CHARACTERIZATION OF AN EMULSION (STABILITY AND SIZE)

INTRODUCTION

Emulsions are colloidal systems commonly used in the cosmetics industry. There are inherently unstable but can be considered as kinetically stable if their destabilization is slower than their expected shelf life. Moreover, in order to sell these products, it is necessary to characterize them and control their quality.

The advantage of the Turbiscan™ technology is that it does not require any dilution and so samples can be characterized as they are. In this application note, the particle size and stability properties are analyzed.

PRINCIPLE

Measurement with Turbiscan®

Turbiscan instrument, based on Static Multiple Ligh Scattering, consists in sending a light source (880 nm) on a sample and acquiring backscattered and transmitted signal. Combining both detectors (BS & T) enables to reach wider concentration range. The backward reflected light comes from multiple scattering as the photons scatter several times on different particles (or drop).

This signal intensity is directly linked to the diameter (d), according to the Mie theory:

$$d = f(BS, \varphi, n_p, n_f)$$

More information

METHOD

We analyzed four direct emulsions of canola seed oil in water with different volume fractions of oil (10%, 20%, 30% and 40%) using the Turbiscan™.

These emulsions are stabilized with a mix of SDS and Span 80.

Using the Turbiscan™ the destabilization process was monitor by scanning the sample every 30 seconds during 1 hour

RESULTS

The different emulsions are characterized by measuring:

- Size of the oil droplets (at t=0)
- The global stability (TSI)
- Migration rate of the droplets

1- Raw emulsion characterization (particle size)

All four emulsions are analyzed using the Turbiscan™ Lab, the following graph is generated:
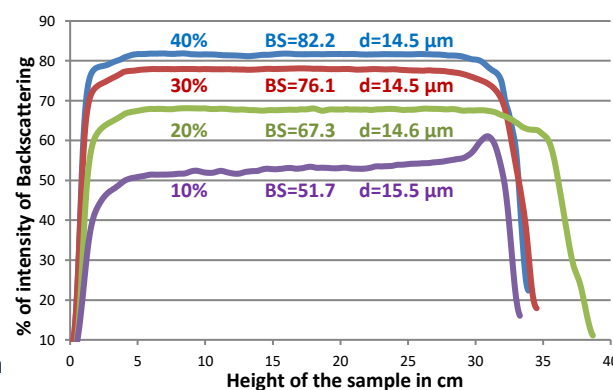

Figure 1: % of Backscattering versus the height for all conc.

The graph in Figure 1 represents the initial level of backscattering for the four emulsions concentrations.

The Turbiscan enables the computation of the mean diameter of the droplets according to the Mie theory law and by using the following parameters:

- Refractive index of the dispersed phase np = 1.471
- Refractive index of the continuous phase nf = 1.33 (water)
- Volume fraction of the dispersed phase φ = 10 - 40 %

Concentration of oil (%)	% of Backscattering	Mean diameter (µm)
10	51.7	15.5
20	67.3	14.6
30	76.1	14.5
40	82.2	14.5

Table 1: % of BS and mean diameter for all samples

Thanks to the previous table, we can conclude:

- The concentration of oil doesn't impact the mean diameter of the droplets
- The mean diameter of oil droplets can be computed by measuring the intensity of an emulsion.

2- Global stability computation: TSI

It is possible to monitor the destabilization kinetics in the samples versus ageing time, thanks to the **T**urbiscan **S**tability **I**ndex. It sums all the variations detected in the sample (creaming, coalescence, size variation …). At a given ageing time, the higher is the TSI, the worse is the stability of the sample.
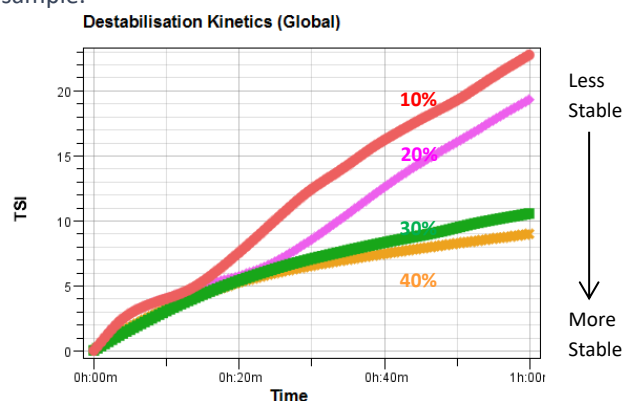

Figure 2: TSI for all emulsions

Concentration of oil (%)	TSI (1 hour)
10	22.4
20	19
30	10.4
40	8.9

Table 2: TSI values after 1 hour of measurement

Thanks to Figure 2 & Table 1, we can compare the effect of the oil concentration on the global stability. Higher is the concentration of oil, more stable is the emulsion with this couple of surfactant.

3- Study of the creaming emulsions

Using the Turbiscan technology, we can identify for all the samples the same destabilization process, the droplet of oil tend to cream toward the top of the sample.
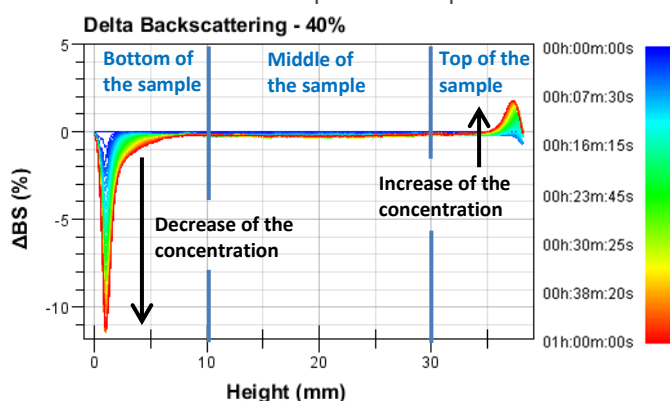

Figure 3: Variation of the intensity of backscattering versus the height of the sample

The following observation can be conducted:

- A backscattering decrease with time at the bottom of the sample due to a clarification of the product
- A backscattering increase with time at the top of the sample due to the formation of a cream layer.
- No backscattering evolution in the middle of the sample meaning no droplet size variation phenomenon.

From backscattering measurements, the migration velocity versus time can be calculated by tracking the migration front over time (Table 2)
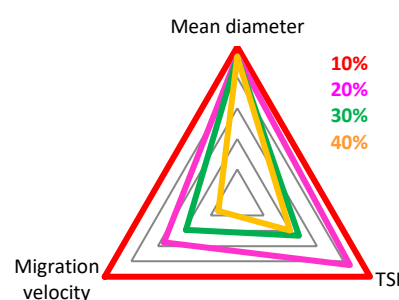
Concentration of oil (%)	Migration velocity (µm/min)
10	168.4
20	93.0
30	65.6
40	24.7

Table 3: Migration velocity of the oil droplets

We observe that the creaming velocity is more important when the phase volume is low. This can be explained by an increase in viscosity of the emulsions when the oil concentration is higher and so slow down the phase separation.

SUMMARY

This application note shows a quick and simple method to characterize different emulsions in a short period of time. The following graph summarizes the results obtained

To conclude, the concentration of oil does not impact the diameter of the oil droplets in the emulsion but, the viscosity of the system increase when the concentration of oil increases and so the migration velocity of the droplets decreases. Consequently, at higher concentration the stability of the emulsion is better. After only one hour of measurement, stability of the samples can be compare.