Detergency properties of surfactants

Introduction

The detergency mechanism is based on the physico-chemical properties of the surfactant, the fat to eliminate and the surface to clean. The spread of the soil on the surface is reduced by the wetting of the surface and the fat by the surfactant (modification of the contact angles water/fat/surface). Hydrodynamic forces thereafter siphon off the fat soil in the cleaning water and fraction it. This is the emulsification step. The oil droplets is eventually solubilized in the water and eliminated.
ARD produces natural surfactants (alkyl polyglucosides) that are used for formulating home care products. Their apolar part is coming from agro resources.
This study is dealing with the potential of natural surfactants to emulsify fat and it is done by measuring the interfacial tension between water and oil and the stability of the emulsions formed using the Turbiscan™ technology.

Reminder on the technique

Turbiscan® technology, based on Static Multiple Light Scattering, consists on sending a light source (880nm) on a sample and acquiring backscattered (BS) and transmitted (T) signal all over the sample height. By repeating this measurement over time at adapted frequency, the instrument enables to monitor physical stability.
The signal is directly linked to the particle concentration (φ) and size (d) according to the Mie theory knowing refractive index of continuous (n_f) and dispersed phase (n_p): $\boldsymbol{BS} = \boldsymbol{f}(\varphi, \boldsymbol{d}, \boldsymbol{n_p}, \boldsymbol{n_f})$

Method

Three different natural detergent surfactants are compared:

- Son 1
- Son 2
- Paille 1

The emulsions are manufactured using a vortex for 30 seconds with the following composition: 6% of sunflower oil, 3% of surfactants and 91% of water.
The emulsions are directly analyzed using the Turbiscan by scanning the sample every 30 seconds during 1 hour.

Results

Raw data

From the graph in Figure 1, we can observe a phase separation of the emulsion. At the bottom of the sample (left of the graph) a light intensity decrease is measured meaning a decrease of the oil concentration and at the top of the sample (right of the graph) a light intensity increase is measured meaning an increase of the oil concentration due to the creaming of the oil to the top. Similar results are obtained for the three samples with different intensities.

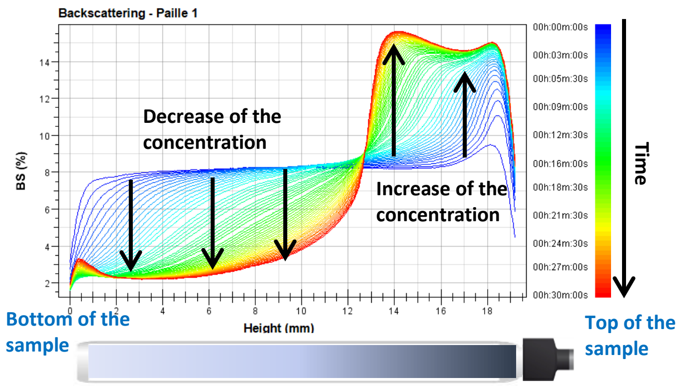


Figure 1: Variation of the transmission versus sample height for sample Paille1

The global stability (TSI)

It is possible to monitor the destabilization kinetics in the samples versus ageing time, thanks to the Turbiscan Stability Index (TSI). It sums all the variations detected in the sample (creaming, clarification, size variation, …). At a given ageing time, the higher is the TSI, the worse is the stability of the sample.

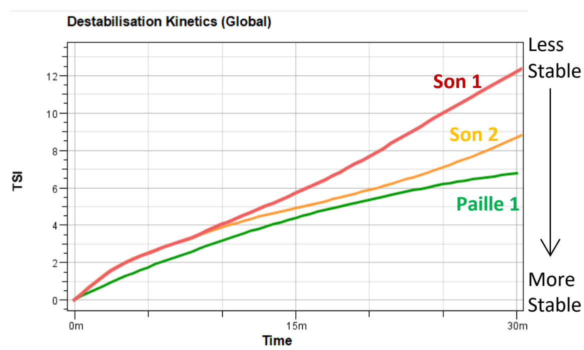


Figure 2: Turbiscan Stability Index for all samples

Using the results above, we can observe that sample “Son 1” is the less stable compared to the two other samples. Moreover samples “Son 2” and “Paille 1” have similar stability properties but still can be discriminated by the Turbiscan™.

Migration rate

In Figure 3, the thickness of the bottom clarified layer of the sample is measured over the time of the analysis. By computing the slope of the curves Thickness = f(time), we obtained the migration rate of the droplets in these emulsions.

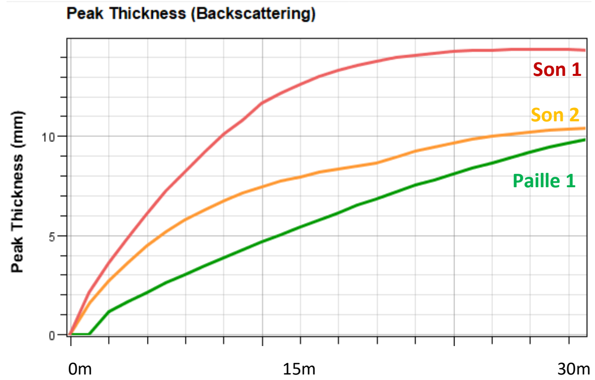


Figure 3: Peak thickness of the cream layer over time

Sample	Migration rate (mm/hr)
Son 1	45.2
Son 2	22.7
Paille 1	21.4

Table 1: Values computed from figure 3

From Figure 3 and table 1, we can conclude that Son1 is less stable than the other two samples as it shows a faster migration of droplets.

Interfacial tension

The results obtained with the Turbiscan™ are compared to the interfacial tension w/o measurement given by a spinning drop tensiometer.

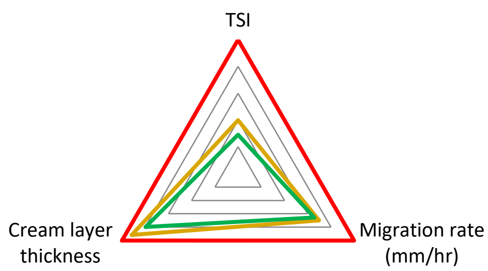
Sample	γ (mN/m) Interfacial tensions	TSI	Migration rate (mm/hr)	Cream layer thickness
Son 1	0.25	12	45.2	14.5
Son 2	0.07	9	22.7	10.7
Paille 1	0.05	7	21.4	9.8

Table 2: Interfacial tension comparison with Turbiscan results

All results are in agreement, the same ranking is obtained. Nevertheless the results obtained with the Turbiscan provide more information (TSI, migration, …) in a very fast and easy way compare to the spinning drop tensiometer.

CONCLUSION

This application note shows a quick and simple is application note shows a quick and simple method to characterize different emulsifiers in a short period of time (1/2 hour). The radar chart summarizes the results obtained. The three emulsifiers studied in this application shows different stability properties and can be ranked as following:
(More stable) Paille 1 > Son 2 > Son 1 (Less stable)



Turbiscan permits the determination of the best surfactant for detergency as the best emulsifier of fat soil, and that very quickly compared to classical techniques.