EFFECT OF POLYMER ON PIGMENT DISPERSION

INTRODUCTION

To be able to offer a wide range of color for coating, different type of pigment are used. To insure a good cohesion between the different components and so optimize the properties of the coating in term of viscosity, polymers are added to the suspension. The aim of the polymer is to insure a good thixotropy (viscous at rest and fluid under stress) and insure a good adhesion to the support.

The concentration of polymer directly affects the stability and the viscosity of the formulations, consequently by adjusting the concentration, the thixotropy and the stability can be optimized.

The Turbiscan technology enables to monitor the stability of these dispersions as a function of the polymer concentration.

PRINCIPLE

Measurement with Turbiscan®

Turbiscan™ instrument, based on Static Multiple Light 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 concentration (φ), according to the Mie theory:

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

More Information

METHOD

In order to perform this study, suspension of phthalocyanin (aromatic macrocyclic pigments) are evaluated at 4 different concentrations of polymer.

Samples are analyzed using the Turbiscan technology during a period of 3 days at 25°C

RESULTS

To evaluate the impact of the concentration of polymer on the suspension stability, 3 different parameters are measured:

- The sedimentation rate of the pigments
- Concentration variation at the top of the sample
- The global stability (TSI)

1- Sedimentation rate of the pigments

Due to the migration of the pigment toward the bottom of the sample, we can observe in Figure 1, a decrease of the light itensity at the top of the sample (decrease of the concentration of pigments).
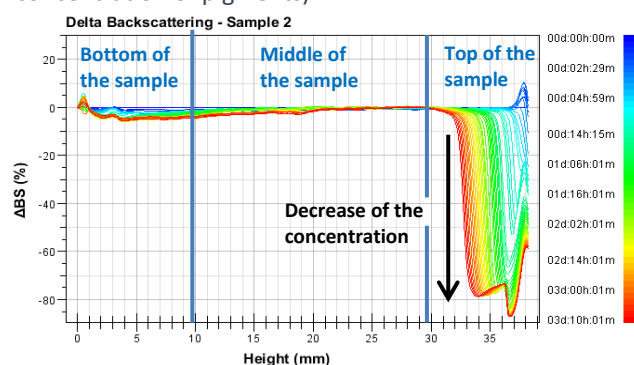

Figure 1: Variation of backscattering versus sample height

By measuring the thickness of the clear layer over the duration of the measurement (Figure 1), the migration rate of the pigment is computed (Figure 2)
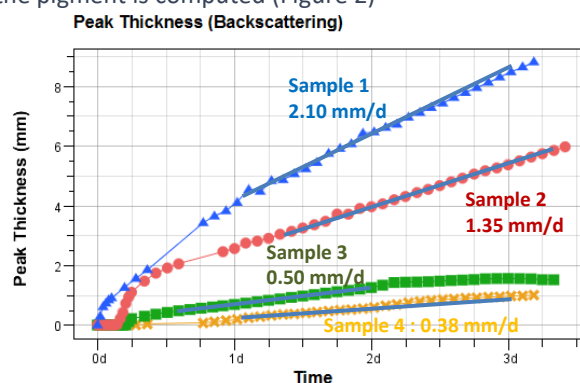

Figure 2: Sedimentation kinetics

Sample	Concentration of polymer	Migration rate (mm/d)	Thickness of the clear layer
Sample 1	-	2.10	8.42
Sample 2	+	1.35	5.36
Sample 3	++	0.50	1.59
Sample 4	+++	0.38	0.95

Table 1: Sedimentation kinetics

Using the results in Table 1, we can observe the impact of the polymer concentration on the migration rate of the pigment particle. In fact, one properties of the polymer is the increase of the thixotropy of the sample, meaning the sample is more viscous at rest (during storage) and less viscous under stress (when the coating is applied). The increase of the viscosity slows down the migration rate of the particle.

2- Concentration variation at the top of the sample

Due to the sedimentation of the particles, a clear layer is generated at the top of the sample. The change of the pigment concentration in this layer can be monitored relatively by comparing the change of the light intensity. In Figure 3, the intensity of backscattering at the top of the sample is measured over the duration of the analysis.
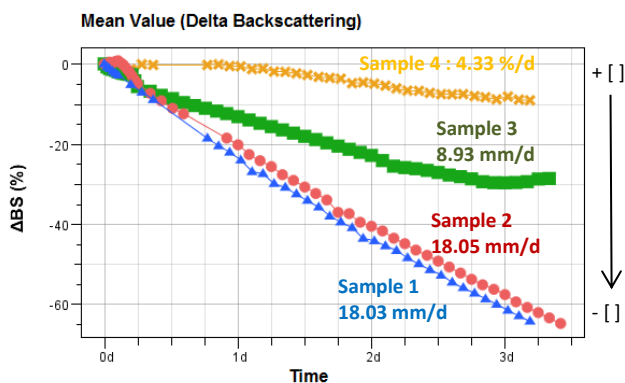

Figure 3: Concentration change at the top of the sample

Sample	Concentration of polymer	Kinetics of concentration change (%/d)
Sample 1	-	18.03
Sample 2	+	18.05
Sample 3	++	8.93
Sample 4	+++	4.33

Table 2: Kinetics of concentration change

We can observe an important change of concentration for samples 1 & 2 meaning more sedimentation compared to sample 4. Measurements were done over 3 days but the same results can be observed only after 1 day.

3- Global stability

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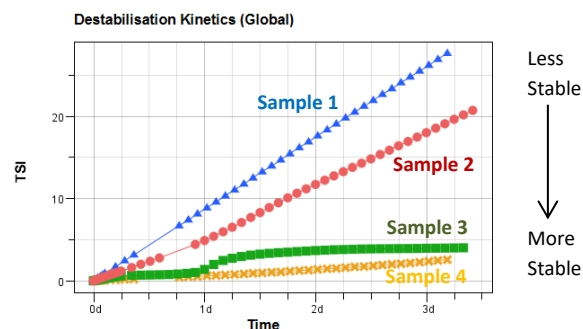

Figure 4: TSI for all samples

Sample	Polymer concentration	Price	TSI (3 days)
Sample 1	-	-	26
Sample 2	+	$	18
Sample 3	++	$$	3.9
Sample 4	+++	$$$	2.3

Table 3: TSI values after 5 hours of measurement

Thanks to Figure 4 & Table 3, we can compare the effect of the polymer concentration on the global stability of the dispersion. Higher is the concentration of polymer, more stable is the sample and so sample 4 is the most stable.

SUMMARY

This application note shows a quick and simple method to characterize different polymer concentration in a short period of time. Only after a day of measurement, samples can be discriminated. The following graph summarizes the results obtained during this study:
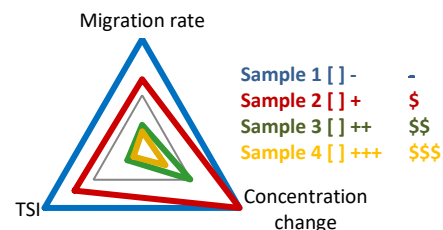
To conclude, the concentration of polymer directly impacts the properties of the dispersion. With no polymer, the migration rate, the change of concentration and the TSI are important, by increasing the concentration, these parameters are improved. The aim is to meet the stability requirement with the lowest concentration in order to reduce formulation cost. Sample 3 is the best compromise between stability and cost.