INK STABILITY AND PACKING
DIFFERENCES BETWEEN PIGMENTS

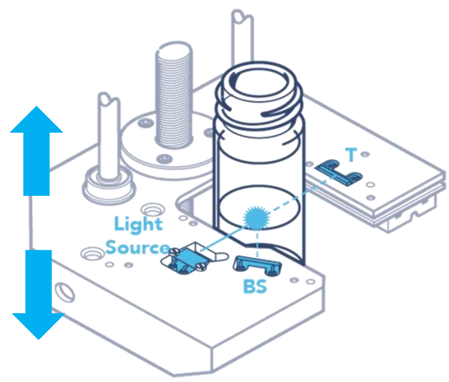
Context

Inkjet formulations contain pigment particles that destabilize over their shelf life, leading to instability in the forms of particle sedimentation and packing. Such events can cause poor product performance and even the clogging of inkjet ports, requiring instrument shutdown while the printing head is cleaned. While mixing by jet head movement or manual shaking may redistribute the sample to its native state, predicting the instability in the first place is beneficial to avoid such product failures in the future. Here, the Turbiscan is used to quantify and predict the instability phenomena associated with various inkjet formulations.

Reminder of the technique

TURBISCAN technology, based on Static Multiple Light Scattering, consists of sending a light source (880nm) on a sample and acquiring backscattered (BS) and transmitted (T) signals over the whole sample height. By repeating this measurement over time with adapted frequency, the instrument enables monitoring physical stability.

The signal is directly linked to the particle concentration (φ) and size (d) by the Mie theory knowing the refractive index of continuous (nf) and dispersed phase (np):



BS and T = f(φ, d, np, nf)

Materials & method

Two inkjet samples, one made with red pigment and another with yellow, were analyzed to observe the differences achieved by using different pigments. Each sample was then scanned every 30 minutes for 3 days to produce the destabilization profiles.

Effects related to sedimentation, packing, and overall phase separation can be determined.

Results

- Raw data

Raw data from the dispersions is seen in Figure 1. From this graph, it is possible to identify occurring destabilization phenomena.

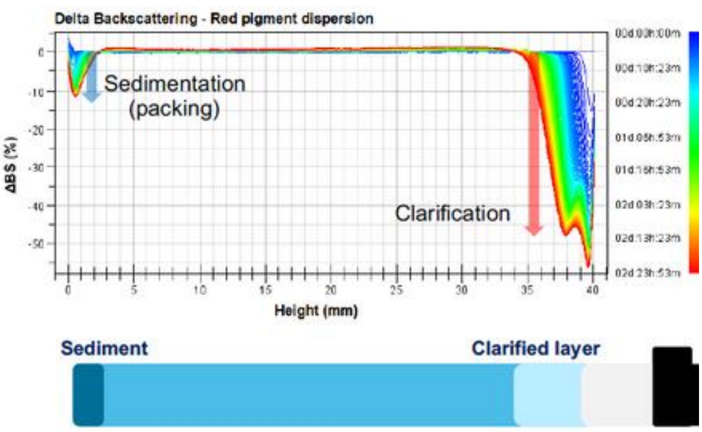


Figure 1. Delta Backscattering data from red pigment dispersion

At the top of the sample (right of the graph) there is a large negative signal in the backscattering (BS) region, indicating that particles are moving away from this region as the sample begins to clarify. At the bottom of the sample (left of the graph) there is a negative signal that is developing. Typically, sedimentation is seen in such samples and would be reflected by an increase in BS data. **Here, a decrease is observed**; both dependent diffusion and aggregation go in the same direction and prove the packing of the sediment layer.

Each sample in this note exhibits similar behavior. The unique features of the Turbisoft™ program allow for further quantification of the kinetics responsible for destabilization.

- Packing kinetics monitoring

Monitoring the average value of backscattered light at the bottom of the sample (where the packing occurs) allows to determine the packing kinetic for each dispersion. These calculations provide the formulator with the additional knowledge to optimize the formulations in order to achieve the desired properties.

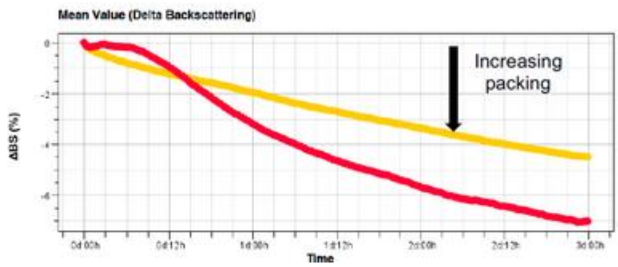


Figure 2. Packing kinetic of both dispersions

It is seen that the yellow pigment has a rather uniform packing kinetic. The red pigment shows slightly more variance as it is slow to begin and then after 14 hours will overtake the yellow as having the more intense kinetic.

- Quantifying destabilization with the TSI

The TSI - Turbiscan Stability Index - is an algorithm-based calculation within the software that compares all destabilizations and sums them into a single number for easy, one-click ranking and comparison.
The TSI considers all kinetics occurring in a sample and will be more influenced by dominating phenomena.

Figure 3 shows the TSI plot confirming that the red pigment sample is to destabilize faster than the yellow pigment.

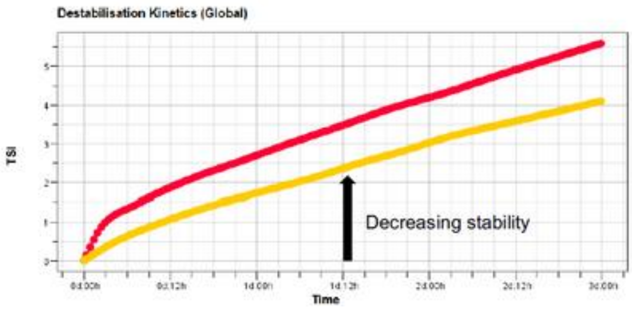


Figure 3. Turbiscan Stability Index (TSI) vs time for both dispersion

In this case, the TSI follows the previously seen trend (packing is the predominant instability), the evaluation of the TSI in only 2h allows to predict further stability differences between the formulations.
It should be noted that the TSI will analyze all phases of the sample and can recognize the instability of the red sample over the yellow, regardless of the result of an individual kinetic.

Even more important to notice, as seen in Table 1, that **the trend has been established only after several hours of analysis!** The ability to quantify the stability of the dispersions in a matter of hours provides an added benefit for the formulating scientist.

	TSI			
Sample	**2h**	**1 day**	**2 days**	**3 days**
Yellow pigment	0.2	1.7	3.0	4.1
Red pigment	0.7	2.7	4.2	5.6

Table 1. TSI values calculated at specific aging times for both dispersions

Conclusion

It was seen that two inkjet formulations provided very similar destabilization phenomena but using only visual observation it is difficult to distinguish which one was more stable. The TURBISCAN technology provides quantified data on the differences between formulations: overall stability (from the TSI) packing kinetics (by monitoring sedimentation and clarification layers) and this in only a few hours of analysis.

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