MultiScan MS 20

Temperature Dependent Stability Analysis of Polymer Emulsions

dataphysics
Understanding Interfaces

Polymer emulsions have been widely applied in different areas as adhesives, binders, coatings, dipped goods, foam products etc, due to their unique properties. A Polymer emulsion is a colloidal dispersion of polymer molecules in an aqueous system. The dispersion stability of a polymer emulsion has a significant impact on its processing, transportation and storage. Among other factors, temperature has a great influence on the dispersion stability. Hence, knowledge of the temperature dependent stability of polymer emulsions is of great interest in oder to modify and improve the formulation for a better processability and performance. As latex is one of the most common and important polymer emulsions, a stability study of two commercially available latex emulsions at different temperatures will be presented throughout this application note.

Fig. 1: A polymer emulsion.

Keywords: MultiScan 20 (MS 20) ▪ Stability Analysis ▪ Polymer Emulsion ▪ Latex ▪ Temperature Dependent

Technique and Method

The MultiScan MS 20 (Fig. 2) from DataPhysics Instruments is the measuring device for an automatic optical stability and aging analysis of liquid dispersions and the comprehensive characterisation of time- and temperature-dependent destabilisation mechanisms. It consists of a base unit and up to six connected ScanTowers with temperature-controlled sample chambers. The ScanTowers of the MS 20 can be individually controlled and operated **at different temperatures (4 °C to 80 °C)**.

With its matching software MSC, the MS 20 is an ideal partner for the stability analysis since **even the slightest changes** within dispersions can be detected and evaluated. The MS 20 enables a fast and objective analysis of the dispersion stability as well as conclusions on possible **destabilisation mechanisms**.

Fig. 2: DataPhysics Instruments stability analysis system MultiScan MS 20 with six independent ScanTower.

Experiment

Two different formulations of polymer emulsions (Latex A, Latex B) were studied. The samples are being shaken to create a homogeneous solution and then poured in two transparent glass vials. Each type of latex formulation was measured at 25 °C and 40 °C every 1 h for 6 days, respectively. The measured zone is between 0 mm (bottom of the glass) and 57 mm (fill level of the vial). Notably, the four measurements were carried out simultaneously, thanks to the possibility to measure up to six samples using individual settings and temperatures with just one MS 20

Results

Figure 3 shows the relative backscattering intensities against the position for both latex samples at different temperatures. The colour-coding of the curves indicates the time at which they were recorded, from red (start of the experiment, t = 0 s) to purple (end of experiment, t = 6 d). Every curve represents one individual measurement.

The backscattering diagrams in Fig. 3 show clearly time-dependent as well as position-dependent changes of the signal. From the change in intensity possible destabilisation mechanism can be deduced, as summarised in table 1.

Both samples are quite stable at 25 °C, with a slight decrease of backscattering intensity in the top layer, which indicates that a sedimentation process occurred. However, with the temperature increased to 40 °C, the stability of latex A and latex B decreased significantly. As shown in Fig. 3, the backscattering intensity of latex A increased remarkably inside the top layer, whereas it decreased in the bottom (1 – 3 mm) and middle layer. This suggests that some of the particles creamed up to the top.

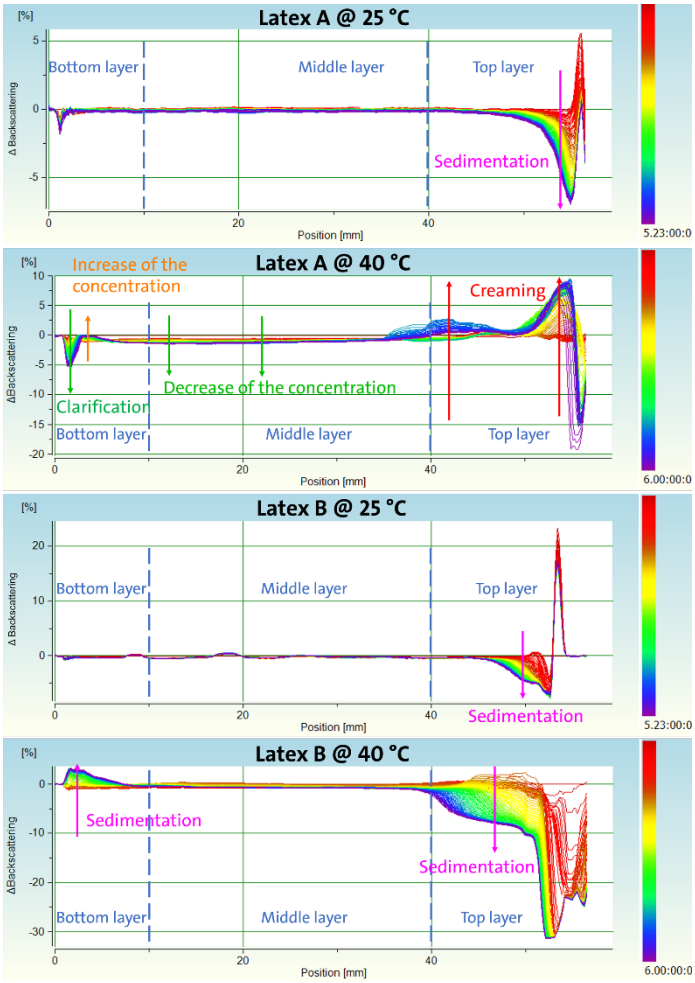

Fig. 3: Backscattering intensity vs. position for sample A & B at 25 & 40 °C

The stability of Latex B also decreased significantly with increased temperature. Here the backscattering signal in the top layer decreases and increases in the bottom layer which indicates that a sedimentation process is predominant.

Table 1: Phenomena and possible destabilisation mechanisms in three different zones for sample A & B at 25 & 40 °C.

Sample	T (°C)	Bottom	Middle	Top
Latex A	25	-	-	Sedimentation
	40	Clarification	-	Creaming
Latex B	25	-	-	Sedimentation
	40	Sedimentation	-	Sedimentation

As the destabilisation mechanisms for the two samples at different temperatures are quite complex and different from another, a sedimentation rate or creaming thicknes are inconvenient when trying to compare the samples. Fortunately using the **stabilty index (SI)** function provided by the MSC software, an overall stablity can be evaluated. Consistent with the observed changes in backscattering intensity the stability index indicates that the two samples are much less stable at 40 °C than they are at 25 °C (Fig. 4).

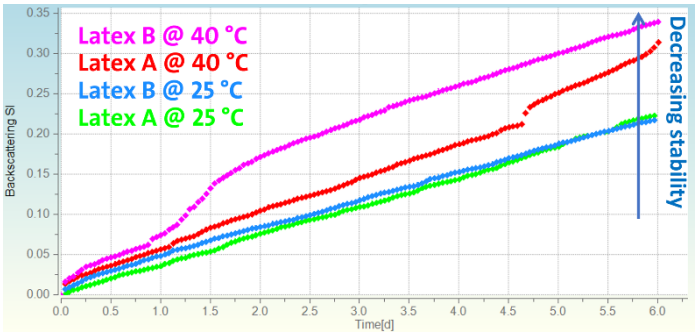

Fig. 4: Backscattering stability index vs. time for samples A & B at 25 & 40 °C

Additionally, as displayed in Fig. 4, the stabilities of latex A and latex B were similar around room temperature, however, latex A exhibited better stability than latex B at higher temperatures, like 40 °C.

Notably the reported **stability index values were very low between 0 and 0.35**, underlining the excellent capability of the MultiScan technique to analyse even visually **very stable formulations** and quantify their stability issues.

Summary

Using the MS 20 stability analysis system and its corresponding MSC software, an **easy and fast way** to study the stability of polymer emulsions could be demonstrated. **Changes can be detected sensitively, easily, fast and reliably** which enables the manufacturer or user of such emulsions to anticipate and quantify even **long term stability issues** and thus guarantee time and cost optimal product development and application.

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