MultiScan MS 20

Stability analysis of latex emulsions with ultra-slow sedimentation rate

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Understanding Interfaces

Latex (Fig. 1) consits of polymer particles which are homogeneously distributed in an aqueous system as a colloidal dispersion. Due to its unique polymer properties rubber materials originating from latex have been widely applied in different areas as adhesives, binders, coatings, dipped goods, foam products etc[1]. In order to process naturally produced latex it is important to know its physical properties as they can greatly differ between sources. Among these properties, dispersion stability has a significant impact on its processing, transportation and storage, which is crucial to evaluate the commercial value of latex. In addition it is of great significance to study the stability of latex formulations in order to modify them towards a better processability and performace. To detect and evaluate even ***slightest stability changes*** *within a dispersion, DataPhysics Instruments developed the MultiScan 20 (MS 20) (Fig. 2). The stability study of five commercial latex samples with* ***ultra slow sedimentation rates below 0.6 mm/day*** *will be presented throughout this application note.*

Fig. 1. Latex flowing from para rubber tree.

Keywords: MultiScan 20 (MS 20) ▪ Stability Analysis ▪ Latex ▪ Emulsion ▪ Ultra Slow Sedimentation < 0.6 mm/d

Technique and Method

The MultiScan 20 (Fig. 2) from DataPhysics Instruments is the measuring device for the automatic optical stability and aging analysis of liquid dispersions, in particular suspensions and emulsions, 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 MSC software, 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 Scan Towers.

Experiment

A small vial filled with the desired dispersion is placed in one of the “Scan Towers” of the MS 20. The scanning system is composed of a transmission and backscattering LED along with a detector. This system moves along the vertical side of the vial (z-axis).

The obtained transmission and backscattering intensity are represented in an intensity-position diagram. The sample was scanned at regular time intervals. Changes in the detected measuring signal can provide explanations on the stability properties of the sample. Fig. 2 shows the MS 20 and its six independent Scan Towers.

20 ml of each latex formulation (Latex A, Latex B, Latex C, Latex D and Latex E) were poured in a transparent glass vial and measured at T = 25 °C every 1 hour for 6 days. The measured zone is between 0 mm (bottom of the glass) and 57 mm (fill level of the vial). Fig.3 shows the latex vials at the end of the measurement.

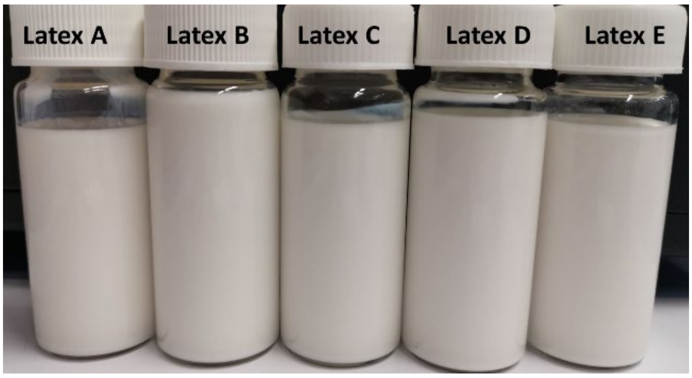

Fig. 3. Samples Latex A, Latex B, Latex C, Latex D and Latex E show a homogeneous particle distribution after 6 days measurement time

Results

As the samples have a significant volume concentration, the transmission signal was 0% throughout the measurment. Hence, only the backscattering signal was analysed with the migration front method to study the sedimentation rate.

Figure 4 shows the backscattering intensities against the position for Latex A. 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 days). Every curve represents one individual measurement. The backscattering diagram shows very little time-dependent change of the signal between 2 mm and 40 mm, but a strong position-dependent change of this signal between 42 mm and 50 mm, indicating a sedimentation process. The sedimentation process can be quantified by the migration rate method which allows a comparisson between the different formulations.

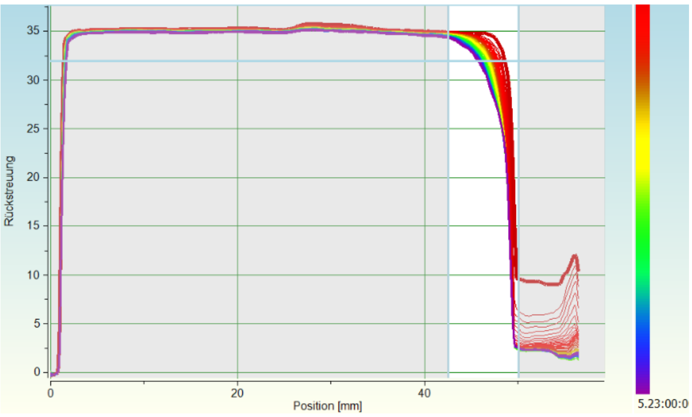

Fig. 4. Backscattering intensity diagram

Calculated with the respective function of the MSC software, the migration front position is plotted over time (see Fig. 5). From this plot an average migration rate of 0.37 mm/day throughout the experiment was determined for Latex A.

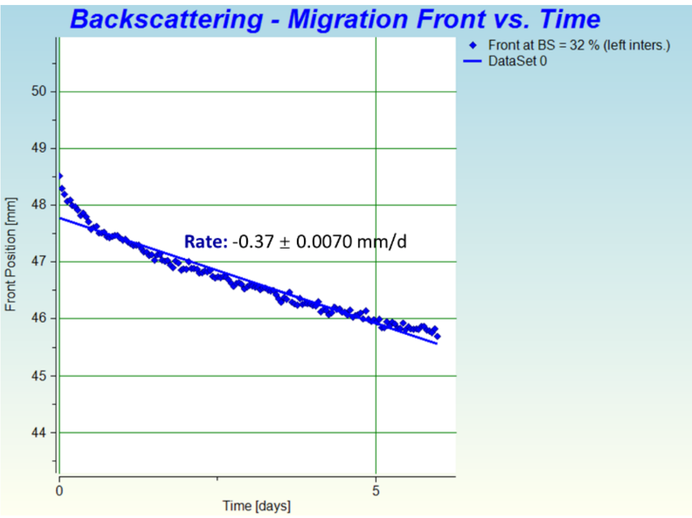

Fig. 5. Changes in migration front position throughout the experiment for Latex A

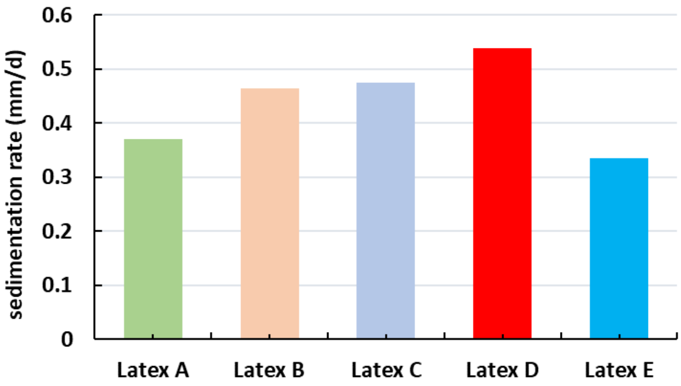

Fig. 6. Sedimentation rates for the five Latex samples (The higher the sedimentation rate the less stable is the sample).

Most notably, even **very slow sedimentation rates below 0.6 mm/d** can be detected with a **small error below 0.01 mm/d**.

Accordingly the other 4 samples were analysed leading to the sedimentation rate diagram in Fig. 6. Latex E was found to be the most stable formulation with a sedimentation rate of 0.33 mm/day, while Latex D was the most unstable formulation with a sedimentation rate of 0.54 mm/day. All the detected **sedimentation rates were very low between 0.33 mm/day and 0.54 mm/day**, underlining the excellent applicability of MS 20 to even analyse **very stable formulations** and to quantify remaining stability issues within shortest time.

Summary

Using the MS 20 stability analysis system and its corresponding MSC software, it was possible to study the stability of different latex formulations. **Even the smallest changes in stability and very slow sedimentation rates < 0.6 mm/d were detected** which enables the producer to anticipate **long term stability issues** and thus guarantee time and cost optimal product development.

Literature

[1] Michael C. Grady (2004). Latex Technology. Kirk-Othmer Encyclopedia of Chemical Technology. DOI: 10.1002/0471238961.1201200507051202.a01.pub2

DataPhysics Instruments GmbH • Raiffeisenstraße 34 • 70794 Filderstadt, Germany
phone +49 (0)711 770556-0 • fax +49 (0)711 770556-99
sales@dataphysics-instruments.com • www.dataphysics-instruments.com

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