Fast and Reliable Creaming studies

How to identify creaming and quantify phase separation kinetics?

Over their lifetime, many industrial products present a creaming phenomenon that usually has undesirable impact on the visual aspect and the end-use properties. The texture, taste and even quality perception of the product might be directly impacted (beverages, syrups, cosmetic creams, lubricants) … Limiting the creaming requires to anticipate the physical stability during the formulation steps and controlling droplets migration can directly improve the shelf life of the product. This note shows how creaming can be studied, using a quantitative method to rapidly evaluate shelf life and compare formulations. Additionally, to fully understand the mechanisms of creaming, we present detailed calculations that can be done using the Turbiscan® technology.

DEFINITION: CREAMING

Creaming is a phenomenon that consists of the migration of the dispersed phase to the top of the container over time. It is mainly observed in oil in water (O/W) emulsions.

An emulsion is a liquid particle (droplets) dispersed in a liquid phase. These systems are thermodynamically unstable and will likely destabilize until complete phase separation. The reason of the instability is the lower density of the dispersed phase compared to the continuous phase which leads to the migration phenomenon, so called creaming.

The creaming process can be quantified by the migration velocity expressed by the Stokes law:

$$v = \frac{\Delta\rho_p \, g \, d^2}{18\eta}$$

v : particle creaming velocity

g : acceleration of gravity

d: particle diameter (assuming spherical)

η: kinematic viscosity of the fluid

$\Delta\rho_p$: difference between mass density of the particle and the fluid

The analysis of the Stokes Law gives some insight on how to limit the creaming: increasing the continuous phase viscosity, reducing the density differences or by reducing the average particle size.

CREAMING: CONVENTIONAL TEST

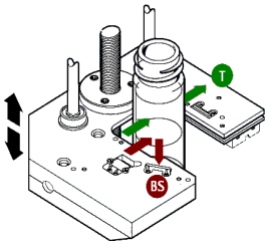
Easy to implement, visual observation remains the most used method for creaming testing, and thus stability analysis. The method is simple but can be time consuming as the variation must be visible to the naked eye to be detected. Additionally, the evaluation of the creaming kinetics is imprecise.

To overcome creaming issues, scientists need an **early identification** and **quantification** to apply the best strategy and measure the benefit of stabilizing agent addition.

TURBISCAN®: HOW IT WORKS

Turbiscan® technology, based on **Static Multiple Light Scattering (SMLS),** consists of sending light pulses (880 nm) into a sample along its height. The reading head scans the sample by moving vertically along the analysis cell and acquire data each 20 µm. Measurements are made over time and variation in the backscattering and transmission levels due to sample instability are recorded.

The signal is directly linked to the evolution of particle concentration (φ) and size (d) by the Mie theory.



$$BS = f\,(\varphi, d, np, nf)$$

Samples with a particle concentration from 10^{-4} to 95% (v/v) and from 10nm to 1mm in particle size can be measured as is.

The instrument enables to monitor changes in physical stability (coalescence, creaming, sedimentation, phase separation, etc...) **without any dilution or any stress** and thus follows ISO TR13097 guidelines.