Soft Drink Emulsions

AccuSizer®

STABILITY MEASUREMENTS OF SOFT DRINK EMULSIONS

Flavoring emulsions used in the production of bottled soft drinks must consist of droplets of uniform size that are small enough to prevent agglomeration, or Ostwald ripening, both of which can result in the breaking of the emulsion and formation of a cosmetically undesirable neck ring inside the bottle. Since the process leading up to the neck ring is gradual, it can be detected in its early stages.

There are many methods for determining the mean droplet size of emulsions, but most are not capable of determining small amounts of oversized material that can lead to neck ring. Methods that are based on sizing and counting individual particles are particularly well-suited for this type of analysis, where even small amounts of outliers are sized and counted in the process.

The AccuSizer® single particle optical sizing (SPOS) system is ideal for quantifying oversized outlier particles in the tail of an emulsion where the main population is less than 1 micron. Since single-particle optical sizing measures particles one-at-a-time, as they pass through a narrow measurement chamber, it has the sensitivity and high resolution to detect the individual particles that are removed from the main distribution. By determining the size, and counts, of these outlier particles, we can determine which emulsions will likely form a neck ring, or sediment.

Depending on the sensors incorporated, the AccuSizer can cover a dynamic range of 0.15 – 400 µm. The system shown in Figure 1 includes the standard LE400 light extinction and scattering sensor that measures from 0.5 – 400 µm mounted in the AD sampler that provides automated dilution of the sample to the optimum concentration for the measurement.

Figure 2 displays the results of a sample (prediluted 1:200) with a total count of 213,432 particles/mL greater than 1 micron.

Figure1. AccuSizer AD

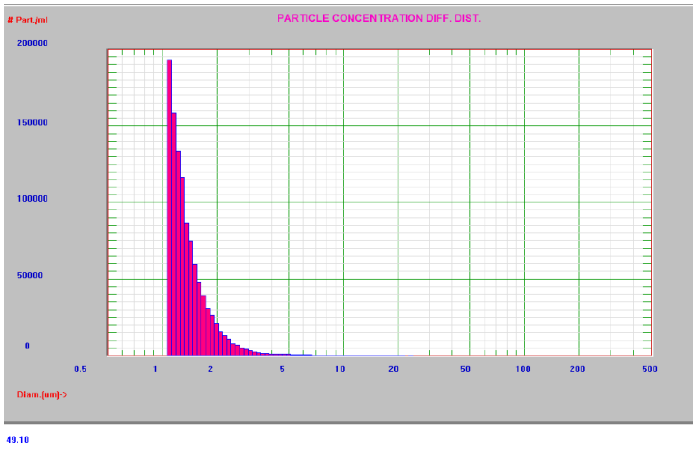

Figure 2. Prediluted flavor emulsion

Since we know the volume of sample measured and the starting volume, we can calculate that this tail represents 0.623% of the total sample volume.

Multiple emulsions can be compared by overlaying sample runs as seen in Figure 3.

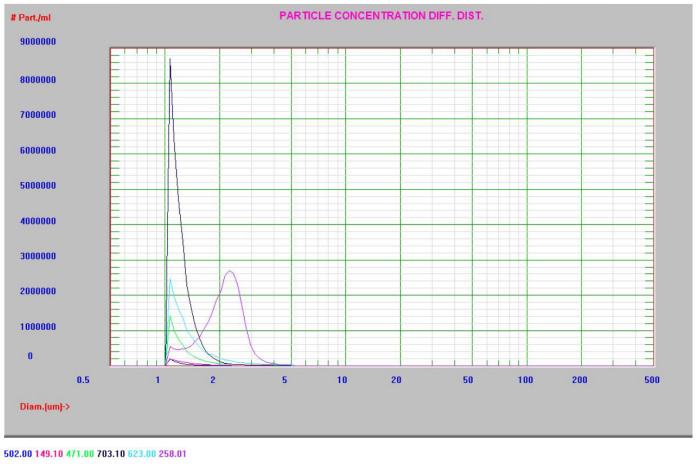

Figure 3. Overlaying sample runs comparing multiple emulsions

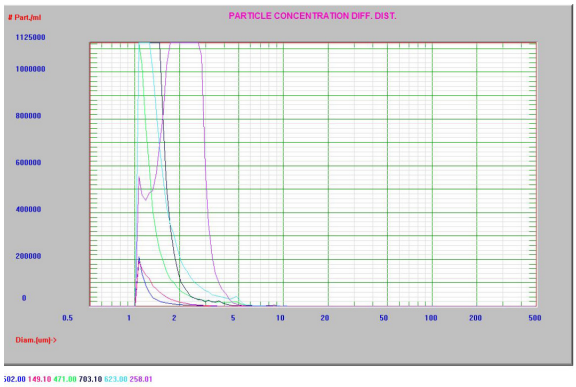

Figure 4. Results from six different soft drink emulsions

The results from six different soft drink emulsions are shown Figure 4. Obvious differences in the amount and size of the oversized particles can be seen. The AccuSizer SPOS single particle counting technique enables zooming in for a clear view of the X and Y axes. Emulsions with large numbers of particles >1 µm are a good indicator for the presence of neck ring. Emulsion stability can be predicted by determining how many particles/mL are greater than 1 micron, and calculating their respective volume fractions emulsion stability can be predicted.

Sample	Particles/ mL >1 µm	Volume fraction >1 µm	Stability forecast
502	1.4×10^8	0.288%	No neck ring/ sedimentation
149	2.1×10^8	0.623%	No neck ring/ sedimentation
471	1.2×10^8	3.600%	Borderline
703	6.2×10^8	7.989%	Neck ring/ sedimentation
623	2.6×10^8	8.189%	Neck ring/ sedimentation
258	5.4×10^8	29.031%	Extreme neck ring

Table 1. Stability forecast

The data in Table 1 demonstrates that as the number of particles greater than 1 µm increase, where the volume fraction is greater than 1 µm, the stability of the product starts to decline and neck ring starts to form.

The AccuSizer has the resolution and sensitivity to quantify the number of particle counts >1 µm that are directly related to the stability of the emulsion and the formation of neck ring.

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