# Application Note

# ----- Size distribution analysis of Polymer Dispersions -----

**using the CPS Disc Centrifuge**

## Polymer Dispersions

Polymer dispersions are stabilized dispersions of polymer particles in a continuous phase (normally water). These products are generally produced using four different methods:

1) classic emulsion polymerization;
2) homogenization of monomers (also called “microsuspension”), followed by polymerization using an oil soluble polymerization initiator;
3) chemical emulsification of monomer(s) using “liposomes” followed by polymerization;
4) a combination of the previous three methods.

Polymer dispersion particles generally range from ~10 µm to ~0.02 µm diameter. Polymer dispersions are used in water based paints and coatings, inks, water based adhesives, solvent-free “urethane” coatings, polyvinyl chloride “plastisol” latexes (PVC particles that will be ultimately dispersed in plasticizer), and in many other applications. In most polymer latex applications, the particle size distribution is very important, and control of particle size is a critical quality control issue. The CPS Disc Centrifuge is often used to characterize polymer latexes, because its particle size resolution, high sensitivity, and rapid analyses (for most samples).

## Instrument/Method description

The measurement range of the CPS Disc Centrifuge are particles in the range from 0.005 micron to 50 microns. The CPS Disc Centrifuge is most effective with particles between 0.005 and 20 microns. The analyzer measures particle size distributions using centrifugal sedimentation within an optically clear spinning disc that is filled with fluid. Sedimentation is stabilized by a density gradient within the fluid, and accuracy of measured sizes is insured through the use of a known size calibration standard.

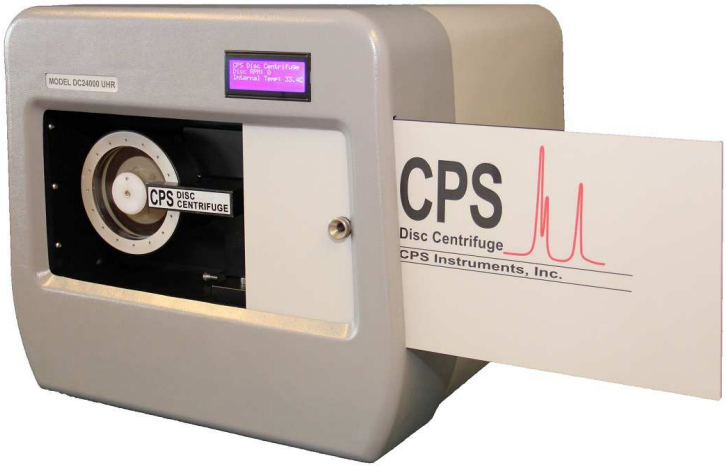


**Figure 1 CPS DC24000 UHR with open door**

Polymers of any particle density can be routinely measured, even those that are neutrally buoyant in water. Low density or neutrally buoyant particles are measured in a fluid of density higher than water, where they float, such as sucrose in water or deuterium oxide. Low density analyses are done using CPS Instrument’s patented low density method. All analyses are carried out with a net difference in density between the particles and surrounding fluid of at least 0.06 g/ml, which insures consistent results for all samples.

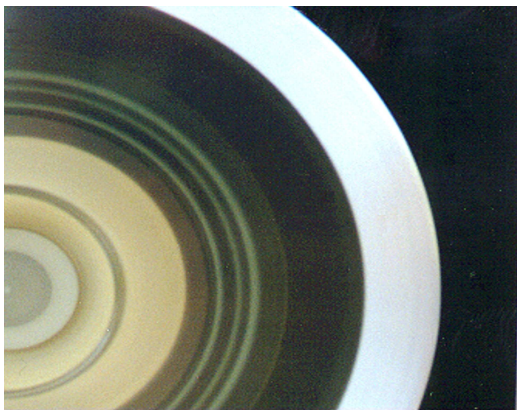

**Figure 2 High concentrated sample with different particle sizes sediment in a disc**

For the measurements of the polystyrene mixture of standards the CPS DC24000 UHR was used. The DC stands for Disc Centrifuge, 24000 stands for the maximum speed (rpm in this case equal to 29000 g-force), and UHR stands for Ultra-High Resolution. This is the most advanced system CPS Instruments offers, but a DC12000 and a DC18000 are available when the ultra-high resolution and high rotation speed/g-force is not needed.

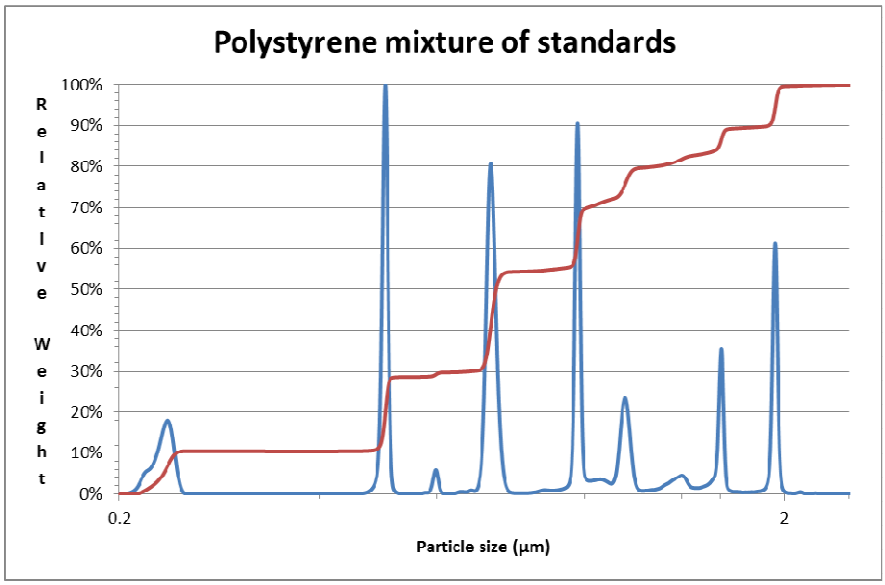


**Figure 3 Weight distribution of a mixture Polystyrene standards**

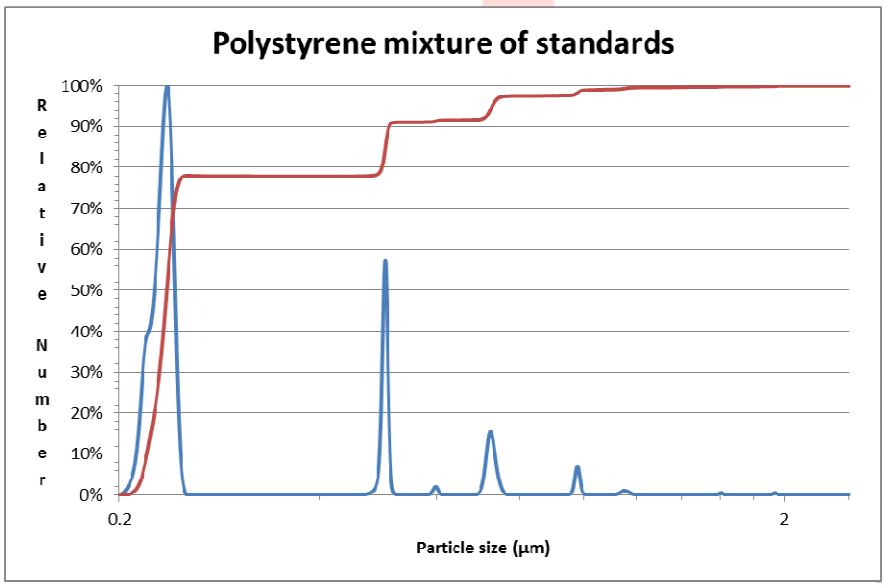


**Figure 4 Number distribution of a mixture Polystyrene standards**

## Results

The results of particle size measurements done with the CPS Disc Centrifuge can be displayed in different ways for different reasons. Figure 3 shows the standard display mode, also called the relative weight distribution, of a polystyrene mixture of standards.

Besides the relative weight distribution the relative number distribution is also often used. Especially in Europe where the European Commission is working on the definition of nanomaterial. In the commission recommendation nanomaterial is defined as followed "'Nanomaterial' means a natural, incidental or manufactured material containing particles, in an unbound state or as an aggregate or as an agglomerate and where, for 50 % or more of the particles in the number size distribution, one or more external dimensions is in the size range 1 nm-100 nm."(1). Figure 4 shows the relative number distribution of the same polystyrene mixture of standards as shown in figure 3.

(1) European Commission Recommendation of 18 October 2011 on the definition of nanomaterial; http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32011H0696:EN:NOT

The table shows the practical size range for several kinds of polymer dispersions. The minimum practical size is the size where noise in the signal becomes more than ~10% of the signal. The maximum practical size is the size where it is not possible collect consistent data run to run.

| Polymer | Max. Size (µm) | Min. Size (µm) | Run Time to 0.06µm (min) |
|---|---|---|---|
| **Acrylic Adhesive** | 35 | 0.030 | 35 |
| **PVC** | 25 | 0.020 | 15 |
| **Polyvinylidene Chloride** | 20 | 0.015 | 10 |
| **Paint Latex** | 30 | 0.025 | 30 |
| **Polyurethane** | 20 | 0.015 | 35 |
| **Styrene/BD** | 30 | 0.025 | 35 |

## Conclusion

Virtually any type of polymer dispersion can be accurately characterized using the CPS Disc Centrifuge, even those that are equal to or lower in density than water. The resolution, sensitivity, and run-to-run repeatability are unmatched by other particle sizing instruments.

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