OPUS ULTRASONIC EXTINCTION: FIELDS OF APPLICATION

H. Geers, W. Witt
Sympatec GmbH, System-Partikel-Technik, Burgstätterstr 6, D-38678 Clausthal-Zellerfeld, Germany

Sympatec developed the OPUS system for the size analysis of high concentrated suspensions. Working with Ultrasonic Extinction, this system is predominantly for in line measurements of suspensions and emulsions. The OPUS system has been proved in many applications. Now the measurement capabilities have been extended towards emulsions and into the sub- and even subsub-micron range. To show the new possibilities of the OPUS system measurements on water - oil emulsions are presented. Furthermore some measurements carried out on commercial paints will be shown.

Keywords: Ultrasonic Extinction, Particle sizing, Emulsions, Suspensions, Submicron Particles

INTRODUCTION

In 1988 Riebel[1] presented work which formed the basis for particle size analysis using ultrasonic extinction measurements in the range from 20 – 1000 µm for suspensions. Ultrasonic extinction is mostly independent of the dispersion state of the suspensions. Measurements can be carried out on any type of liquid, at high solid concentrations and over a wide temperature range. These features characterise ultrasonic extinction for on line particle size measurements for suspensions and emulsions.

Developing Riebels work further, Sympatec introduced, in 1990, a commercial instrument (OPUS®) for on line particle sizing. Results obtained with this instrument have already been reported, for example by Geers[2], and Witt[3]. In the last few years the technique has been rapidly improved. The measurement range covered by ultrasonic extinction measurements has now been extended at the fine and the coarse end to 0.01 µm to 3000 µm. The concentration may vary between 1 – 70 % Vol.

The basic instrument was made for the characterisation of suspensions. The interaction of ultrasonic waves with particles is not dependent on the state of the particles (solid or liquid) but dependent on the differences in the acoustical properties (e.g. density, speed of sound, attenuation coefficient). In the case of emulsions these differences may be small and therefore, the computation algorithm had to be adapted to meet these requirements. As a result, measurements on emulsions are now possible using the same sensor.

ULTRASONIC EXTINCTION MEASUREMENTS ON EMULSIONS

OPUS Measurements on a water/oil emulsion have been carried out using a test loop. An impact plate inside the flow system dispersed the oil with respect to the flow rate. Thus, it was possible to change the droplet size distribution by altering the speed of the peristaltic pump used for the transport of the emulsion.

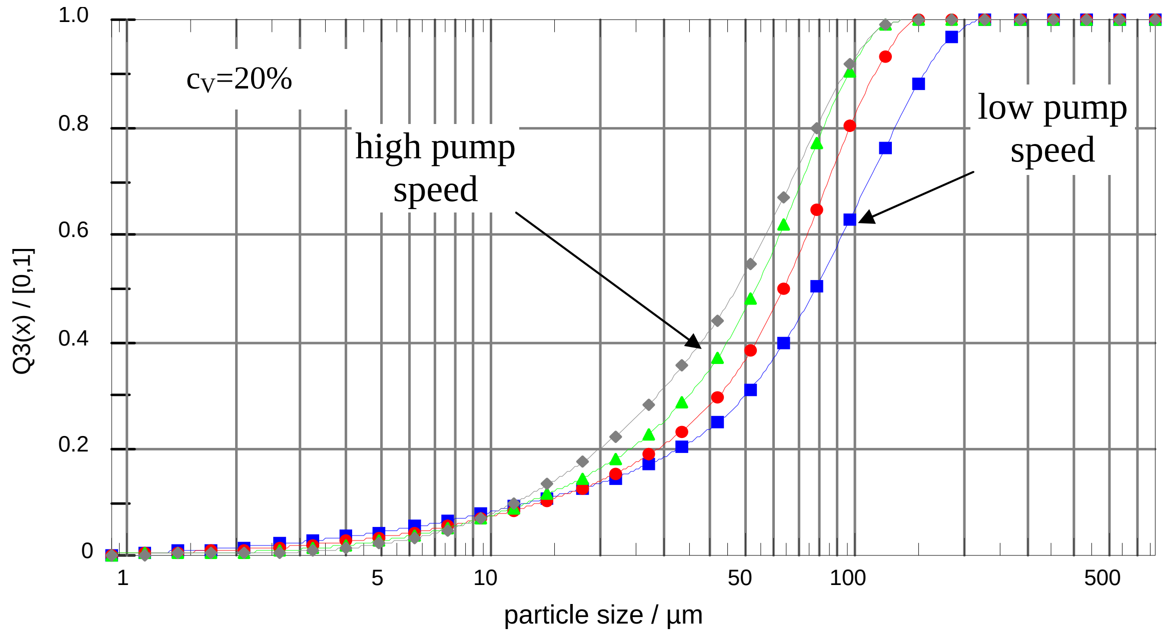

Figure 1: Results obtained for a water/ oil emulsion at different dispersion energies

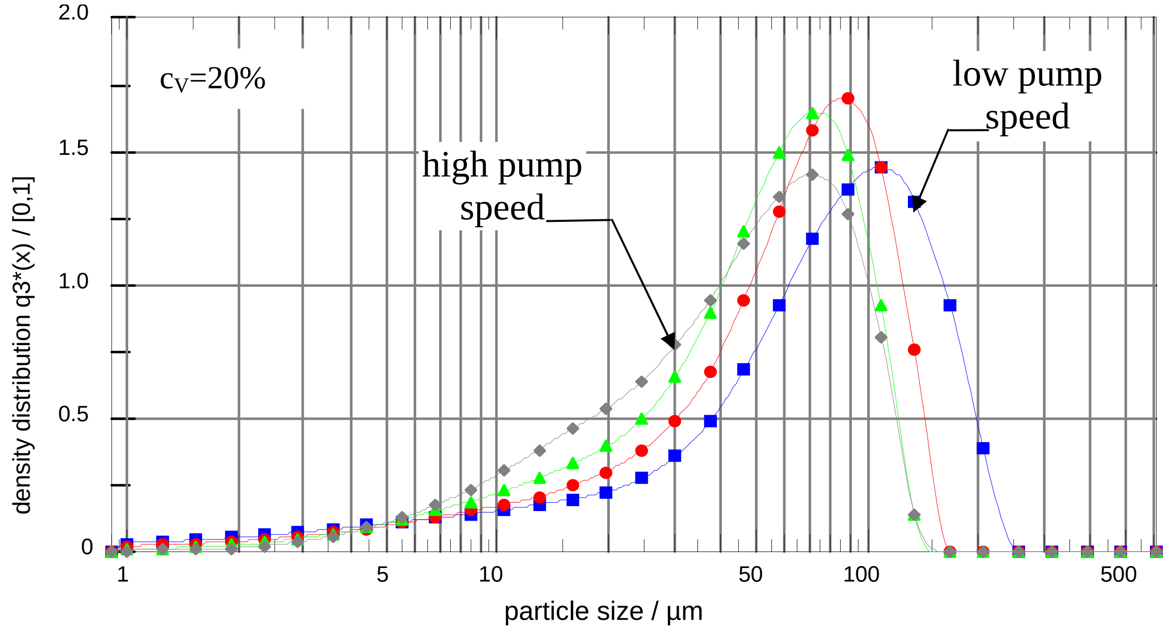

Figure 2: Results obtained for a water/ oil emulsion at different dispersion energies

This in-line experiment on the laboratory scale shows the possibility of monitoring a dynamic change in the droplet size distribution with the OPUS system. The density and speed of sound contrast between the two phases is very small. The result is, that the matrices needed for the calculation of the droplet size distribution had to be calculated by a special algorithm based on the scattering theory for ultrasonic waves. For these calculations, material dependent data of the pure liquids are needed. It is possible to measure these data (speed of sound, attenuation coefficient) with the ultrasonic extinction sensor itself.

The next example shows the results obtained for emulsions of paraffin oil in water.

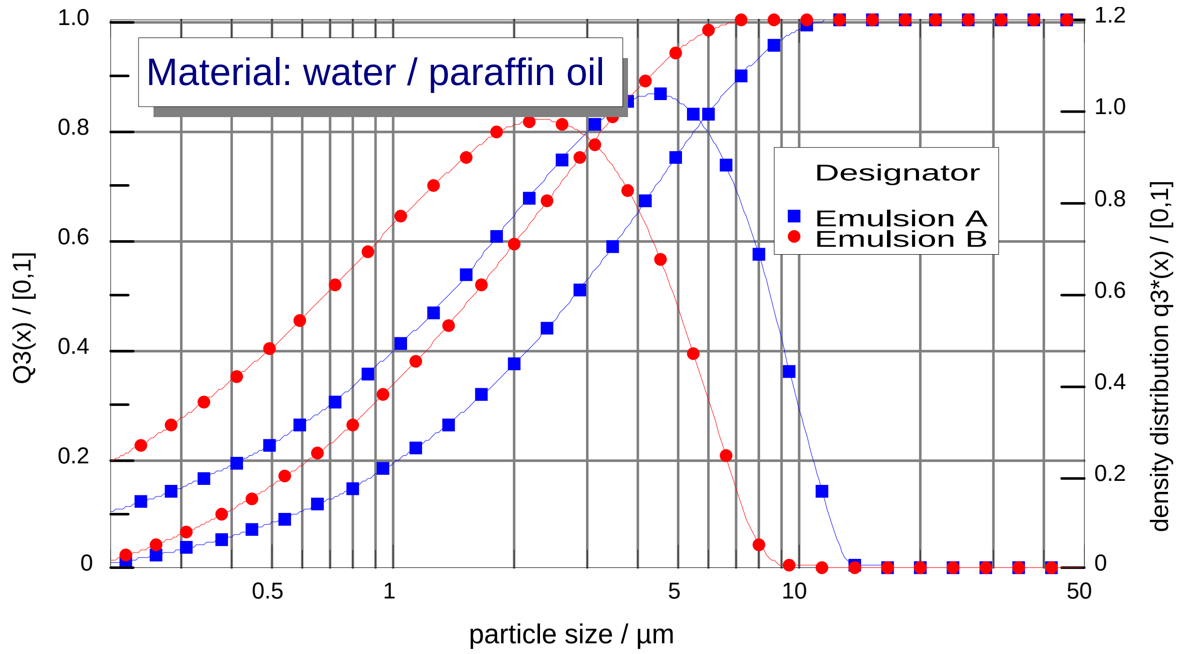

Figure 3: Results obtained with water/ paraffin oil emulsions

The differences in the droplet size distribution of the samples (Emulsion A + Emulsion B) is obvious. The droplet size distribution of each emulsion was stable. Therefore, it was possible to mix the two emulsions and carry out measurements on this mixture. The results obtained for the mixed emulsions compared with the droplet size distribution that has been calculated from the measurements of the two inertial emulsions will be found in Figure 4.

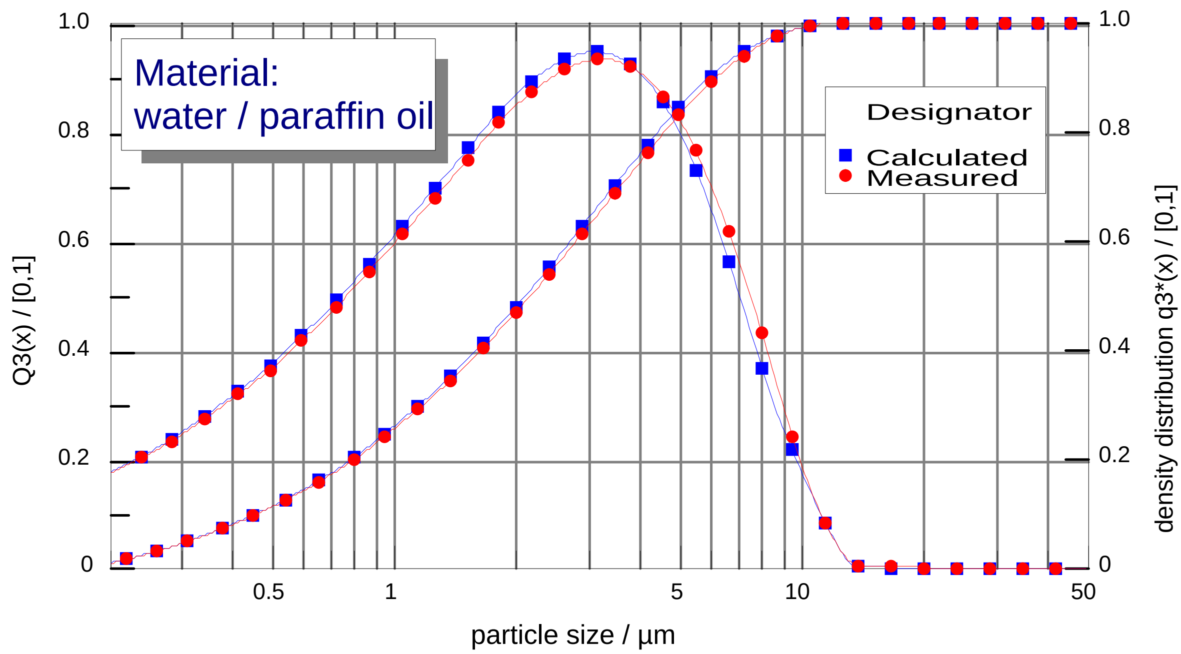

Figure 4: Comparison of the measured droplet size distribution (Mixture A+B) and calculated mixture

The deviations between the droplet size distribution predicted by the calculation and the measured droplet size distribution are very small.

MEASUREMENTS IN THE SUBMICRON RANGE

The measurement range of the OPUS System has been extended into the Submicron range. The first examples for this are measurements on commercial paint (Figure 5):

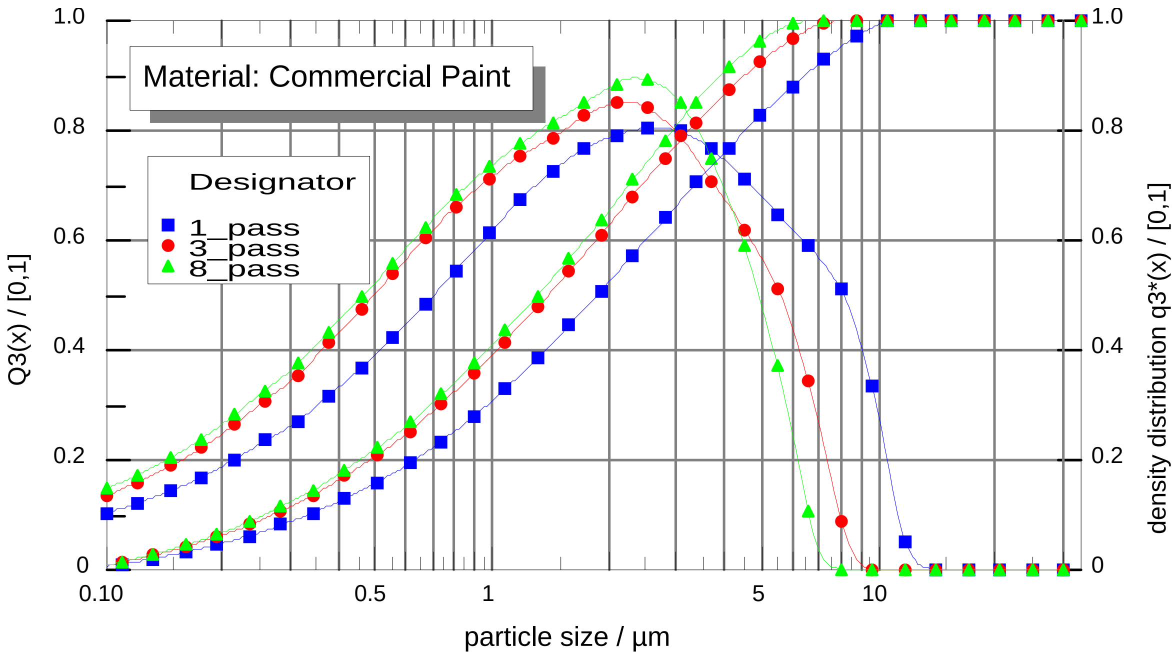

Figure 5: Results for commercial paints at different grinding steps

The paint is optically opaque and the suspension liquid has a high viscosity. The results show, that it is possible to monitor the change in particle size distribution during the grinding process with ultrasonic extinction measurements.

The next diagram shows results obtained for paint pigments in water. The viscosity of the suspension liquid is much lower than in the previous example but the suspension is also optically opaque. For this material the measurement range was extended down to 0.01 µm.

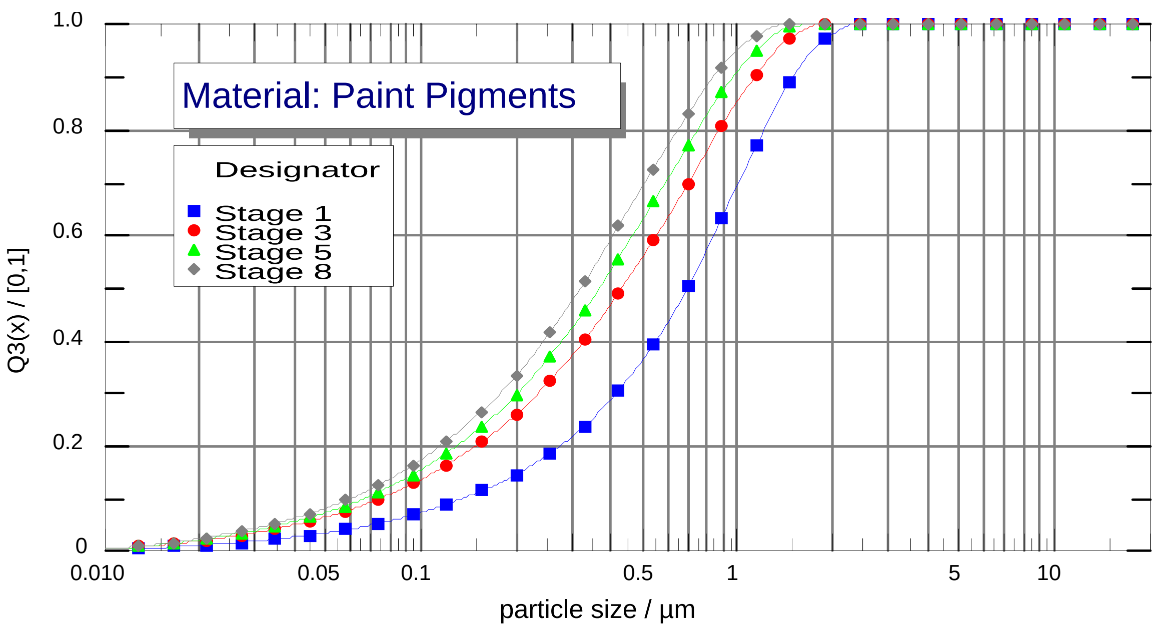

Figure 6: Results for paint pigments in water at different grinding steps

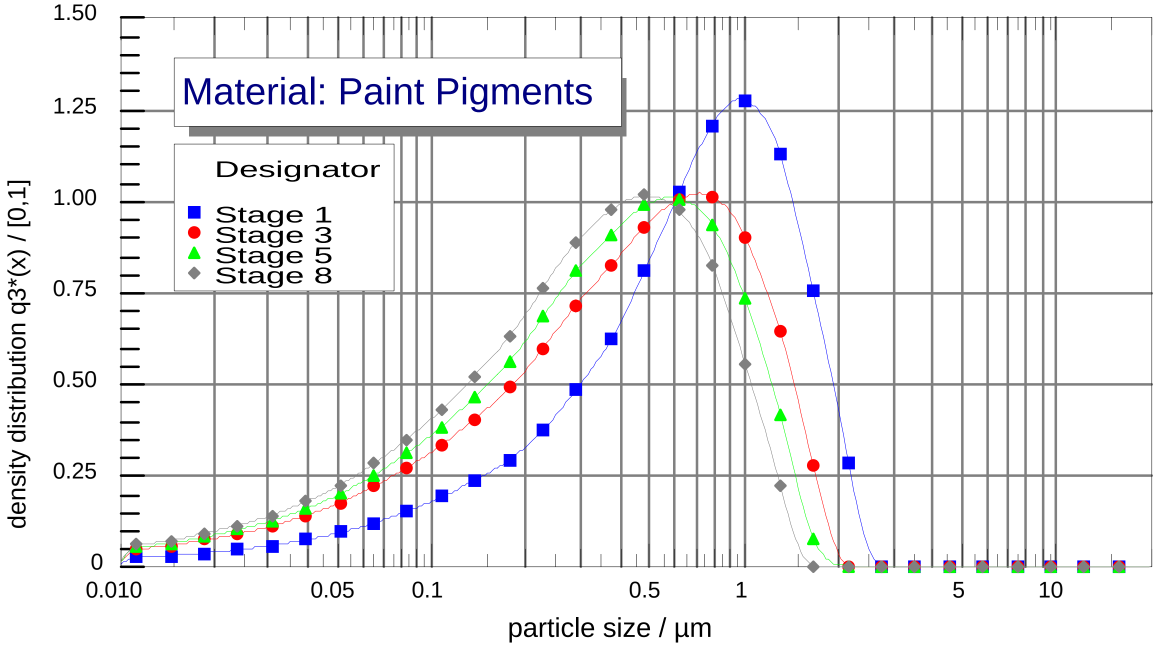

Figure 7: Results for paint pigments in water at different grinding steps

The results show that it is possible to monitor the trend of the particle size distribution during a grinding process using the suspension at its original concentration. The measurements can be carried out under the conditions (concentration, temperature, pressure) given by the process. Therefore, the measurements will introduce a minimum of disturbance to the process to be monitored.

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