MEASUREMENT OF HIGH-CONCENTRATION INKS AND PIGMENTS USING DYNAMIC LIGHT SCATTERING

Inks are dispersions of pigments used to impart color to a substrate. There are a huge variety of applications, including writing pens, printing inks for magazines and books, inkjet printers for computers, and packaging materials including paper-based materials and plastics. This leads to an equally wide range of inks, each optimized for the particular application.

Summary
Printing inks are made up of the pigment, carrier fluid, and additives formulated to reduce smudging, picking, and other printing problems associated with the ink. The choice of ink depends on the type of paper and the printing process. Thousands of raw materials are available for consideration in the final formulation.

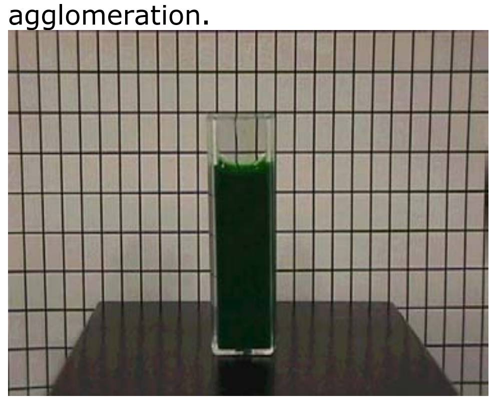
To provide the full spectrum of colors and for different applications, a wide range of pigment materials are available. These include both organic and inorganic materials. Depending on the application, the carrier fluid can either be water or an organic fluid.

Importance of Particle Size
Particle size of the pigment is a significant determinant of color strength, surface finish, and impacts the delivery method. Control of particle size, both the target size and distribution width, and consistency from batch to batch, is important in delivering the required product to the end user.

Monitoring incoming raw materials, through milling, and in the final dispersion is critical to providing optimum performance.

The stability of an ink dispersion is also critical to performance, from manufacturing through delivery, storage, and until final use. Monitoring particle size to look for agglomeration is important to verifying stability.

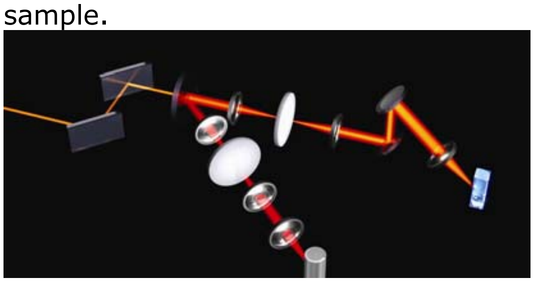
Analysis Method
Despite this wide range of possible combinations, ink dispersions can generally be analyzed for particle size with a fairly consistent method. In most cases, the preferred method of analysis has been laser diffraction which has the ability to measure relatively small sizes and has a fast analysis time. It would be preferable not to dilute the sample as much as is generally necessary in these instruments, as there are questions about the dilution causing agglomeration.



4.5 wt.% organic green pigment

The LB-550 Solution

The Horiba LB-550 Dynamic Light Scattering Particle Size Analyzer has the ability to measure samples like this with little or no dilution, giving significant advantages in the analysis of pigment dispersions. The back-scatter optical arrangement allows for measurement of materials as high as 40 wt% solids, depending on the sample.



Optical Bench Layout of the LB-550

The dynamic light scattering technique is able to measure much smaller sizes than traditional static light scattering instruments, allowing the measurement of sub-100nm inks with a high degree of accuracy. The LB-550 has a size range of 1nm to 6µm.

Measurement Considerations

One of the prime variables in dynamic light scattering is viscosity of the dispersion. If the dispersion is acting as a Newtonian fluid (in most cases, where the viscosity is less than 3cP), then the viscosity of the dispersion fluid can be entered and accurate particle sizes reported. However, as the solids content increases, the dispersion viscosity increases due to particle-particle interaction, and using the fluid viscosity can lead to inaccurate results. [See Technical Note 140 for a full discussion of this subject]

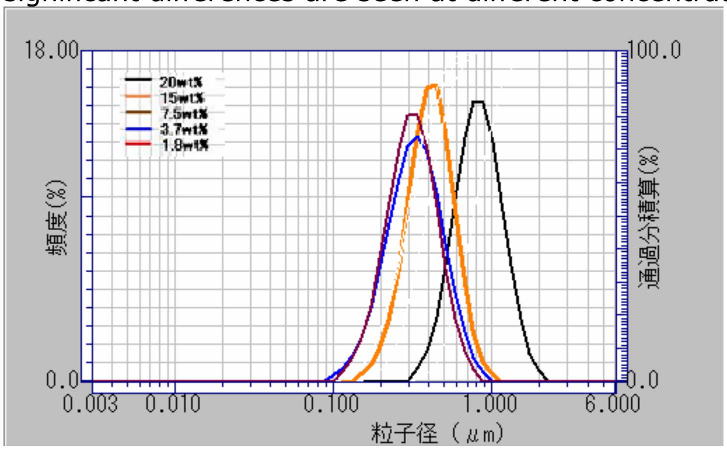
There are two approaches to take in this situation, both of which are aided by the LB-550V with a built-in viscometer, because it can measure viscosity as the sample is being tested. The sample can be diluted until the viscosity is in the optimum range for measurement. This is still a much higher concentration than competitive techniques. Rather than always using a very high dilution ratio and risk the stability of the dispersion, we can make smaller dilutions until we get to this region. The viscometer can confirm exactly how much dilution is required.

Horiba LB-550V Dynamic Light Scattering Particle Size Analyzer

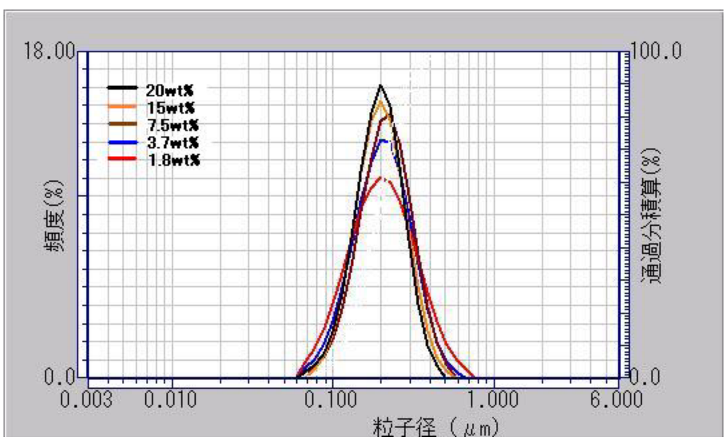
In most cases, it is possible to avoid the dilution all together. It has been empirically determined that using the viscosity of the whole dispersion will provide accurate results up to a fairly high particle concentration loading. An accurate measurement of each sample’s dispersion viscosity is therefore necessary. The LB-550V is able to do this for each sample without requiring a separate viscometer measurement that then needs to be transferred to the analyzer.

Example of Viscosity Effect

The following data shows the effect of correcting for dispersion viscosity in a high-concentration sample. The original sample was approximately 20 wt% solids content. When the results are calculated using the viscosity of the pure dispersant fluid, significant differences are seen at different concentrations.



When the data is corrected with dispersions viscosity measurements made at the same time as the measurement, the concentration/viscosity effect is avoided. This shows that accurate measurements can be made on this sample at concentrations up to 20 wt% solids, avoiding the need for dilution.



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