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Application News

iSpect™ DIA-10 Dynamic Particle Image Analysis System

Evaluation of Concentration of Coarse Particles in Paints

- Foreign Matter Detection Using Dynamic Image Analysis Method -

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User Benefits

- Foreign matter detection with little oversight using telecentric optical system.
- High concentration samples can be measured at undiluted solutions/low dilution rates using micro cell.
- Low consumption of samples and rinsing

■ Introduction

Coarse particles or aggregates of primary particles in paints (e.g., inks) can cause problems, such as clogging of the flow path of printing equipment, coating deterioration, and uneven coating.

The Shimadzu iSpect™ DIA-10 dynamic particle image analysis system (Fig. 1), which is based on the dynamic image analysis method, is an instrument which acquires images of particles in liquid samples and measures the particle size distribution, concentration, and shape. It is possible to analyze tens of thousands of particles and to detect small amounts of coarse particles or aggregates in only minutes with this optical system, which misses very few particles and has an image acquisition efficiency of 90 % or higher. In addition, the microcell method enables high concentrations and high turbidity samples to be measured without dilution or at low dilution rates, which reduces the effect of diluting samples.

This article introduces an example in which the concentration of coarse particles in inks was evaluated without dilution or at a low dilution rate by using the iSpect DIA -10.

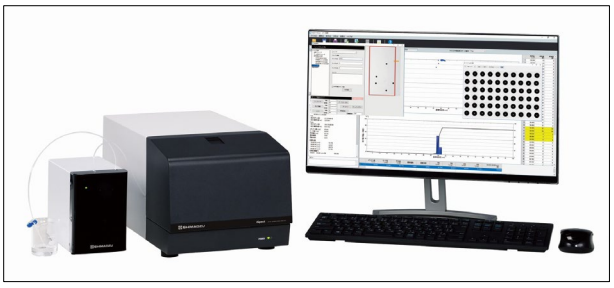


Fig. 1 iSpect™ DIA-10 Dynamic Particle Image Analysis System

■ Particle Detection in Colored Solutions

Since the particle size measurement range of the iSpect DIA-10 is 5–100 µm, submicron particles in paints cannot be detected. However, it is possible to detect coarse particles in the order of microns (foreign matter, agglomerates, etc.) contained in suspensions of submicron particles. Fig. 2 shows standard particles added to water and colored solutions. As shown in Fig. 2, in a colored solution, the background is darker than in water, but particles are still detected.

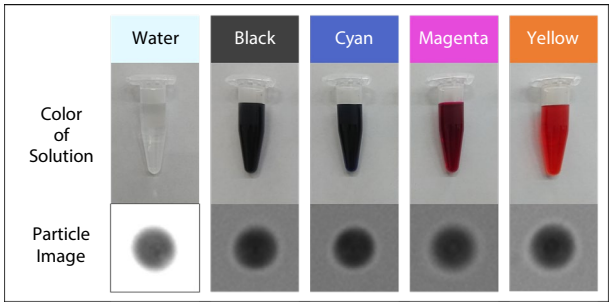


Fig. 2 Particle Images of Polystyrene Latex in Colored Solutions

■ Samples and Methods

Commercial fountain pen inks (black, blue black, and red) were used as the sample. Table 1 shows the measurement conditions and Fig. 3 the appearance of the diluted samples.

Table 1 Measurement Conditions

	Black	Blue Black	Red
Dilution rate [times]	20	6	Undiluted
Frame rate [fps]	8	8	8
Efficiency [%]	96.5	96.5	96.5
Pump volume [µL]	500	500	500
Pump rate [mL/min]	0.1	0.1	0.1
Average brightness of measurement area	90	80	90
Threshold of binary image	68	60	68

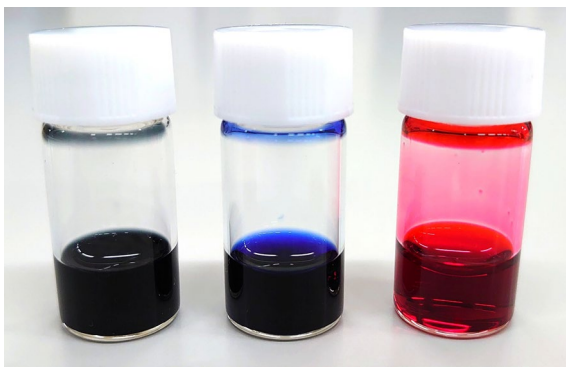
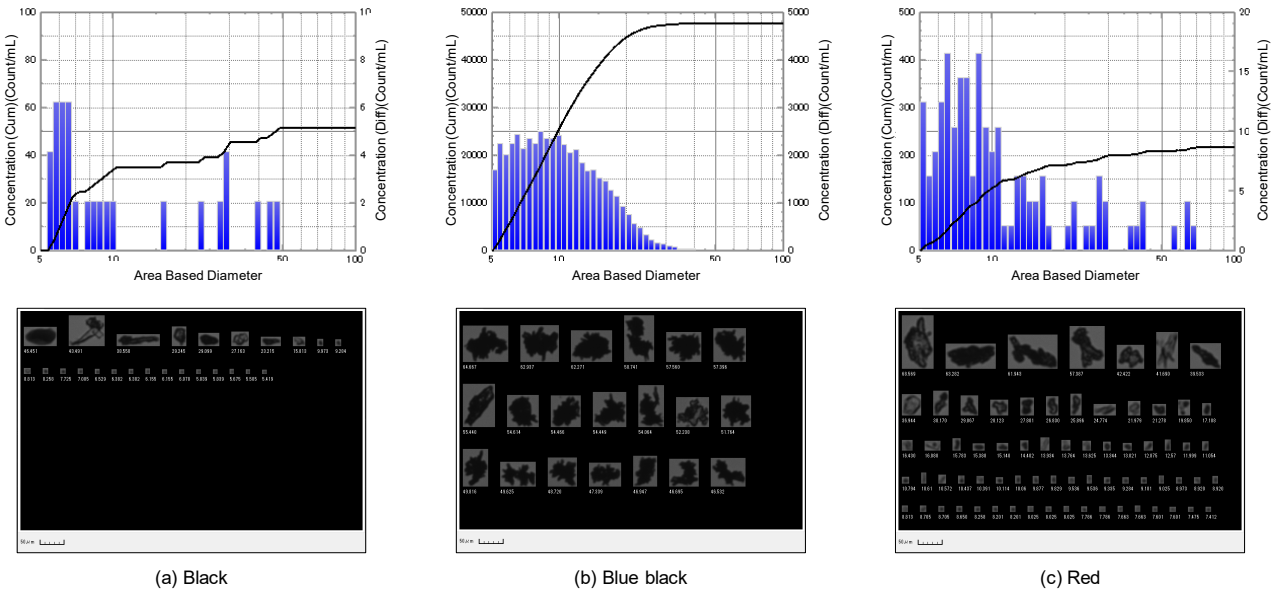


Fig. 3 Appearance of Diluted Samples



(a) Black (b) Blue black (c) Red

Fig. 4 Particle Size Distribution and Particle Images

■ Results

Fig. 4 shows a typical particle size distribution and the particle images. In the black and red inks, many particles were smaller than 10 µm, but particles around 50 µm were detected. The blue black ink had high particle concentrations with a peak of less than 10 µm and a maximum particle size distribution of several tens of µm. In addition, particle images show that it contained particles of various shapes, such as amorphous or long particles. By using information on particle shapes and brightness, it was possible to infer the origin of the particles.

Table 2 and Fig. 5 show the concentration measurement results (the average of three measurements) and the calculated concentration of undiluted samples. As Fig. 5 shows, the blue black ink contained more particles than the black and red inks.

Table 1 Concentrations

Sample	Dilution rate [times]	Concentration*1 [count/mL]	
		Diluted*2	Undiluted*3
Black	20	59	1188
Blue black	6	51831	285071
Red	Undiluted	217	217

***1 The concentration is calculated for the area based diameter of 5 µm and more.**
***2 The diluted value is the average of three measurements.**
***3 The undiluted value is calculated from the dilution rate and the measurement results of the diluted sample.**

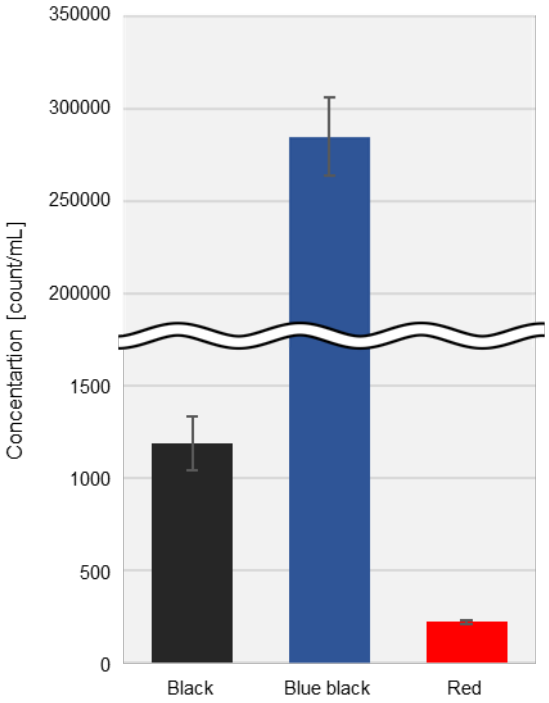


Fig. 5 Calculated Concentrations of Undiluted Samples

■ Conclusion

By using an iSpect DIA-10 dynamic particle image analysis system, it was possible to detect particles in the order of microns in commercial fountain inks without dilution or at low dilution rates, capture images of particles, and evaluate particle size distribution and the concentration of coarse particles. It was possible to infer from the obtained particle images whether these were foreign substances derived from the environment, aggregates, or large primary particles. The concentration of coarse particles, which are a cause of defects, can be used as an indicator of quality control. The iSpect DIA-10 can measure colored solutions without dilution or at low dilution rates by utilizing the microcell method. Because quick measurement with high detection efficiency is possible, the iSpect DIA-10 is an effective tool for concentration evaluations and detection of coarse particles (foreign matter and aggregates) in quality control.

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