APPLICATION NOTE

Compact Toner Draw-Off Charge Measurement System: Trek 210HS

Q/m Measurement Overview

Toner charge-to-mass ratio (Q/m) is one of the more important factors involved with high quality printing in the electrophotographic process. The Trek 210HS Q/m Meter performs highly accurate charge measurements by employing a newly developed toner transport system called toner "draw-off". Utilizing this new draw-off system together with a compact Faraday cage assembly, precision coulomb meters, a regulated air-flow system, and a separate weight scale, the Trek 210HS can perform highly accurate Q/m charge measurements of dual component and single component toners.

The toner draw-off technique used in the Trek 210HS was developed by the Hitachi Research Laboratory in Japan. Tests were performed comparing this new draw-off system with both the traditional blow-off method and the E-SPART analyzer Q/m system. Through comparative measurements on various mixtures and types of toner, test results confirmed that the Trek 210HS, utilizing the draw-off method, had a higher stability of the measured charge value over its entire range of 0 to ±2 microcoulombs (±1.999 µC full scale) than the traditional blow-off method.

To perform dual component toner charge measurements, the separation of the toner from the carrier (and/or development roller) is necessary. There are currently available several different methods for the separation of toner and carrier including: the blow-off method, the developer separation method, and the newly developed draw-off separation method.

Blow-off separation can further subdivide into two distinct techniques: (1) blow-off with wire mesh, and (2) magnetic blow-off.

The blow-off method is primarily used for the measurement of dual component toner and may not be applicable for the charge measurement of single component toner.

A specific toner separation apparatus is needed for the developer separation method. The apparatus can hinder performing direct charge measurements of toner located on a drum, on intermediate transfer media, or on paper.

The size of the Advanced Energy Trek 210HS draw-off apparatus is small and compact enough to perform charge measurements of toner, wherever the toner is located. A metal mesh is used to separate the toner from the carrier of dual component toner mixtures.

Configuration of Draw-Off Apparatus

The schematic diagram of the Trek 210HS draw-off apparatus is shown in Figure 1 and the specifications of the system are given in Table 1.

The 210HS draw-off system consists of (1) nozzle unit, (2) indicator unit, with which each charge amount of toner and carrier is shown, and (3) sample cell case, in which the mixture of toner and carrier (namely dual component toner) is placed. A metal mesh is placed in the sample cell case.

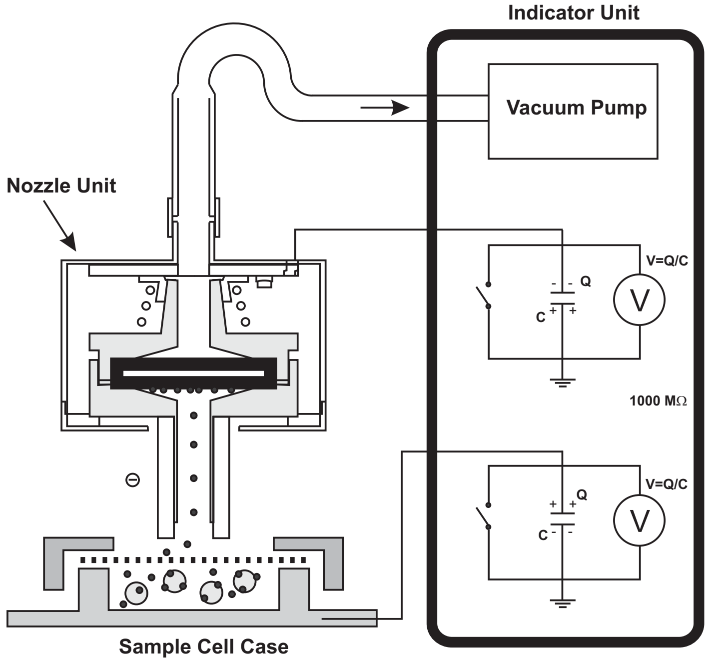

Figure 1: 210HS apparatus

The openings of the metal mesh are smaller than the carrier particles and larger than the toner particles. When air pressure (suction) from the nozzle is applied through the sample cell case mesh, the smaller toner particles are passed through the mesh and the larger carrier particles are left behind. A filtering system in the nozzle unit prevents the toner from being drawn into the pump.

The physical size of the nozzle unit is small enough that it can be positioned wherever toner is located for easy removal and subsequent measurement. The nozzle unit is designed as a Faraday cup. The toner being sampled through the draw-off process is carried to the measuring area by airflow. A coulomb meter connected to the Faraday cup measures the toner charge. Therefore, an accurate and repeatable charge measurement can be accomplished.

Advanced Energy Trek 210HS Specifications	
Main Indicator Unit	210 mm H x 250 mm W x 370 mm D
Nozzle Unit	1600 mm L
Sample Cell Case	40 mm H x 120 mm W x 120 mm D
Measurement Circuits	
Measurement Resolution	0.001 μC (1 nC)
Input Impedance	Over 1000 MΩ
Pump	
Air Pressure	About 10 kPa

Table 1: Specifications of the 210HS instrument

There are two Faraday cups for the Trek 210HS, one in the sample cell case and one in the nozzle. The sample cell case used for dual component toner measurements has already been described. When the measurement of toner charge is being conducted, the charge amounts of the carrier are also being measured simultaneously.

Charge amounts of the carrier are known to be the same in quantity, but having the opposite polarity of charge amounts for the toner. Therefore, it is possible to compare the charge amounts of toner and carrier when measurements are made.

Through comparative weight measurements and mathematical calculation, Q/m charge can be determined. The sample cell case is very light in weight. The weight change between the mixture of toner and carrier, and of the carrier itself after toner has already been removed, can be easily measured using a separate fine weight scale. Information concerning charge-per-mass can be obtained by weight comparisons of toner and carrier in the sampling case. Mathematical calculation will obtain the answers for charge-per-mass of the toner compound.

Measurement of Dual Component Toner

The blow-off system has been widely used as a standard charge measurement method of dual component toner for years. E-SPART analyzer is also commonly used for the measurement of diameter of toner particle versus each charge amount.

The Hitachi Research Laboratory has compared each of the results obtained from the 210HS draw-off system, the blow-off system, and the E-SPART system. The blow-off system that the Hitachi Laboratory utilized was the system using metal mesh. The magnetic blow-off was utilized by the E-SPART for the separation of toner and carrier. The results from three different measurement systems are shown in Figure 2 for the dual component toner agitated for the duration of 1 to 60 seconds.

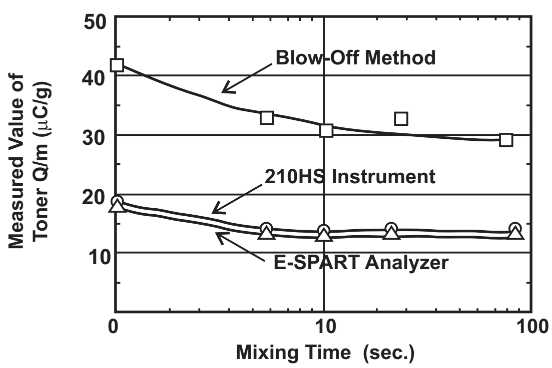

Figure 2: Compared result with usual measuring methods on dual component developer

The data from the Trek 210HS and E-SPART were almost identical. However, data from the blow-off system is different from the data taken from both the 210HS instrument and the E-SPART.

Data from the blow-off system showed much higher charge amount as compared with the data from the other two measurement systems. The air pressure used with both the Trek 210HS and the E-SPART system was approximately 0.3 kg/cm^2.

When low-pressure air (0.3 kg/cm^2) is being used with the blow-off system, complete separation between toner and carrier particles cannot occur and accurate measurements cannot be accomplished. The Hitachi Research Laboratory prepared several different toner/carrier mixtures and types. These were tested with both the Model 210HS and the E-SPART system. The results are shown in Figure 3.

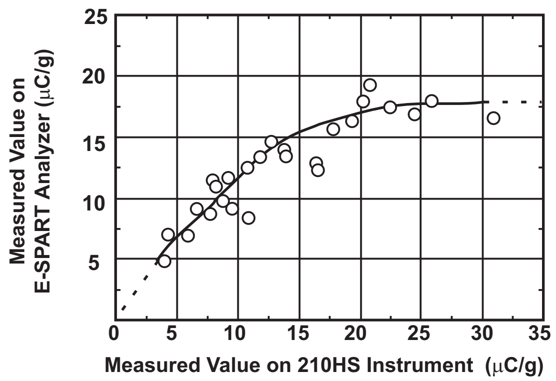

Figure 3: Comparison of measured values between 210HS and E-SPART analyzer

Above average data matching results between the Model 210HS and E-SPART were confirmed for those mixtures having relatively low charge. However, if the charge amount exceeded 20 μC/g, some saturation occurred with the E-SPART system because the data from E-SPART went flat at 20 μC/g (and beyond). The reason why this occurred was because the E-SPART achieves toner separation using the magnetic blow-off system. The magnetic blow-off separation method could not provide sufficient toner and carrier separation because the charge on the toner exceeded certain levels.

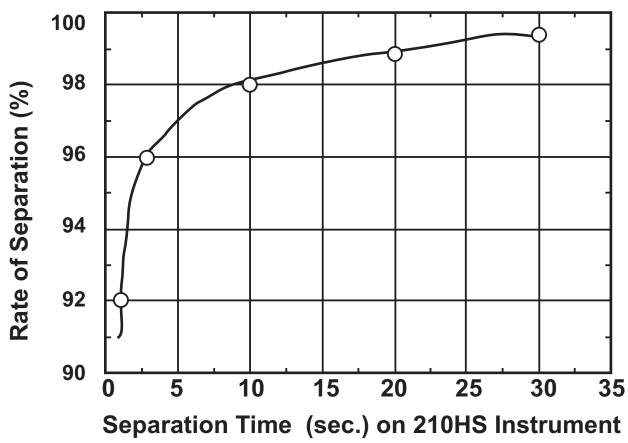

Figure 4: Relationship between separation time and rate of toner separation.

If the air pressure becomes too intense for the separation of toner and carrier with the magnetic blow-off system, the carrier and toner may both be removed from the magnetic roller. The roller can act as a charging device for the mixture and accurate measurements can not always be guaranteed.

Figure 4 shows the relation between the ratio of acquired toner with air pressure, using the internal pump system only, versus the duration of applying the draw-off force to the mixture (of toner and carrier) for separation.

The air pressure used to obtain this graph was only 0.26 kg/cm^2. However, results confirm that 98% separation, in terms of volume content, would be achieved if the draw-off method were applied to the sample under test for more than 30 seconds, even though the air pressure for the draw-off was relatively low.

The separation between the toner and carrier occurred at the area very close to the mesh in the sample cell case. The toner and carrier were migrated to the measurement area by airflow with sufficient amounts of air pressure to insure that good separation had occurred. The 210HS draw-off instrument has the capability to measure the charge on dual component toner having a wide range of charge density.

Measurement of Single Component Toner

The Model 210HS draw-off method can measure charges in both single component toner and dual component toner. The internal configuration of the development unit for charging nonmagnetic, single component toner is shown in Figure 5.

The development unit consists of development roller, toner supply roller, and the blade, which controls the amount of toner applied to the development roller. The contact pressure of the blade to the development roller will dictate the thickness and the charge amount of the toner layer on the development roller.

Test data from both the contact pressure of the blade versus toner charge amount, and the contact pressure of the blade versus toner mass on the development roller are plotted in Figures 6A and 6B. Figure 6A indicates the relationship between contact pressure of the blade on single component development rollers and toner charge. Figure 6B indicates the relationship between blade pressure and toner mass on single component development rollers.

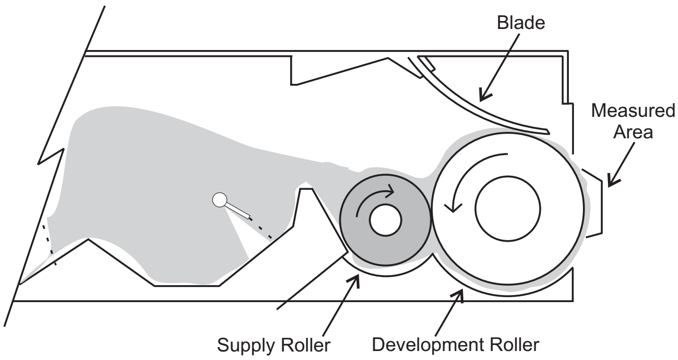

Figure 5: Structure of single component development unit

The total charge amount on the development roller increases and the toner mass on the development roller decreases, in accordance with the increase in contact pressure of the blade. The Hitachi Research Laboratory confirmed that the Trek 210HS performs stable measurements even when the toner layer becomes very thin.

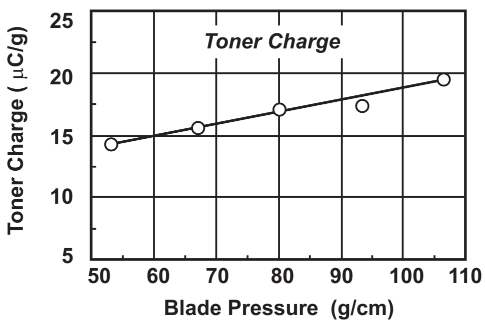

Figure 6A: Measured results of contact pressure of the blade on toner charge in single component development rollers.

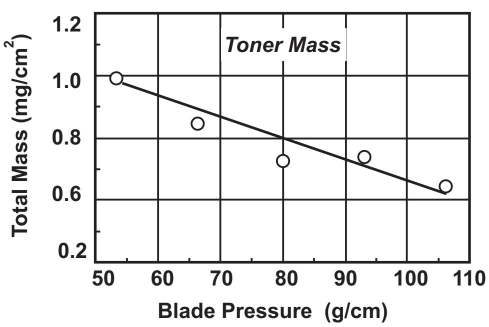

Figure 6B: Measured results of blade pressure and toner mass in single component development rollers.

In Conclusion

The Hitachi Research Laboratory developed a toner charge measurement system using a new draw-off technique which has the capability of testing both single component toner and dual component toner. The Trek 210HS can also make direct measurements of toner, located on the photoreceptor, on intermediate media, or in several other hard to reach locations.

The Trek 210HS toner charge measurement system provides high maneuverability due to the small size of the nozzle unit and ensures extremely versatile measurement capabilities. The drawn-off toner is directly introduced into the nozzle unit Faraday cup so measurements are highly accurate. The Hitachi Research Laboratory tests confirm that accurate measurements can be obtained for dual component and single component toner having wide ranges of toner charge.

An optional external pump is available to increase the draw pressure of the Trek 210HS for single component toner or other applications where more air pressure is required.

The draw-off system of toner charge measurement is extremely useful and valuable for the development of electrophotographic systems.

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