



Compact Toner Draw-Off Charge Measurement System: Model 210HS-2B



Q/m Measurement Overview

The charge-to-mass ratio (Q/m) characteristic of toner is one of the more important factors involved with high quality printing in the electrophotographic process. The Trek Model 210HS-2B 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 Model 210HS-2B can perform highly accurate Q/m charge measurements of dual component and single component toners.

The toner draw-off technique used in the Trek Model 210HS-2B 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 Model 210HS-2B, utilizing the draw-off method, had a higher accuracy and repeatability 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 while confirming comparative results to the E-SPART technique.

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 Model 210HS-2B draw-off apparatus is small and compact enough to perform charge measurements of toner, wherever the toner is located. A metal mesh (filter) screen is used to separate the toner from the carrier of dual component toner mixtures.

Configuration of Draw-Off Apparatus

The schematic diagram of the Model 210HS-2B draw-off apparatus is shown in Figure 1 and the specifications of the system are given in Table 1.

The 210HS-2B draw-off system consists of (1) nozzle unit, (2) indicator unit, which separately indicates the charge transfer quantity associated with both the toner and carrier components and (3) sample cell case, in which the mixture of toner and carrier (namely dual component toner) is placed. A metal mesh (filter) screen is placed in the sample cell case.

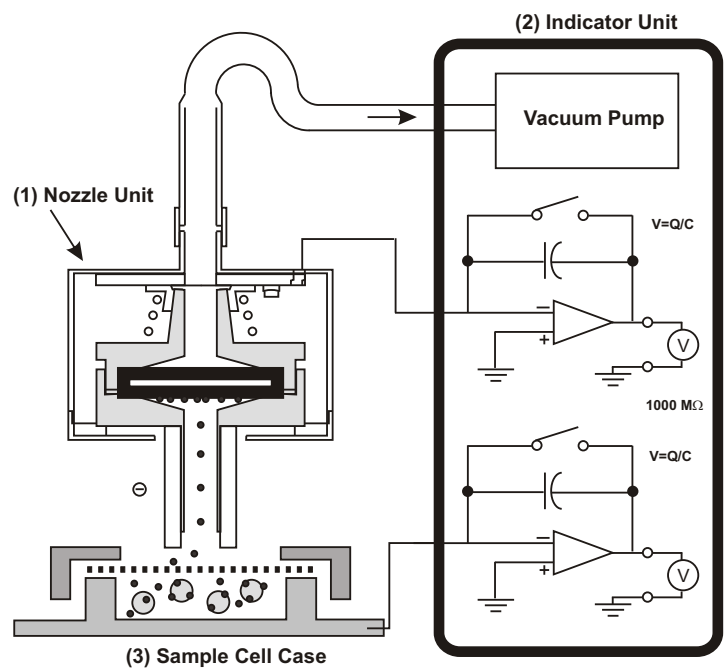


Figure 1: 210HS-2B apparatus

Compact Toner Draw-Off Charge Measurement System: Model 210HS-2B (cont.)

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 cup by airflow. A coulomb meter connected to the Faraday cup measures the toner charge, while a second coulomb meter measures the charge of the sample cell case. Therefore, an accurate and repeatable charge measurement can be accomplished.

Through comparative weight measurements and mathematical calculation, the charge-to-mass ratio charge can be determined. The sample cell case is light in weight. The weight difference of the sample cell case caused by the removal of the toner during the separation process is a measure of the mass of toner removed and can be easily measured using a separate fine weight scale. Information concerning the charge-to-ratio of the toner mass can be obtained by dividing the indicated charge transfer amount by the change in sample cell case weight (mass) due to the separation process.

Measurement of Dual Component Toner

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

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

Model 210HS-2B 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 μ C (1 nC)
Input Impedance	Essentially Zero Ohms
Pump	
Air Pressure	About 10 kPa

Table 1: Specifications of the 210HS-2B instrument

There are two Faraday cups for the Model 210HS-2B, one in the sample cell case and one in the nozzle. 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 should 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 to ensure that no extraneous charge sources are introduced during the separation process.

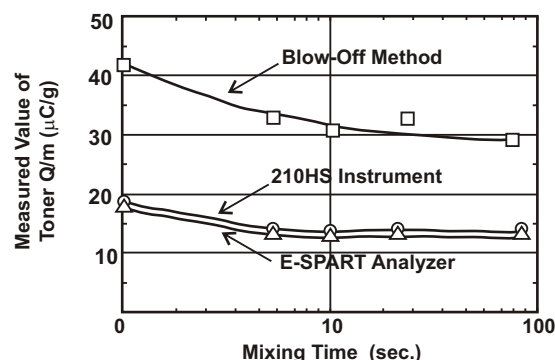


Figure 2: Compared result with usual measuring methods on dual component developer

The data from the Model 210HS-2B and E-SPART methods were almost identical. However, data from the blow-off method is different from the data taken from both the 210HS-2B instrument and the E-SPART.

Data from the blow-off method showed much higher charge amount as compared with the data from the other two measurement methods. The air pressure used with both the Model 210HS-2B and the E-SPART method was approximately 0.3 kg/cm².

Compact Toner Draw-Off Charge Measurement System: Model 210HS-2B (cont.)

When low-pressure air (0.3 kg/cm^2) is being used with the blow-off method, 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-2B and the E-SPART methods. The results are shown in Figure 3.

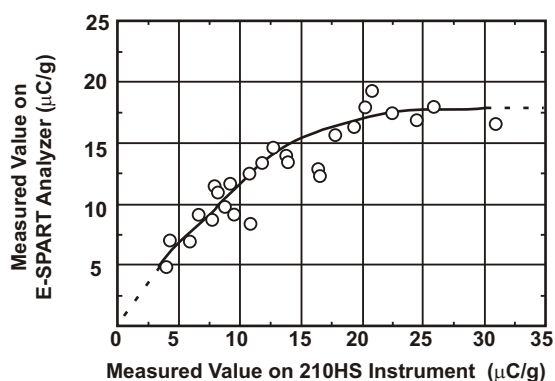


Figure 3: Comparison of measured values between 210HS-2B and E-SPART analyzer methods

Above average data matching results between the Model 210HS-2B and E-SPART were confirmed for those mixtures having relatively low charge. However, if the charge amount exceeded $20 \mu\text{C/g}$, some saturation occurred with the E-SPART system because the data from E-SPART went flat at $20 \mu\text{C/g}$ (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 can provide toner/carrier separation only up to some maximum value of toner charge, beyond which further separation cannot occur.

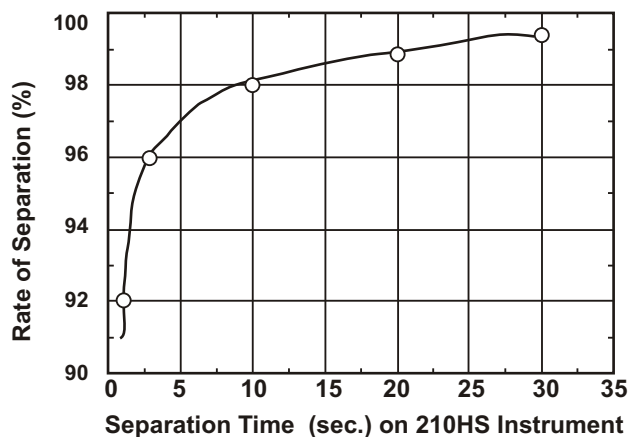


Figure 4: Relationship between separation time and rate of toner separation.

If the air pressure becomes too intense for the separation of toner and carrier with the magnetic blow-off method, 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 performed.

Figure 4 shows the relation between the ratio of acquired toner with air pressure, using the internal pump method 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-2B 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-2B 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 a development roller, a toner supply roller, and a 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.

Compact Toner Draw-Off Charge Measurement System: Model 210HS-2B (cont.)

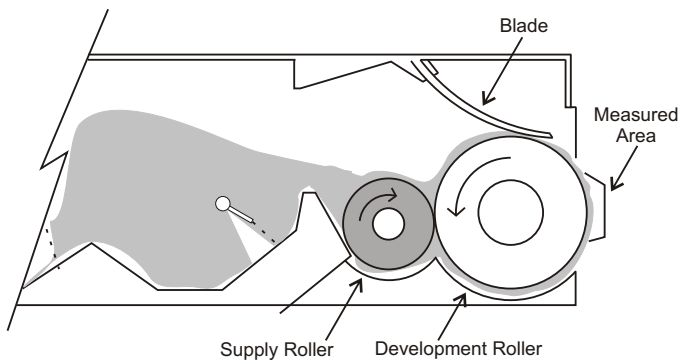


Figure 5: Structure of single component development unit

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 Model 210HS-2B performs accurate measurements even when the toner layer becomes very thin.

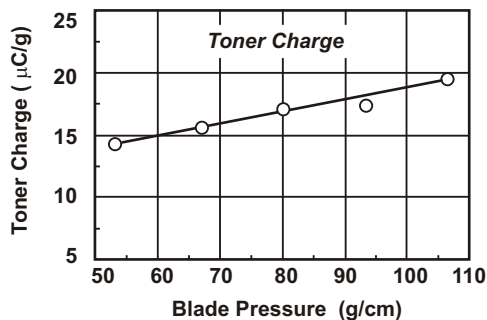


Figure 6A: Measured results of contact pressure of the blade on toner charge in single component development rollers.

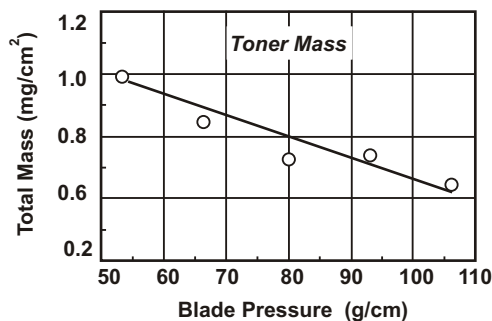


Figure 6B: Measured results of blade pressure and toner mass in single component development rollers.

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. This technique is employed by the Trek Model 210HS-2B. The Model 210HS-2B can also make direct measurements of toner, located on the photoreceptor, on intermediate media, or in several other hard to reach locations.

The Model 210HS-2B toner charge measurement method 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 Model 210HS-2B for single component toner or other applications where more air pressure is required.

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

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