Measured Specific Toner Charge Dependence on Suction Pressure in Blow off Method

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Abstract

Blow off method is most popular in the measurement of specific toner charge. Toner is charged with mixing with carrier in rotating cylinder and the measurements of the specific toner charge are carried out on the various blowing off pressure 2KPa – 20KPa. From the measured specific toner charge and the blow off toner amount dependence on blow off pressure, the specific toner charge distribution is estimated. The data is compared with the data by E-SPART measurement and reasonable agreement is obtained between them.

Introduction

Charging characteristics of toner is very important in electrophotography. The charging characteristics are influenced by many factors such as toner materials and shape, carrier materials and shape, charging methods, humidity, and so on. Many studies have been carried out on the toner charging mechanism.[1-5] Method of measuring toner charge is also important. Several methods have been proposed and are used.[6] The methods of blow off, E-SPART, and toner motion analyze in airflow with the application of electric field are main. Among them, blow off method is most widely used,[1,7,8] because it has characteristics of simple measuring mechanism. E-SPART is a powerful method, because respective toner charge and toner size can be measured.[9] But, the apparatus is complex. In these measurements, the sampling of toner must be paid attention to if the sampling is carried out adequately or not.

In this paper, taking care of the sampling of toner, blow off measurements are carried out. With changing the suction pressure, blow off measurements are carried out and it is tried to obtain the information of toner charge distribution. These data are compared with the data of E-SAPRT measurements.

Experimental

The sample of toner used in this experiment is made by crushing method and the average diameter is around 7-8μm. The toner is adjusted for negative charging type by CCA (Charge Control Agent) and the flowing property is controlled by silica treatment. The carrier is made of steel and the diameter is around 60μm. The developer sample is prepared on the conditions of 2, 5 and 7 weight % of toner. The developer is mixed in rotating cylinder of the rotating speed of 120rpm and the toner is charged. The apparatus used for measuring the specific charge of toner is shown in Fig.1. Toner and carrier is separated by stainless steel mesh (#500) with air flow. The suction pressure is controlled by the power of vacuum cleaner. The suction pressure is monitored by pressure gauge.

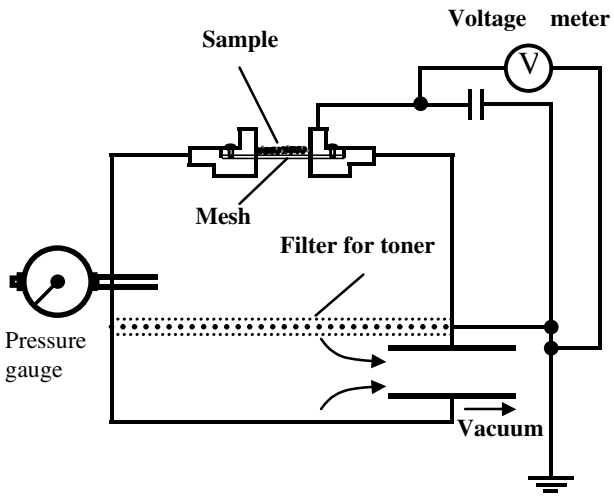

Figure 1. Apparatus for Blow off measurement.

Results

Figure 2 shows the relation of the amount of toner blew off versus the suction pressure. It is found the amount increases with the increase of the suction pressure. Figure 3 shows the relation between the specific toner charge and the suction pressure. It is found that the specific toner charge also increases with the increase of the pressure.

Figure 4 shows the photos of developer after toner blew off. It is found that at the pressure of 10kPa the toner remains partially on the carrier and at the pressure of 20kPa almost all the toner is blew off.

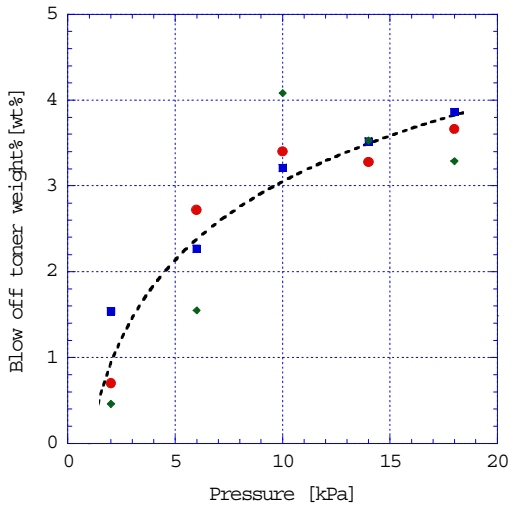

Figure 2. Dependence on suction pressure: toner wt% 5%.

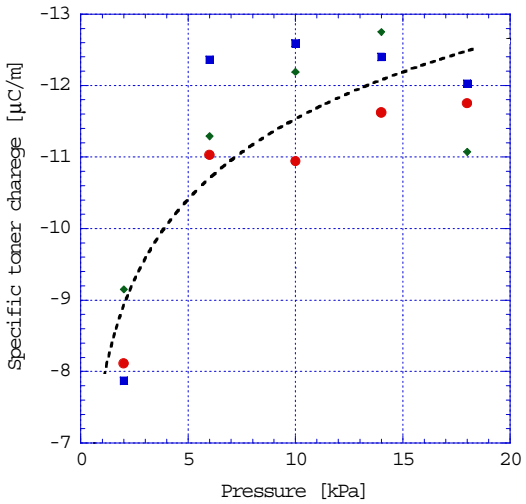

Figure 3. Specific toner charge dependence on suction pressure: toner wt% 5%

The charge amount and the diameter of individual toner are measured by using E-SPART analyzer. The measured result is shown in Fig. 5.

Discussions

Concerning the result of the blow off toner versus the pressure shown in Fig. 2, the reason of the increase of the blow off toner amount is considered as follows: the force between toner and carrier is distributed widely, and the toner of more strongly attaching to carrier is blew off as the suction pressure increases. When the pressure increases, the airflow increases and the force for blowing off toner from carrier increases.

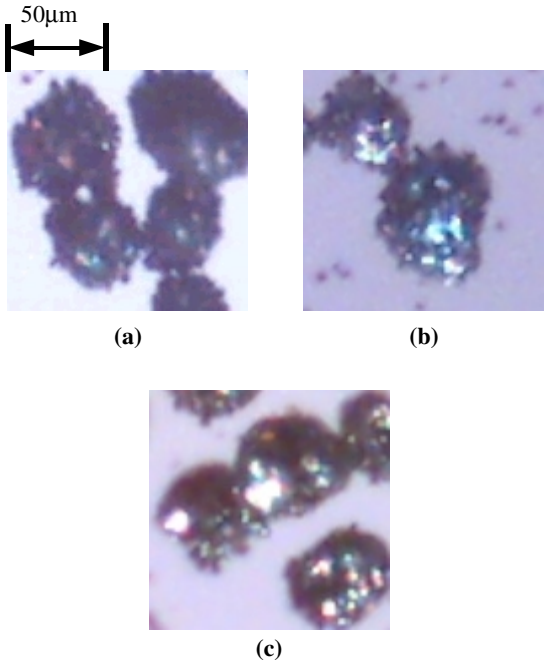

Figure 4. Photos of developer, (a)Before Blow off,(b)Blow off at 10kPa,(c)Blow off at 20kPa.

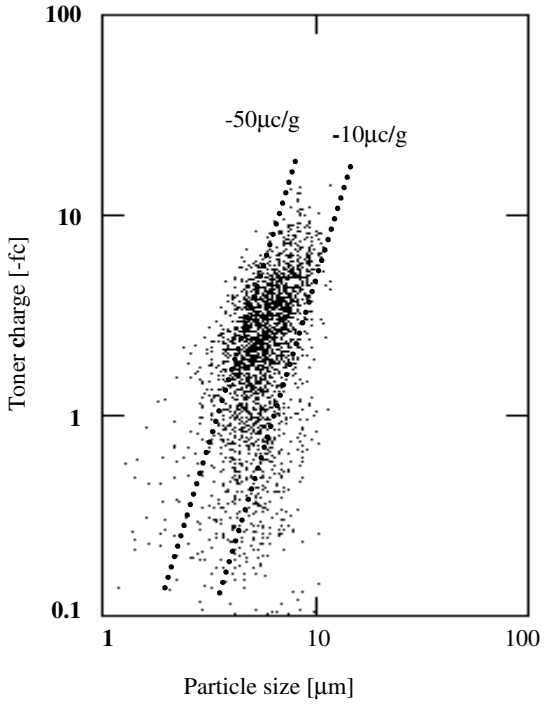

Figure 5. Distribution of toner charge and size by E-SPART analyzer.

The attaching force between toner and carrier consists of electric force and van der Waals force. In an insulator toner case the force is mainly from the electric force.[10] So, it is considered that the toner that is charged higher has

stronger attaching force. When the pressure increases, the blow off force increases. The above explains the increase of the measured specific charge according to the increase of the pressure. It is suggested that the information of toner charge distribution is obtained by measuring the specific charge of toner dependence on the suction pressure.

We summarize the measured data of blow off amount and q/m in Table 1. The data of *a* kPa means that the blow off amount is blew off toner less than the pressure of *a* kPa and that the value q/m is (total charge of blew off)/(blew off toner weight). So, when we consider the toner blow off amount and q/m between *a* kPa and *b* kPa, the toner weight% and q/m blew off between *a* kPa and *b* kPa are expressed as follows ($b > a$):

$$wt\%_b = wt\%_a + wt\%_{a-b}, \tag{1}$$

$$\frac{q}{m_b} \cdot wt\%_b = \frac{q}{m_a} \cdot wt\%_a + \frac{q}{m_{a-b}} \cdot wt\%_{a-b}. \tag{2}$$

Table 1. Dependence of blow off toner wt% and specific toner charge on pressure: toner wt% 5% when mixing.

Suction Pressure [kPa]	Blow off toner Weight % [wt %]	Specific toner charge [μC/g]
2	0.95	-8.9
4	1.9	-10.05
8	2.75	-11.15
12	3.3	-11.8
16	3.75	-12.25
20	3.95	-12.65

Equation (1) is from the relation that the blow off toner wt% at *b* kPa is the summation of blow off toner wt% at *a* kPa and blow off toner wt% between *a* kPa and *b* kPa. Equation (2) is from the relation that the blow off charge at *b* kPa is the summation of blow off charge at *a* kPa and blow off charge between *a* kPa and *b* kPa. From Eq. (1) and Eq. (2), q/m_{a-b} is obtained:

$$q/m_{a-b} = \frac{q/m_b \cdot wt\%_b - q/m_a \cdot wt\%_a}{wt\%_b - wt\%_a} \tag{3}$$

Using Eq. (3) and the data of Table.1, the distribution of q/m is estimated and is shown in Fig. 6. From Fig. 6, it is found that q/m is distributed from -9 to -19μC/g.

In Fig.5 , the lines of -10 and -50μC/g μC/g are drawn. More than half of q/m values of toner are distributed between theses lines. So, it is concluded that the blow off method of varying suction pressure can estimate q/m distribution, though E-SPART show a little higher q/m values.

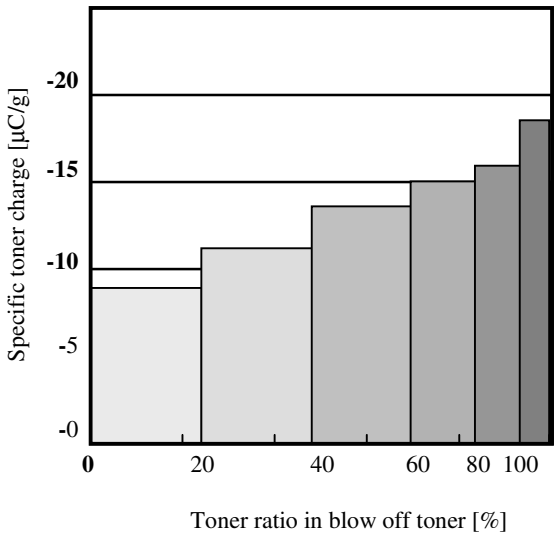

Figure 6. Estimated specific toner charge distribution.

Conclusion

Specific toner charge is measured on the various conditions of the suction pressure. It is obtained that the specific toner charge measured increases with the increase of the suction pressure. The reason is considered that the highly charged and strongly attaching toner is blew off in the strong suction pressure.

It is shown that the q/m distribution can be roughly estimated from the pressure dependence of the measured data of blow off amount and q/m.

Acknowledgements

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Biography

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