

The Use of Conductive Core Fibers in the Constuction of Cleaning Brushes for Electrophotographic Engines

James Maher, Theodore Morse, David Thompson, John Locke, Michelina Molongoski, Dean Smith, Steven Kepner, Douglas Anderson, Kenneth Brown, and Graham Wright
Eastman Kodak Company

Abstract

The higher speed electrophotographic engines are migrating toward conductive fur brush cleaning as alternatives to either vacuum fur brush or magnetic brush cleaning. The typical fiber construction is either a conductive sheath of carbon loaded polymer surrounding an insulating polymer core, or a composite of carbon or other conductive material dispersed throughout the polymer matrix. In this paper we report the use of fibers that have an insolating exterior with a carbon loaded conductive core for use in the construction of cleaning brushes. The use of this type of fiber reduces the concerns about loose fibers interrupting the process, as well as loss of conductivity due to wear. It has also been demonstrated that Paschen breakdown, that will tend to discharge toner can be effectively quenched using this fiber construction.

Introduction

The electophotographic process typically consists of six steps, charging, exposure, development, transfer, fusing, and, cleaning. Since the process of transfer is not 100% efficient the photoconducter must be cleaned of any residual debris before the process can be repeated. One method of cleaning is to scrape the photoconducter with a blade, which is efficient at lower process speeds. Higher process speeds require more aggressive techniques to remove the residual debris. One method is to use a fur brush with vacuum, very similar to a household vacuum cleaner. The underlying principle is to use the sweeping action of the brush fiber to break the bond of the van der Waals force of the toner to the photoconducter and capture them within the confines of the brush network. To prevent recontamination the toner must be removed from the brush. This can be achieved by vacuuming the particles out of the brush. One of the problems with this approach is the amount of noise generated and power consumption.

An alternative approach to cleaning is to use a biased conductive fur brush. This configuration still relies on the sweeping action of the brush to break the van der Waals force of attraction to the photoconducter but relies on the fact that the toner particles are charged and will be attracted to the brush by electrostatic forces. In addition this same force can be used to clean the brush by applying the appropriate bias by what is referred to as a detoning roller. The detoning roller can be cleaned by removing the toner that has been removed from the brush with a scraping blade.

The characteristics of the detoning roller in this application can be designed to maximize both removal of toner and also carrier that may have been transported from the development zone. Removal of this carrier is accomplished by a unique internal magnet design within the detone roller. Toner removal is maximized by using a chrome coated non-magnetic stainless steel detoning roller, in concert with a unique fiber design for the cleaning brush. The typical fiber designs in use in the industry have thin conductive sheath of carbon loaded material that adhere to an insulative fiber. A second type of fiber that is popular is a dispersion of carbon in the polymer matrix that makes up the brush fiber. Each has their respective weakness. In the case of the conductive sheath there is probability of the conductive material wearing off, plus the detone roller must be designed to prevent Paschen breakdown by applying a high resistivity coating to the surface of the detoning roller. In the case of the carbon-loaded matrix it is hard to control conductivity.

The unique fiber design referred to is a fiber with a conductive core surrounded by an insulative sheath. There are several advantages to this construction. The first is that the conductive coating will not wear away. The second is that Paschen breakdown is controlled by the brush parameters and not the detone roller. (Experimental evidence has shown that conductive detone rollers, without an insulative coating, were more effective at removing toner from the cleaning brush). A third advantage is that the fibers will not play havoc with the chargers. A cross sectional view of each type of fiber is shown in figure 1.

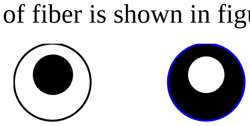

Figure 1. Cross Sectional view of the two types of fibers used for conductive brush cleaning. The black represents the conductive polymer.

To form a brush these fibers are then woven into a carpet. The carpet is slit to size and wrapped around and glued to a conductive cylinder with a conductive glue.

In the case of the conductive sheath the electrical contact is ohmic and real current can flow which may accentuate breakdown. Loose fibers from the brush may also create charger arcing.

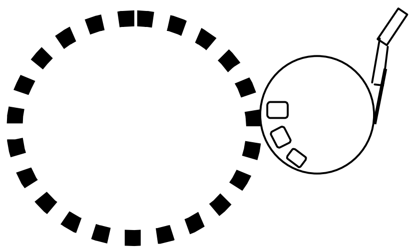

Figure 2. A typical conductive fur brush cleaning subsystem. The differences in the Kodak design are the conductive core fiber used for the cleaning brush, the surface of the detone roller, and the addition of interior magnets in the detone roller to facilitate the removal of any excess carrier.

With the conductive core fiber there is no ohmic contact and the applied voltage is induced in the fiber. The result is that little current can flow reducing the possibility of breakdown. Figure 2 is a cartoon of a typical conductive fur brush cleaning subsystem.

Conclusion

A novel approach to conductive fur brush cleaning has been demonstrated. Its main attributes are the use of conductive core fibers for brush construction which then enables the use of conducive surface detone rollers with internal magnets to control excess carrier in the brush.