Media influence on print performance, reliability, and longevity of dry-electrophotographic printers

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Abstract

With decades of consistent, dependable printing, dry-electrophotographic (DEP) printing has become known for reliable, long-lasting performance. However, poor choice of papers to run through these DEP printers might negate the benefits of DEP's reliability and reduce DEP printer's life.

We present a new class of media that includes a set of specifications to ensure print performance reliability and longevity on DEP printers. The key screening test controls the maximum allowable amount of large filler particle size. We obtained an excellent correlation between paper filler size to reliability and longevity of DEP printing.

The paper filler size testing is a part of ColorLok ™ quality standard and has been applied to numerous brands carrying ColorLok ™. Our results show that papers following ColorLok ™ quality standards ensure DEP printers to meet the designed printer-life and maintain the great print performance and reliability from DEP printing technology throughout the designed-printer life.

Background: Paper structure

Paper is defined as a felted sheet of usually cellulosic fibers laid down on a fine screen from a water suspension (Webster). The definition is a snapshot of paper making, the knowledge and art that started as early as 105 AD in human history. The whole process of paper making is, however, a lot more complicated than the definition above. It involves forest management, harvesting, pulping, bleaching, refining, forming, drying, all the way until converting and packaging, to the familiar form of paper we see everyday. Throughout the decades and years, paper making evolves and adapts to the demands from the society. From chemical recovery, optimization in energy and fresh water usage, to compliance to environmental regulations, we see paper manufacturing's evolution from how it first started in mass production of paper.

A subset of paper products is office paper. Office printing paper mainly consists of fiber and filler. Fiber gives strength, stiffness, and absorptivity in paper, while filler is needed due to improvements in paper brightness and opacity, also in helping the drainage and drying capacity, maintaining flatness (smoothness), and replacing fiber (lowering the cost). Uncoated wood free printing paper typically used between 12-26% weight of filler[1]. Some SEM images showing fiber and filler in paper structure are presented in Figure 1 (top)

Most commonly used filler types are clay, ground calcium carbonate/precipitated calcium carbonate (GCC/PCC), and talc. The type of filler used in office papers is greatly influenced by the availability in the region. The snapshot of filler usage and types of filler worldwide is presented in Figure 1 (bottom).

Filler particle in paper plays an important role in determining the longevity of DEP printers and their print quality and reliability at their expected lifetime. The abrasive nature of hard particles such as paper filler restricts the size and amount that is acceptable for DEP printers.

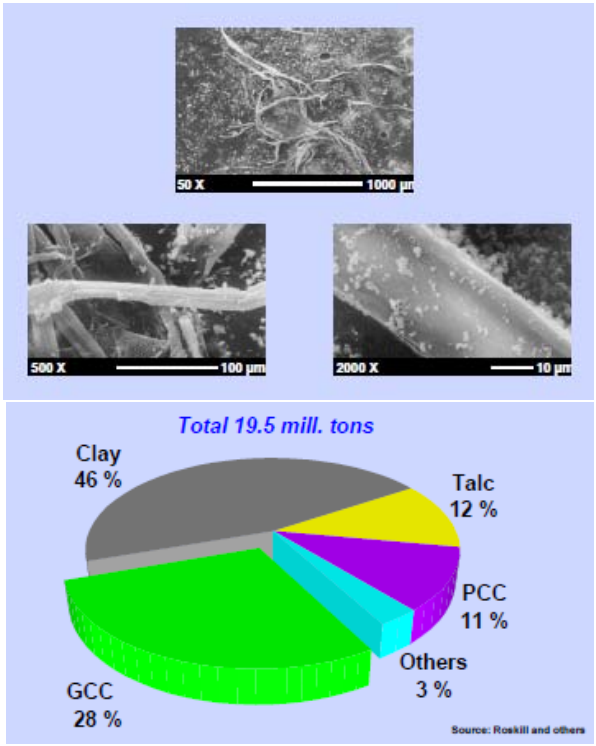

Figure 1. *SEM of paper showing fiber and filler (top) and filler types and usage*

[1] Handbook of Paper and Board, Herbert Holik, 2006.

Correlation between Smoothness, Paper Filler and DEP print quality

DEP printing requires a good contacting surface on the paper to ensure good printing quality. Toner particles are fused onto the paper surface to generate images. SEM image on good quality fused toner particles and un-fused toner particles are shown on Figure 2.

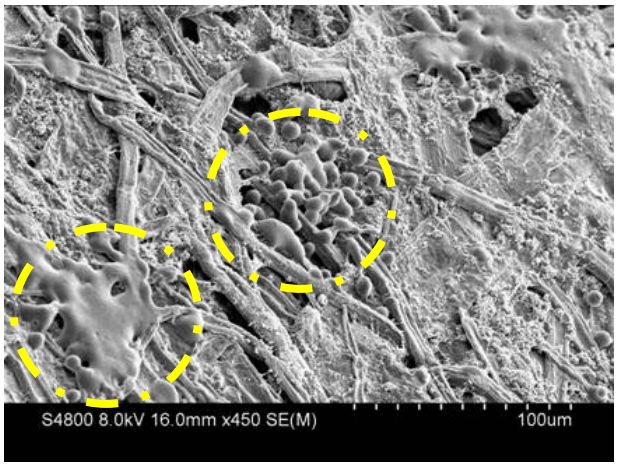

Figure 2. *The two highlighted areas in this image depicts good quality fused toner particles at lower, left area and poorly fused toner particles (mostly un-fused) on the upper, right area.*

The demand for good contacting surface for DEP translates in the required paper specification of **smoothness** and **filler particle size**. The requirement for smoothness is an obvious, short-term (immediate) specification related to the print quality related to the toner transfer and fusing step in DEP – while the specification for filler particle size ensures reliability and longevity of the printer in long-term, ensuring print quality performance at optimum level at the lifetime of the DEP printer[2].

Bigger (or More) is NOT Better

The size and amount of large particle size in paper filler content is correlated to relative printer wear. Any parts directly coming in contact with paper, such as pickup roller, fuser roller, and pressure roller, are at risk of premature wear due to filler particle size issue. The higher the amount of large particle size paper filler, the more printer wear is seen. Filler particle size and the content (by weight) are correlated to printer wear as shown in Figure 3

Wear on the pick-up roller, fuser roller, and pressure roller are correlated directly on the print quality and reliability of the printer performance. Worn pick-up roller will cause higher jam rate and sheet-feeding problems. Worn fuser roller and pressure roller will cause poor print quality due to poorly fused toner particles or absence of toner (in a more severe case) in worn or damaged area.

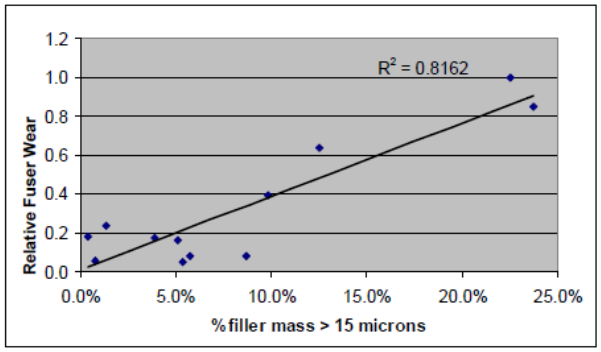

Figure 3. *Correlation between large particle filler content and printer wear.*

Trend in Filler Usage

An increasing trend in the amount of filler content (by weight) is observed in office paper, as shown in Figure 4 below. Furthermore, the amount of larger particle filler content is also increasing (by weight). This alarming trend is correlated to lower reliability, lower print quality, and shorter printer life due to the abrasiveness of the paper to parts of DEP printer that are directly in contact with paper.

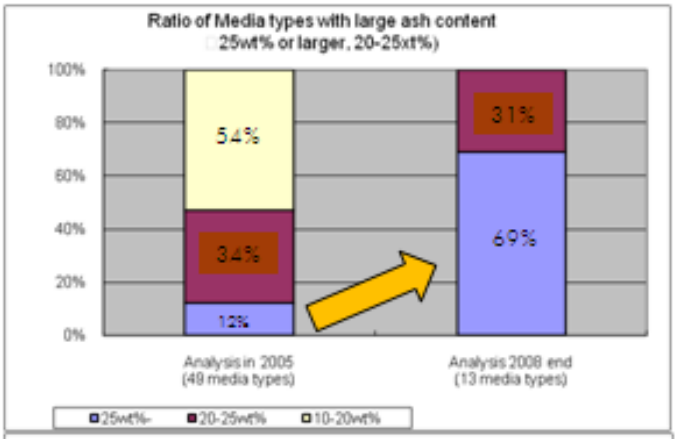

Figure 4. *Trend in filler particle size and type in Asia.*

The impact of larger filler particle size to DEP printer's parts is displayed in Figure 5 below.

Figure 5 showed the non-stick surface of the fuser roll being damaged by constant abrasion of the papers to the fuser roll. The absence of uniform, non-stick surface on the fuser roll caused toner build-up on the roll, seen as the grey material wrapping around the roll.

[2] Worn parts might translate to poor print quality, e.g. abraded toner fuser roll surface will translate to printing defects

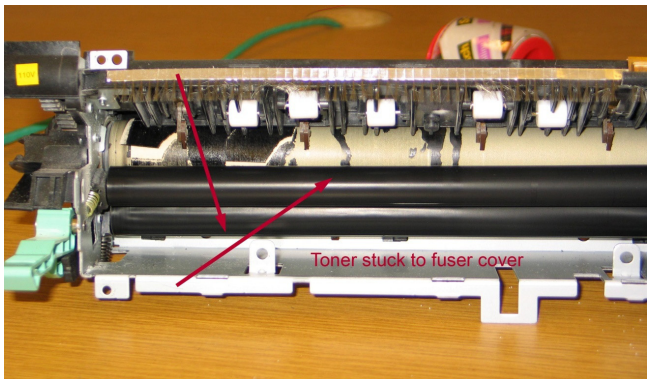

Figure 5. *Visual observation of worn fuser rolls after only 50,000 pages printed of a Non-ColorLok paper with large filler particle size on high weight content.*

ColorLok® and Laser Printing

As described above, there is a strong correlation between paper filler particle size and DEP print quality, reliability and longevity. ColorLok recognizes this relationship and include specifications targeted for DEP platform in the program.

ColorLok specifications related to DEP-related attributes are described below:

1. control maximum allowable amount of large filler particle size weight content

2. control maximum paper smoothness value (NOTE: lower number means smoother paper).

The design of DEP printers has reliability and longevity embedded in the technology itself, ColorLok specifications will help to ensure these are fully passed onto customers through their actual printing experiences.

The driving force to improve print quality and printer life will be greatly dependent on how well digital printing industry and paper industry can engage more and work together in the future. ColorLok is one way to enhance this engagement and ensure better future for office printing industry.

Acknowledgment

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Author Biography

Stoffel's career at HP began with projects involving plasma enhanced vapor deposition of silicon carbide, silicon design, printhead construction, and ink formulation for PaintJet, HP's first color ink jet device. After PaintJet was successfully introduced, Stoffel directed his efforts primarily to ink formulation, becoming a Senior Member of the Technical Staff in 1991, a Project Manager in 1993, and the Hewlett Packard Ink Jet Ink Technology Manager and Master in 1998. As a member of special product development teams at HP, he took part in the creation of the first color ink jet inks for HP printers; the first pigmented black ink jet ink, the black ink used in the HP 45 cartridge, and, the first six color set of ink jet photo inks. John Stoffel holds over 28 patents relating to ink jet ink, media, and printhead design.

In 2005 he was promoted to Distinguished Technologist. His responsibilities included managing Hewlett Packard's inkjet ink technology roadmap and investments. In 2005, John led the HP team that worked with International Paper to introduced ColorLok media across HP Everyday Paper. In 2007, Stoffel moved to the HP Media supplies and Solutions Division as the position of Director of Research and Development. Under his leadership, groundbreaking photographic media for retail photo printing and coated media for HP's web press were developed. In 2010, John moved to provide technical support for both ink and media roadmaps and investments.