

Toner-based Digital Printing Technologies for Commercial, Transactional and Industrial Printing

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Abstract

Toner-based marking technologies in production printing apply in 3 areas: transactional printing, commercial printing and industrial printing. Each area is imposing specific requirements as well on the marking engine as on the toner and on the front-end. One of the main advantages of toner-based printers consists of its intrinsic "offset" character, meaning that at least one intermediate member is physically separating the inking or development process from the transfer/fixing of the image on the final carrier. This opens the printing process for a much wider choice of printing media and improves the up-time and the performance. The never-ending question whether the future is dry or liquid, will remain unsolved as there are advantages for both.

Printing Going 100% Digital?

Although still a minor player in the printing field, all market studies agree to predict an accelerated growth of digital printing. This is mostly due to an enormous market pull. Today, the pre-press workflow is largely digitized, including plate-making. Direct-to-paper is the next logical step as was confirmed at DRUPA 2000. It will link-up the professional printer with the e-printing society and the dot-com business. There is simply no excuse to stay back: everything becomes digital, even the traditional offset press is offered with a PostScript input and CIP3 interface. Variable data applications, more demand for short-runs, applications related to e-business or Internet, all this will push the printer to invest in new printing technologies, enabling real digital printing in full color.

Nevertheless..what about his current machine park?

He invested heavily over the years and still has many years of pay-off ahead. Instead of a massive switch, he will decide to do rather tactical investments in the new technology, primarily in applications that are complementary to his current business. So, this transition to digital will be more like an evolutionary process, take probably a generation for it to become 100% completed.

Of course, there is also the push of the technology itself: the better the image quality, the faster the printing

process, the cheaper the cost per page, the more the pressure on the printer-craftsman to start the transition.

As far as the product offerings are concerned, we will see evolving several digital printing technologies one next to the other, each focussing especially at a certain segment or application. Whether there will be a main player (just as litho-offset did among the many other as flexo, gravure, screen..) or several important technologies co-existing, is yet unknown. But, we believe that toner-based systems have been and will remain to be a most important player in this arena.

Direct and offset printing processes

The table below summarizes in a generic way the different printing technologies that are or could become developed. Where applicable, some commercial product offerings are mentioned. The table is generated around to 2 basic classes, a classification that is consistent with conventional printing techniques:

1. the direct printing process.
2. the indirect or "offset" printing process.

In the direct printing process, the image-wise developed "ink" is immediately transferred towards the print medium. In the offset case, the "ink" is first applied (image-wise) to an intermediate medium before being transferred to the final medium.

In the offset process 2 steps of the printing process are separated or split:

1. on the one hand the development of the image with ink/toner.
2. on the other the transfer to the substrate and subsequent fixing.

Splitting allows a better control of each individual step. It allows to optimize the image quality, the performance, the reliability, the uptime, the cost per page, whilst keeping the flexibility of different types and weights or substrates. This kind of flexibility is very important in production printing where a large variety of substrates is requested. The offset process also keeps the abrasive dust-polluting substrate away from the delicate image generation modules. This enhances reliability, consistency and life of the critical printer components.

Table 1. Classification of marking processes.

	Direct process	Offset process
"Liquid toner"-based	Electrostatic or electrographic printer/plotters	Electrophotographic printes, cat. I (OPC only) Electrophotographic printers, cat. II (using intermediate "blanket", ex. Indigo-process)
"Dry-toner"-based	Tonerjet	Electrophotographic printes, cat. I (OPC only) Magnetographic printers Electrophotographic printers, cat. II (using intermediate "blanket", ex. Océ-process, Xerox 2060. Nexpress)
Thermal	Thermal printers	
Inkjet	Inkjet printers	

On the other hand, the direct process is simple and straightforward, allows excellent image quality and speed, but... only on well chosen, qualified and clean substrates. While the initial investment cost will be lower and the maintenance simpler, the set-up is much more fragile: the aggressive paper is in many cases rubbing against and wearing off the expensive heads, hence limiting life-time or creating clogging or contamination problems. In brief: the direct process is very well suited for low volume work (home, small offices) or for special applications where one can live with a restricted choice of special (=expensive) substrates.

For electrophotographic processes the OPC is always acting as an intermediate carrier. However, because of its fragility, it does not allow to take full profit of this split between development and transfer/fixing. Therefore, you see more and more printers coming up using an additional intermediate member, a kind of blanket, that takes the image from the OPC and transfers it further on to the final substrate. Then the offset process comes fully into play. Aside from creating a distance between OPC and paper, the "blanket" may get other functions as well for conditioning the ink/toner image before it is transferred. For example the ink/toner image can be pre-heated to remove excess carrier or to make it more compact or less viscous for better fixing and for denser images (less toner coverage for similar densities). This intermediate image can also be used for final quality inspection or proofing of the image to be printed (density, color registration, dot gain, etc.). If the quality is not OK, the image is simply wiped off from this intermediate carrier without spoiling paper.

Interesting to see the empty boxes as well. Combining an offset process with inkjet or thermal print-heads may very well result in new printer generations with better control of inking (evaporation of solvent before application to paper), with more versatile use of different kind of substrates (e.g. textured papers) and with a far greater endurance (no contamination of head by paper dust).

Future of Toner-Based Marking Technologies

Production printing basically splits up in 3 application areas: transactional printing, commercial printing and industrial printing. Each of these areas is highly different, not only technically in the way that the print application is processed, but also in the workflow and the printing environment. If it comes to the printing itself, each area will impose specific requirements as well onto the marking engine, as on the consumable or the front-end. Let us see what the chances are for toner-based machines.

Transactional Printing

Transactional printing means printing from databases for applications ranging from statements, ticketing, security papers up to direct-mail materials. This segment will gradually move from B/W to color. There is also a migration from the 240/480 dpi standard towards 600 dpi graphic arts quality. Transactional printing means pure variable data. Web presses are preferred for reliability reasons. Speed is limited primarily by the front-end; however, in the coming years we may get close to the speed limits of the marking technologies (200 m/min for B/W magnetography, 100 m/min for B/W electrophotography, 50 m/min for color electrophotography). Because of its convenience, the reasonable image quality and the machine reliability, dry toner will prevail. Smaller particle size (5 to 6 μm) and liquidizing fusing techniques will drastically reduce the toner usage per copy and hence cost per page. With in addition a very good printability on many commercially standard papers and even more exotic synthetic media, the toner-based systems (using intermediate blankets) will clearly remain a serious challenger of the high-speed continuous inkjet, even in low image quality applications.

Commercial Printing

Commercial printing covers everything between traditional offset (and its digital hybrids) and larger office copiers/printers. In the former case digital marking technologies bring the advantage of an economic short-run

duplication with personalization capability, in the latter case they offer significant performance and quality increase in print-on-demand or electronic collation applications.

1. For the short-run market, there can be no compromise on image quality: offset look and feel is the one and only reference. Liquid toners and electro-inks do have a distinct advantage over dry toners, but we might see an evolution from the current Isopar-solutions to sophisticated organic or even water-based electro-inks. The challenge is to keep the machine simple, reliable and not too expensive to allow a widespread use over the multitude of small print houses. Sheet presses offer the greatest flexibility with regard to instant paper type choice and the possibility to run very short runs or proof runs. We may see more and more a merger of offset printing technologies with plate-less digital ink processes. In terms of resolution and addressability, there will be a clear shift to 600 dpi-multitone and beyond (1200 dpi).
2. Print-on-demand or electronic collation requires a combination of features from transactional (convenience and reliability, low cost per page, high throughput) and commercial printing (image quality, paper type flexibility). We will see a major shift towards color for manuals, reports, newsletters, catalogues while B/W P-O-D may further penetrate in book-printing applications, mainly through e-commerce impulses. Front-ends will focus on dynamic book streaming/collation linked to Web-based workflow solutions. Dry toner electrophotography used on sheet or web presses will remain dominant in this area, because of its reliability, convenience and good price/performance. Use of intermediate “blankets” may further enhance durability and reliability.

Industrial Printing

Industrial printing includes areas as packaging and label printing, decoration printing, textile printing, printing of laminates, The variety of printing substrates - size, thickness, relief, material type, ... - makes it a playground for many different printing technologies. While this segment is the traditional home-base of the electrostatic

plotter/printers - mostly based on liquid toners -, it is certainly the strongest segment for the large variety of inkjet printers. But, there are also many opportunities for toner-based marking. Aside from the advantages typical to digital printing, the assets are an excellent combination of high image quality and throughput, a well proven up-time even in harsh environmental conditions, reasonable investment costs. In addition, there might be more unique elements, like a specific match between the toner polymer and the base material, or an ecologically friendly alternative to solvent-based inks, or the possibility to add a new security feature in PVC-cards or passports.

Conclusion

When it was discovered, just about 100 years ago, that ink could be more reliably controlled if it was printed in offset, it meant a real revolution in process printing. For toner-based marking technologies this indirect method is intrinsically incorporated. Use of intermediate “blankets” can even enhance the “offset” capabilities as this blanket may act as a conditioner for the ink/toner. New toner formulations (as well in liquid as dry) will lead to offset-like image quality, convenience of copiers, very low cost per page and reliable and fast printing presses.

Biography

Dr. Jan Van Daele is Senior Vice President of Research and Development for Xeikon N.V. in Mortsel, Belgium. Xeikon is the world leader in digital production printing presses offering as well digital color presses as high speed B/W printers.

Prior to joining Xeikon, he held several management positions at Agfa-Gevaert in the development and marketing of digital imaging products, such as graphic arts scanners and medical film recorders.

He received his Master of Science degree from Leuven University in Belgium in 1976 and was awarded a PhD in electronic engineering from the same university in 1980.

Dr. Van Daele is the author of numerous papers and patents in the field of digital image scanning and processing.