Materials for In-line Protection and Expanded Color Gamut of Electrophotographic Prints Using Fifth Imaging Module

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Abstract

Images produced with digital color presses are now being generated for many novel applications that were earlier considered not possible with xerographic process. In order to make endure that such solutions feasible, they need to be economical and easily adaptable without affecting workflow. For typical digital presses that have only four-color imaging modules, option of providing protection by applying clear toner overcoat is not available. When additional modules are available, such as with NexPress 2100 digital color press, the fifth module can be utilized to provide in-line solutions to meet some of the new needs. For example, an Intelligent Coating using clear DryInk can provide better print abrasion and scuff resistance. Such a coating also provides resistance to damage caused during mailing process. Most photo rich applications also require much higher gloss as well as more protection against light fade. Variety of solutions that are possible with the availability of fifth module will be discussed.

Introduction

Color reproduction with a four-color process delivers 45 to 55% of the standard color chips and is still not satisfactory for many applications. If digital printing hopes to make inroads into off-set printing, it has to enable print shops to create the same documents that they are currently producing with standard lithographic inks.

Most of these problems can be addressed by adding more colors to the standard four-color toners. Several digital printers are now available that have incorporated additional modules to expand the color rendering capabilities like the NexPress 2100 (Figure1).

The choice of colorant added to the mix plays an important role in realizing the expanded color gamut. All this has to be achieved within the basic requirements that are demanded from a toner so as to not affect the reliability of the machine. Selection of fifth module colorants and the benefits of the pentachrome process will be touched but is be discussed in other papers more in detail.[1-3]

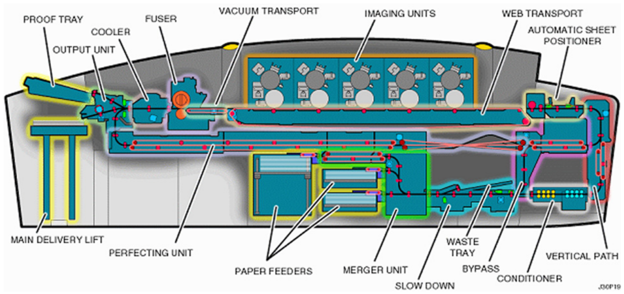

Figure 1. NexPress 2100 digital press equipped with 5 print units.

Another problem that faces digital printers is to provide adequate print protection. Unlike offset inks, toner does not penetrate the substrate and is fixed above the surface. This inherently exposes the fixed image to physical damage that can be caused by abrasion and scuffing. The damage can occur during finishing, mailing or routine handling of the digital print output. The problem is aggravated further by the fairly brittle resins used in toners in order to achieve high speed fusing and efficient pulverizing. With the availability of a fifth module in a four-color press, it is possible to use a clear toner to provide an in-line coating process that provides protection for digital prints and enhances image quality.

Color DryInks for Fifth Module

To complement the four-color process, the choice of colorant used in the fifth module is limited as many are not suitable for dry toner. Some affect charging issues - others have been cited to have heath concerns.[1]

The colorants that are often requested by a customer are blue and red with green as distant third choice (Figure 2). These colors also happen to be the ones that are very difficult to reproduce with the standard SWOP colorants. As a result, these three colorants make a logical choice for toners for digital printers with fifth module capability.

The impact of NexPress Red, Blue and Green DryInks on color gamut was measured and the results are reported in Table 1 using a standard paper with 3 dE tolerance. In these measurements, the fifth color was not used as spot color but rather as the 5th color of a pentachrome process. The results show that there is a significant increase in color gamut volume when any of these three colors are added to a standard CYMK color set. Unlike the standard dedicated spot colors, the pentachrome process can produce many more standard spot colors by mixing various levels of the CYMK colors that are already present in the digital printer. This is not only more efficient, but allows colors to be reproduced that may belong to a different color matching standard.

It is possible to change the DryInk in the fifth module so as to provide enhanced gamut in an area of particular hue angle that may be required by the printing job. With this flexibility, it is possible to match more than 85% of standard spot colors (Table 1, last line).

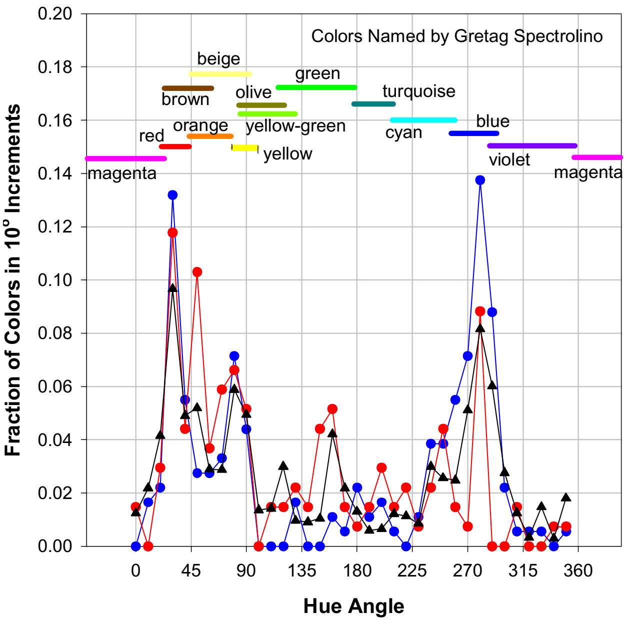

Figure 2. Distribution of popular colors shown in 10° hue angle increments

Table 1. Effect of various 5th Color Toner in Pentachrome Process

Condition	Gamut Volume	# of Std Spot Colors within Gamut	% of Standard Spot Colors in Gamut
CMYK	475070	593	52%
CMYK + 3 dE	595890	746	65.60%
CMYKG + 3 dE	682390	805	70.80%
CMYKR + 3dE	661655	795	69.90%
CMYKB + 3dE	673312	804	70.70%
CMYKRGB + 3dE	870779	972	85.50%

Clear DryInk for Fifth Module

With the availability of a fifth module in a press, a clear toner can be used along with the standard CYMK toners. Although, the clear toner would not increase the color gamut capability of the printer, it can provide several benefits. These include:

Abrasion resistance
Scuff resistance
Resistance to damage in mailing equipment
Protection during post-finishing
Resistance to food and liquids
Uniform Gloss
No differential gloss
Improved granularity
Spot Coating

Depending on the requirements, these clear toners can be electrostatically deposited in a small area of the image, or applied as flood coating all over the image. By covering the color toners that form the image underneath, clear DryInk prevents the loss of image content and thus provides protection to abrasion and scuffing. Images were tested for abrasion and scuff by using standard tests. In Figure 3, results from a Taber Abrasion Tester show the improvement provided by the clear overcoat by preventing the loss of color toner as indicated by the absence of density loss. Similar results were obtained with various rub tests[1] on images with and without the clear overcoat. The smudge resistance of the prints was markedly improved when a protective coating had been applied to the print.

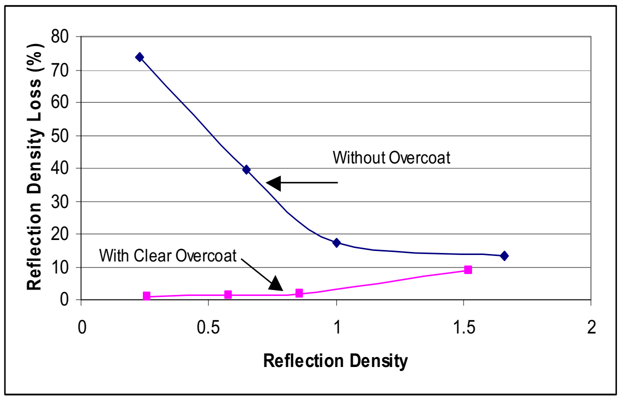

Figure 3. Results from Taber Abrasion tester showing increased image protection provided by clear overcoat.

When an overcoat of clear toner is applied to an image, the uniformity of the print is dramatically increased. For digital output, the image gloss is low even on a highly glossy paper in areas where the print density is low. This is caused by the scattering due to islands of toner present on a smooth surface. At higher densities, islands of toners grow bigger until uniform high gloss is obtained. As a consequence, the differential gloss that is commonly observed even in uncoated offset images can be overcome with the use of a clear toner overcoat.

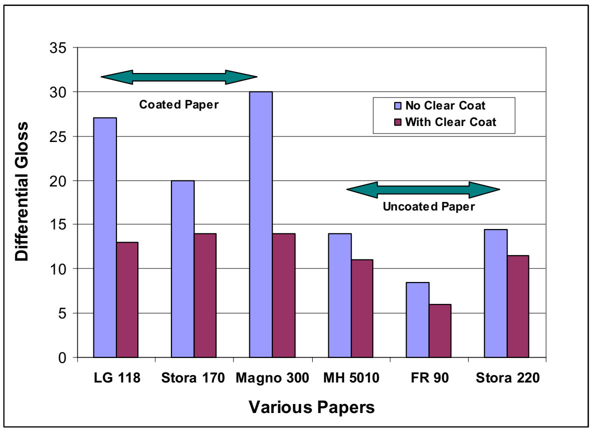

Figure 4. Improvement in differential gloss is demonstrated with the clear toner overcoat on various paper surfaces.

Effects of a clear overcoat on differential gloss are shown in Figure 4 for various coated and uncoated papers. The clear overcoat provides a uniform gloss on all types of media because a uniform coating is applied over the entire image.

Advantages of Clear DryInk

Some type of overcoat is commonly applied in conventional offset printing presses for various reasons that include quick drying for improved throughput, gloss effects and print protection. Many of these coatings such as varnish or aqueous, are applied in-line. UV coating and lamination are typically carried out off-line.

Digital prints are often not as durable as offset. Many digital printers resort to off-line laminators or UV coating devices to impart sufficient durability to their digital prints. These coatings can be applied in-house if they own such equipment, but for many print shops the job must be outsourced. For example, print shop owners, if they own a offset press, pass their digital output through it to apply an aqueous coating. Not only are these time-consuming and expensive processes, many of the coating do not adhere properly to digital images because of incompatibility.

In digital color presses that have five modules available, many of these shortcomings can be avoided by the use of clear toner in the fifth module. This provides an in-line coating capability with the most efficient workflow. By eliminating off-line coating or outsourcing, coating for digital prints can be produced in a cost effective manner. With an in-line coating process, not only are the production times and hence the labor costs significantly reduced, but problems associated with mistakes caused during multiple “touching” events are also eliminated. Since the clear toner is compositionally similar to the color toners, there is no issue of coating problems caused by incompatibility. In addition to the improved durability against various types of mechanical damage, the in-line clear overcoat also provides improved resistance to spills and stains.

If an additional near-line KODAK NEXGLOSSER glossing unit is used higher gloss than UV-coating processes can be achieved.

Conclusion

With the availability of a fifth module in digital color presses, the capabilities of the digital presses have been vastly improved. The addition of a fifth color toner allows access to large numbers of standard spot colors that cannot be reproduced by the CYMK process. The pentachrome process is superior to simply using a spot or custom color to the fifth station because it allows for much more matching of the standard spot colors. This is achieved by mixing them with the CYMK toners already existing in the digital press.

Besides the addition of a fifth color toner to print colors that cannot be reproduced by the CYMK process clear toner can also be used in the fifth module to provide an in-line process for coating digital prints. Such coatings with clear toner offer improved protection and image appearance.

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Biography

Detlef Schulze-Hagenest received his Ph.D. in Physics from Kaiserslautern-University in 1980. Since 1980 he is working in the field of processes and materials for electrophotography. He is currently Senior Engineer Advanced Technology at NexPress GmbH, Kiel, Germany. He is a member of the IS&T and serves as European program chair of this conference.