Paper and Digital Printing - What is Happening?

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Abstract

One of the benefits of digital printing is speed. This means that the demands are high on every part of the production and distribution chain, as well as interactions between papers and different digital printing techniques. Important factors are paper fibre properties, printing technology, customer demands and, last but not least, competence of people involved.

It is quite obvious that there are a number of factors that can make or brake this chain. This paper together with the posters will give the background to and explain how and why the paper fibres and hence the paper reacts during the different digital printing processes as well as during finishing. Finishing is an often forgotten but even though highly important area.

Recent results from research studies concerning how to improve and secure a high and consistent print quality will be presented. Altogether this will reveal good mixture of important basic information and new findings beneficial to all users of digital printing machinery's.

Introduction

Digital colour printing was introduced to the market by Xeikon (web-fed) and Indigo (sheet-fed) during IPEX exhibition 1993. For most papermakers the requirements on coated papers for achieving high quality printouts, came as a surprise even though there were uncoated papers for normal colour copying readily available.

This was a typical example where the communication between OEM's and papermakers was missing. This despite the fact that the OEM's quite rapidly recognised that special papers were needed for these different print techniques.

With the exception of my current company Metsä-Serla (at that time though the independent former Modo Paper company) only one more paper company was involved during test prints in October 1993 on the first Xeikon press (company PrePress in Belgium) and later on at the Indigo press.

During 1993 Indigo sold 20 presses and Xeikon 11 worldwide. We as a special paper manufacturer considered the digital printing to be an important part in the future with options of variable data and personalisation in relation to conventional offset printing. We started to work very close with the OEM:s to develop paper substrates for each technique. This co-operation with OEM's did significantly improve the understanding of different problems appeared during printing and gives joint possibilities to solve the problems at early stages.

In the later years we have also noticed and followed how the OEM's for traditional copying have introduced a new generation of "Digital Colour Copying" machines for to complete the Print On Demand sector.

Definition Digital Printing

Digital printing is defined as any print-on-demand method most economical for short runs based on digital image processing using various printing techniques without an intermediate step (e.g. plate making), providing the possibility to make each print different.

Definition Digital Printing Papers

Digital printing papers are special papers with optimised surface treatments and paper properties designed to obtain excellent print quality and runnability in digital printing processes.

Xeikon Technique

Xeikon is an electrophotographic dry toner technique with demands similar to copy printing. Important properties for this machine are electrical conductivity, surface energy and moisture content. As this machine is web-fed and prints both sides, during one pass through the machine, the electrical properties are even more difficult to define than for a normal copier.

Agfa, at that time, was and still is, the major producer of toner and we started an R&D project together. The aim was to create best possible "window-settings" for both uncoated and coated papers. In order to do that we concentrated on electrical conductivity and surface energy as well as paper fibre properties in relation to humidity.

This was not an easy task and required a lot of attention and competence from both sides. During the cause of our common development activities we experienced several difficulties but simultaneously also developed significant improvements.

From the paper side we applied the knowledge from the uncoated copy paper with emphasis on high dimension stability together with the high competence in coating technologies. The major findings regarding the properties influencing on paper for the Xeikon printing system were:

- Controlled Moisture Content
This is required in order to ensure a uniform toner transfer as well as to prevent curl in the conditioning and the high temperature fusing process. We also know that the paper changes its dimensions the strongest in the cross direction of the web, which has to be considered before finishing. Most paper problems in the printing room are related to temperature and moisture. As paper is a living material the fibres expand or dry out and change the properties dramatically.

- Very Smooth Surface
High stiffness and smoothness improves runability and the production of a good image. Very rough surfaces can cause incomplete fusing (not completed) and bad printed image quality.

- Low Dusting
Another important precondition is that the paper is dust-free since loose particles can degrade/deteriorate a good image.

- High Stiffness at a High Surface Gloss
When coated paper was introduced, the same substance as for uncoated papers was behaving completely different due to the filler content. The coated paper had a lower caliper as well as a lower stiffness. This caused some problems when using lower substances and particularly when a glossy surface was introduced.

- Resistance Towards High Temperatures
Due to the high fusing temperature another problem also occurred when using coated papers due to that the coating itself became soft and stuck to some parts in the machine. This led to significant changes in the coating formulations in order to avoid softening at high temperatures. The tests also gave experience on how the fusing temperature could cause blistering and curl.

- Correct Surface Energy

- Flatness After Printing
Using coated paper substrates in high substances became more and more interesting to produce postcards and business cards. The big challenge for both paper supplier and Xeikon was the stiffness, friction and conductivity in relation to the toner transfer. As the paper web is quite stiff, it is not that easy to get the right contact to the drums.

In addition to these properties we also found out that we needed to control some other properties such as

- Controlled surface resistivity
- No crease in folds
- Moisture resistant wrapping

The research to give correct resistivity and surface energy showed how important the absolute moisture content and smooth profiles were together with a very special affinity to get a high quality printed image.

Different paper qualities were re-conditioned in different humidity and the equipment we used for measurements was the Model 6105 Resistivity Adapter (ASTM standard). This is a guarded test fixture for measuring volume and surface resistivity of materials when used with a regulated power supply and an electrometer.

All individual substrates have to be properly tested to produce a unique script file. Every change/improvements of a substrate has to be re-qualified. Independent institutes do this.

Finishing is often forgotten but a very important area. The operator has to plan this from the very beginning. Will it be brochures or folders, postcards, invitations, illustrations from catalogues, menus, gift vouchers, tickets etc? The very first consideration is if the paper will be folded. The right grain direction (fibre-orientation) must be selected due to the layout! How many pages will it be? If high substances are used the paper should be pre-scored before folding for achieving the best result. The next step could be varnishing of the cover for the brochure. There are obviously a lot of things to consider which can make or brake this chain.

Indigo

The Indigo technique utilises wet toner and an electrophotografic process using electro ink. The Electro ink image is transferred from the photoreceptor to a rubber blanket and then, applying pressure, the heated blanket transfers the image colour by colour to the paper, which is held perfectly in position by grippers.

From the papermakers point of view this is very much a similar process to the offset printing process.

The toners look very much the same when magnified (see poster).

Paper demands for the Indigo printing process are

- Correct surface energy to the Electro ink
- Good oil absorption
- Good surface strength
- Very smooth surface
- Low porosity
- Long or short grain direction depending on substance
- When duplex, 100 % square sheets with perfect cutting
- Relative humidity of 45-55 % (Like offset-printing)

The most critical properties related to this printing process are surface strength, surface energy and oil absorption. Almost all uncoated papers and most of the coated papers have to be Sapphire surface treated before printing to get a good toner adhesion. Otherwise it is very easy to peal off the "toner-film".

As a paper manufacturer we investigated and tested different coating formulations based on the knowledge we had from the offset printing. From these tests we developed a recipe for a coated paper with matt and gloss finish suitable for this type of digital printing technique. The goal was to offer a wide range of substances as Indigo focused very much on the "commercial printing" business.

Coated paper was and still is in favour of uncoated due to the surface smoothness that will give a very good print result with high density and small variations.

This printing technique with a straight passing of the sheet through the press makes it much easier to use higher substances. On the other hand lower substances can be very difficult due to the feeding technique (vacuum). In that respect a paper with very low porosity is needed but also the correct fibre orientation to get the optimum runability.

Another important property is static electricity and hence doubles feeding, very often caused by low humidity.

Finishing is of very high importance for this printing technique as well. The same paper properties have to be considered as for the Xeikon operation.

Digital Colour Copying

In recent years, the market growth of short run colour copy printing in favour of black and white has been dramatic.

To meet the competition from suppliers such as Xeikon and Indigo the major OEM's have introduced a third opportunity of sheet-fed digital printing using a different technique for the Print On Demand market including variable data and personalisation.

The colour copiers have consequently become digital, being able to use a wider range of products and substances as well as larger sizes (up to SRA 3). Most of the substrates can be printed duplex even up to 220 g/m^2.

New techniques with new toner transfer, new toner quality and fusing with lower fixing temperature has been introduced to produce high print quality.

The resolution is in the area of 600x600 dpi and even higher has led to a printed quality very close to offset printing.

Another important factor is that less amount of silicon oil is used to print a high quality image, which supports the duplex side as well, in particular for coated papers.

Substrates used in the colour copying have mainly been uncoated qualities in lower substances. But with the introduction of the new generation machines and the challenge from commercial the printing market, coated qualities like those used for offset printing were needed.

As the printing technique is xerographic with dry toner and relative high fixing temperature the paper has to be manufactured with strict control of the humidity. The paper has to be resistant to curl and cockling, as well as having a very good formation, high rigidity and smooth surface together with correct conductivity and surface energy.

To develop a coated paper for this process we used some parts of the development related to the Xeikon substrates but still more developments were needed to produce a quality for the print providers to cover the range of new machines. Availability of copiers and printers in areas where humidity can vary from 10 to 90% RH increases the demands on the paper significantly.

Together with our R&D different papers and coating formulas were produced on a pilot coater, test printed on the major OEM-s digital colour copy machines before we reach the final product.

This work was very time consuming and requested a lot of efforts from parties involved. All earlier mentioned properties had to be tested step by step for each correction done. As an example we could easily see how improper moisture or coating formulations created difficulties of the final copy.

The challenge was to produce a fully coated glossy paper surface with the already mentioned requirements. The range of paper grades will be shown at the "Poster Session".

Print Quality

High print quality consist of

- Even density and toner coverage
- Good colour reproduction
- Good " dot sharpness "
- No miss-register between the colours
- Gloss without variations

The level of the print quality varies depending on the resolution but also due to the printing technique and kind of paper. There are different paper demands for different printing technique. There is not one unique paper for all methods.

Another very important factor is the skill of the operator. It is important to understand how ICC profiles and Script files should be used. Some paper knowledge is also needed.

We have seen a dramatic quality improvement during the last two years in the digital printing area both from the OEM's and the paper manufacturers.

Printed samples, bad and good ones from our tests with the presented techniques will be shown at the "Poster Session". I would also like to refer to another "poster session" in this matter and that is

A comparison of Print Quality Between Digital, Offset and Flexographic Printing Presses Performed on Different Paper Qualities by Mid Sweden University.

Conclusion

The answer to "What is happening" is that the digital printing for Print-On-demand is here to stay. We see how the new digital machines, mainly used by Copy-shops and Pre-press companies until now, have been

adopted by commercial printers for small runs with personalisation. The printing press manufacturers have launched digital presses to complete their portfolio of products.

The development goes faster and faster. The results from all techniques are "sufficiently good". The technique is interesting for the printer - the application for the customer. The market demands related to paper substrates are for a wider range of qualities, more substances, smoother surfaces for a minimum 600 dpi resolution and more sizes.

It is also quite obvious that the digital printing can be divided in four major parts such as printing-on-demand, short runs, distribute and print as well as personalisation.

Print-On-Demand has also forced the logistic side at both paper distributors and digital printers to set up a Service-On-Demand.

The number of machines increases, the need of special paper for each technique is there but a very important part is that the papermaker and the machine manufacturer need to work together for further developments.

Market key trends affecting paper suppliers will be within:

- Promotional print, such as direct mails, manuals and brochures
- Commercial work, requiring short runs and fast turnarounds
- Publishing, books-on-demand, maps and newsletters
- Business forms area for bills, statements and forms

For digital printing systems we foresee a general growth in use of coated papers.

Digital printing is still in the beginning of a new era and there will be a very exciting future to come due to rapid ageing of information, finding new ways of addressing customers, wide application spread (one to one marketing).

There is still a need of information/education for end users/consumers to learn how to use this technique. Digital print will gain ground from traditionally printed products. A PIRA international study of Digital Printing - technology forecasts to 2005 – estimates that whereas digital printing currently has 9% of the market share of printing technologies, this will rise to 20-25% by 2010. This is a big change from conventional production and will radically change the printing industry.

Biography

Ingvar Lamperth is Sales Director for Speciality Papers at ModoPaper AB, Silverdalen Mill in Sweden, today owned by Metsä-Serla. He graduated in Jönköping as Technical Engineer specialising in pulp and paper 1968. Between 1969 and 1996 he worked as a Production Manager, Technical Services Manager and Product Manager including sales support at the Silverdalen Mill. Since 1997 Mr. Lamperth is Sales Director for speciality papers world wide including responsibility for OEM contacts within digital printing.