Solutions for Digital Textile Printing

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Situation and Trends in Textile Printing

Textile printing metrages are becoming shorter and shorter. To keep pace with this trend, new, cost-effective printing techniques are required.

Around 85 % of printed fabric is currently produced by screen printing on rotary (61 %) or flat (24 %) machines. Most of the rest is gravure-printed and a very small percentage (1 %) is hand-printed. A total of around 26 billion m² of printed fabric was produced in 1996. Common to all these textile printing methods is that printing screens are required to transfer the design to the substrate, one screen per color. The main substrates used are cotton, polyester, regenerated cellulose and their blends.

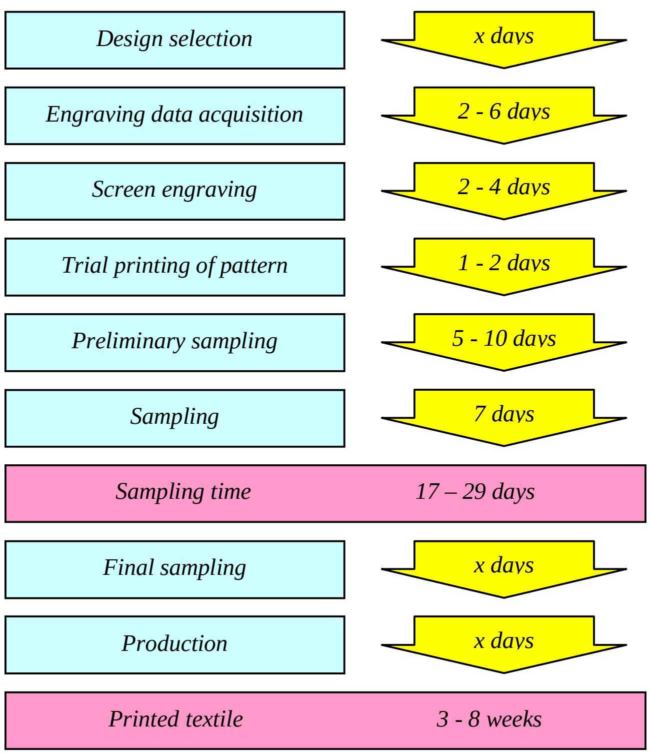

Figure 1. Operating sequence in textile printing

Fig. 1 shows the individual process steps involved in producing the printed textile and the average time required for each step. It is apparent, that more than half the production time is taken up in preparation for the printing process (preparing gravure data and printing screens) and in sampling. The textile printer also takes a considerable risk in creating a new design. Experience shows that only about 40 to 60 % of new designs result in sufficient orders to recover costs.

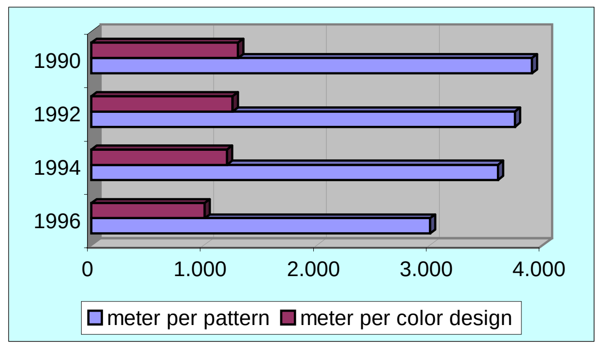

Figure 2. Average printing metrages

On the other hand, the fashion trends are for textiles with ever more exclusive and original designs. Add to this the reluctance of resellers to take risks and the result is increasingly short metrages per pattern. In Europe printing runs have fallen well below 1,000 m per colorway and are still declining (Fig. 2).

Textile printing processes and machinery have changed little in recent years and do not offer much scope for further rationalization. Consequently, there has been a search for alternative, cost-effective printing techniques, especially for sampling. Obvious candidates are the digital printing techniques that have already proved successful both in the workplace and the home.

Digital Printing Process – State of the Art, Possibilities and Limits

Digital printing processes can provide an immediate impression of the design as soon as it has been created, either on paper or, more vividly, by printing it on the intended textile substrate. Which digital printing processes are most appropriate?

Electrostatic printers generally use solvent based toner systems and achieve printing speeds of up to 100 m²/h. However, since this technique is limited to paper, its only textile application is transfer printing.

Ink-jet printers are much more versatile. In addition to a high resolution of up to 1440 dpi, they offer good reproducibility and stable flow characteristics. A disadvantage is the low printing speed – currently 1 to 30 m²/h, however, the fastest printer now available operates at up to 1 m/min with a printing width of 1.6 m, indicating that a substantial increase in printing speeds may be expected in the near future.

Table 1. Digital Printing Techniques

Electrostatic	Ink Jet	
	Drop on demand	Continuous flow
• Special paper for electrostatic printer • Toners based on organic solvents • Production of charged, latent image to which toner is applied • Print width up to 1.37 m • 400 dpi, no gray levels • up to 100 m²/h	• Paper and textiles • Water-based ink systems • Drop on demand • Print width up to 1.6 m • Up to 1440 dpi, • 1 to 100 m²/h	• Paper and textiles • Water-based ink systems • Continuous drop production; selection from drop stream during printing • Print width up to 1.6 m • Up to 200 dpi, gray levels • Up to 1.3 m²/h

The demands on digital printing processes are nonetheless high. The initial objective is a significant reduction in sampling costs, however, the technology also needs to be simple, reliable and yield reproducible results – naturally for only a small capital investment. Screens should not be required. Finally, the printing results obtained in sampling by the ink-jet technique must agree with those obtained by the conventional processes generally used in today's printing plants.

In ink-jet printing the digital image is made up of a large number of pixels, which in turn consist of a large number of dots. How are color levels and, in particular, gray levels produced in such a system compared with conventional printing processes?

In textile printing premixed colors called "spot colors" are used. The number of colors theoretically has no limit, but technically is held back by the number of screens that can be employed in the printing process at any one time. Ink-jet printing on the other hand involves a limited number of "process inks", which are used to mix all the required shades directly on the substrate. The number of possible shades is determined by the number of dots below the resolution limit of the eye that can be printed per color.

The way in which different shade depths are produced on the textile substrate is also different in ink-jet printing from that in conventional printing. In conventional methods the depth of shade is varied simply by changing the color content of the print paste. Since ink-jet printers generally use only process inks with fixed colorant concentrations, an alternative technique, known as "dithering", is required. Combining many dots in a pixel allows different gray levels to be obtained. It follows that image resolution is one of the key quality criteria for ink-jet printers. As well as viewing distance the resolution determines the number of possible color and gray levels.

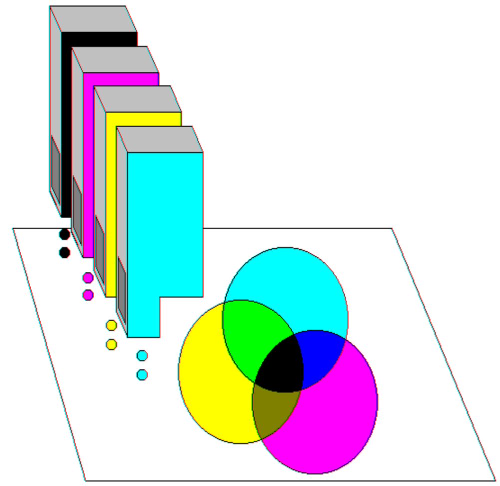

Figure 3. Creation of color

New Developments in Ink-Jet Printing

BASF has long been one of the main suppliers of textile printing products, offering the textile printing industry a broad range of products – the Helizarin® system and the Indanthren®, Procion®, Palanil® and Bafixan® dyes – for virtually every substrate.

Development work initially focussed on the drop-on-demand process. The target was to meet the demands of the textile printer described in section 2 by developing inks that had perfect flow characteristics on all drop-on-demand printers and yielded the same printing results as those of conventional production

At the 1998 General Meeting of the VTCC in Baden-Baden, BASF presented its Bafixan® inks as a first solution to the requirements of digital textile printing. This article takes a closer look at a new range of textile printing inks, the Procion® inks.

Like the Procion® dyes, the Procion® inks are water-based formulations. Minimal inorganic content and high purity ensure excellent flow characteristics and prevent blocking of the jets. A good indicator for the flow characteristics of the Procion® inks is the cogation test. Approx. 10 million droplets are printed through each nozzle of the print head and the average droplet weight is determined after every one million droplets. It is essential, that this weight should not change significantly during the test period if a reproducible shade is to be obtained.

The results of this test are shown in Fig. 4. It is clear that there was no decrease in droplet weight over a test period in which 10 million droplets were passed through each ink-jet nozzle. This confirms the reliable flow characteristics of this new ink development.

With reactive dyes there is always a risk of hydrolysis of the reactive anchor. A 3-week storage test at 50°C was therefore carried out to test the inks long-term stability. The fixation performance of the reactive dyes served as a parameter for characterizing this stability.

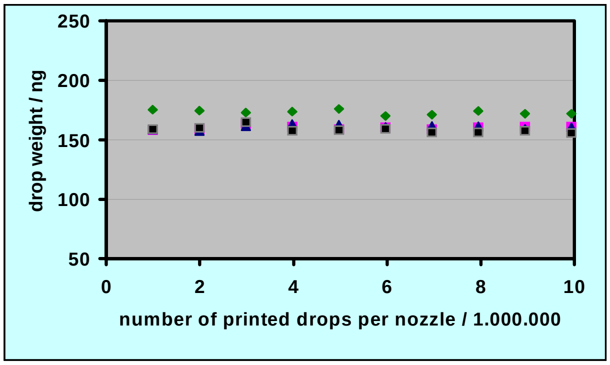

Figure 4. Flow characteristics of Procion® Inks

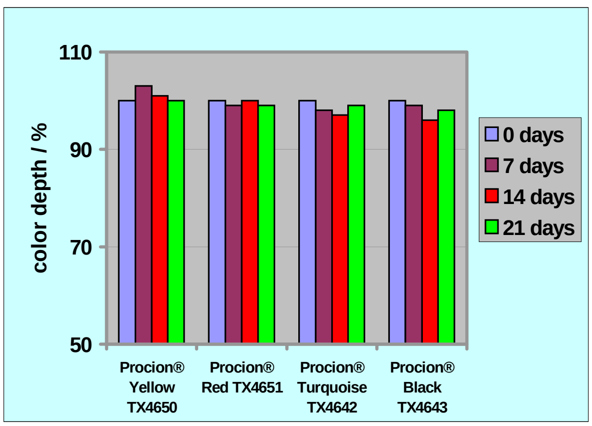

Figure 5. Fixation performance of Procion® inks after storage at 50°C

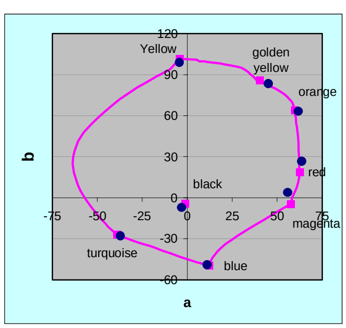

Figure 6. Color space comparison

Fig. 5 compares the depth of shade after storage at 50°C with increasing periods of time. The final values indicate no color loss, confirming the excellent stability of the new development and guaranteeing reproducible printing results over an extended period.

Of crucial significance in ensuring agreement between the results of digital sampling and conventional production is the attainable color space. Fig. 6 compares the color space that can be obtained in ink jet printing with the color space obtainable with conventional Procion® dyes. The color coordinates for both dyes and ink are virtually identical. This is a prerequisite if the results of digital patterning are to be comparable to those of conventional production.

To ensure reproducible results, the textile should be pretreated. Pretreatment must be such that sharp dots and a high fixation level are obtained. Ink-jet printing is followed by the fixation and washing-off operations usual in reactive printing.

Printing Applications

Agreement between the results obtained by digital and conventional production is now state of the art (cf. Melliand 11/12 (1998), p. E 235). It is one of the prerequisites for applying the ink-jet technique to textile printing. The hardware and software requirements have been met, as have the requirements for inks adapted to textile applications.

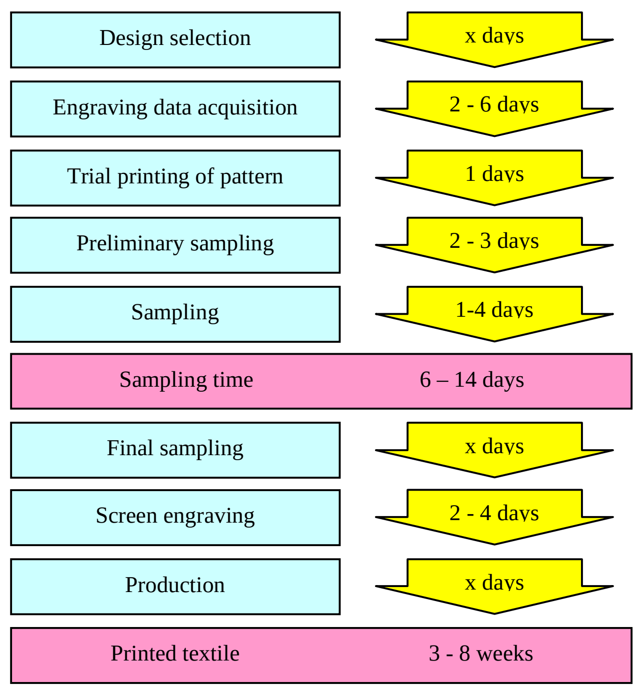

Figure 7. Operating sequence in digital textile printing

A comparison between conventional (Fig.1) and digital sampling times (Fig. 7) shows the latter to be considerably shorter. This implies significant cost savings, because one of the more expensive aspects of conventional sampling, the engraving of screens, is dispensed with. Since screens are made only when it is completely certain that the new design will be used in production, investing in them is much less of a risk.

Summary

Ink-jet printing has become a technology powerful enough to meet the demands of the textile printer. The problem of achieving agreement between digital sampling and conventional production has been resolved. Suitable hard- and software are available at an acceptable cost-benefit ratio. Adequate reproducibility of the prints is guaranteed by inks with reliable flow characteristics.

Ink-jet printing is therefore the digital, screenless printing technique of the future. It will soon be possible to achieve greater printing speeds with no loss in quality, so that application of the technique will be extended from sampling to cost-effective production of short metrages. Bafixan® and Procion® inks that meet the requirements of the technology are available.