

Textile Printing: A Challenge for Ink Jet Printing Technology

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Abstract

For a few years, aside from the printing of carpets and banners, ink jet technology has been used successfully for printing textiles. Compared with the traditional textile printing process, the market share using ink jet technology is not yet very important. However, a market study¹ predicts a very strong growth within the next few years.

What are the requirements that ink jet technology has to fulfill?

The paper will describe the main demands and differences between the known ink jet print - mainly on papers and foils - and the textile print.

Different fibers and applications of a textile print automatically demand different pretreatment and aftertreatment processes, and the use of special chemicals and dyes as well.

Because of this complexity we can not expect one solution for the textile ink jet printing process.

This will be the challenge for textile ink jet printing.

The faster the solutions become available, the more quickly the predicted market growth will be reached.

Introduction

To produce a textile print with traditional equipment like rotary printing, a lot of expenditure of work and plenty of time are necessary. For the production of print models and for the print as such, a lot of expensive materials and chemicals are used, accompanied with the corresponding environmental pollution. Because of these reasons there is a demand for new printing technologies. A promising technology for that is the ink jet technique. For the production of carpets ink jet printers have been used for many years.^{2,3}

Textile ink jet printing for proofing systems and short run productions can shorten the total textile print production time scale, with consequently considerable savings. For the future this technique will gain much more interest for textile printing because of improved systems. In consideration of the quantity of printed textiles worldwide⁴ we can understand the market study¹ which predicts a very strong growth within the next few years. Figure 1 gives an idea about the amounts of chemicals and printers for this market.

• Printed Textiles (0,2 kg/m ² ; 2,0 %dye content)	26 billion m ²
• Amount of colorants	104,000 tons
• Necessary ink (10% colorant)	1.04 billion liters
• Printer speed (60 m/h; 1.6 m)	96 m ² /h
• Print time	10 h/d; 240 d/y
• Printed textile	230,400 m ² /y•printer
• Necessary printers	
- for 1% of total printed textiles	1,128 printers
- for 10% of total printed textiles	11,280 printers

Figure 1. Printed Textiles and Consequences

Demands of the Traditional Textile Print

In principle there is no difference between an ink jet print on a textile and an ink jet print on paper or other substrates. Whether or not a substrate needs a special treatment does not have any influence on the printing process as such. In case of a textile print which must be washed, the colorants have to be fixed with an aftertreatment process and a special pretreatment process is necessary, too. Figure 2 gives an schematic diagram.

The great differences are within the properties of the substrates and their use. Demands for the necessary chemicals, the properties of the inks, the fastness properties of the dyes etc. depend on them. Figure 3 gives an overview of existing textile materials which are used in the traditional textile printing industry.

Substrate	Pretreatment	Printing Process	Aftertreatment (Fixation/Washing)
Paper	—	✓	—
Foils	—	✓	—
Textile	✓	✓	✓

Figure 2. Necessary processes for a print

<ul style="list-style-type: none"> • Individual fibres <ul style="list-style-type: none"> - Natural cellulosic fibres <ul style="list-style-type: none"> • cotton • bast fibres (linen, ramie, jute, coconut) - Regenerated cellulose fibres <ul style="list-style-type: none"> • viscose (CV) • triacetate (CTA), acetate (CA) - Animal fibres <ul style="list-style-type: none"> • wool • silk - Synthetic fibres <ul style="list-style-type: none"> • polyamide • polyester
<ul style="list-style-type: none"> • Fibre blends <ul style="list-style-type: none"> • polyester/cellulose • polyamide/cellulose • polyamide/Lycra • polyamide//CA/CTA • and all fantasy blends

Figure 3. Textile Materials

<ul style="list-style-type: none"> • Clothing textiles <ul style="list-style-type: none"> • woven goods • knit goods • pile goods (velvet, corduroy, flock, towelling)
<ul style="list-style-type: none"> • Household textiles <ul style="list-style-type: none"> • woven goods • knit goods • pile goods (velvet, corduroy, flock, towelling)
<ul style="list-style-type: none"> • Transporation textiles <ul style="list-style-type: none"> • woven goods • knit goods • pile goods (flock) • non-woven goods

Figure 4. Textile Forms

<ul style="list-style-type: none"> • Clothing textiles <ul style="list-style-type: none"> • ladies outerwear • mens outerwear • shirts • lining fabrics • sportswear • T-shirts • underwear-shirts
<ul style="list-style-type: none"> • Household textiles <ul style="list-style-type: none"> • curtain fabrics • table linen • bedlinen • towels • upholstery fabrics • decorating fabrics • wallpaper
<ul style="list-style-type: none"> • Transporation textiles <ul style="list-style-type: none"> • automobiles • ships • aeroplanes

Figure 5. Textile Applications

<ul style="list-style-type: none"> • for all materials <ul style="list-style-type: none"> • well pretreated goods with the desired degree of whiteness, perfect absorbency and stability
<ul style="list-style-type: none"> • cotton <ul style="list-style-type: none"> • causticized at least, better still mercerized
<ul style="list-style-type: none"> • viscose <ul style="list-style-type: none"> • causticized
<ul style="list-style-type: none"> • wool <ul style="list-style-type: none"> • chlorinated
<ul style="list-style-type: none"> • silk <ul style="list-style-type: none"> • degummed
<ul style="list-style-type: none"> • polyamide/Lycra <ul style="list-style-type: none"> • relaxed and fixed
<ul style="list-style-type: none"> • all synthetic fibres and their blends <ul style="list-style-type: none"> • fixed

Figure 6. Pretreatment requirements for printing

Figure 4 describes different forms of textiles.

In figure 5 some important applications for textiles are listed.

Independent from the substrate, form or application of a textile, a very important step for a successful textile print is the pretreatment process. Figure 6 gives an overview of

pretreatment requirements for printing. For each type of fiber a special pretreatment process is necessary.

The next important step is the selection of colorants. For each type of fiber different dye classes can be used. In figure 7 combinations between fibers and colorants are described, without considering mixed fabrics.

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|--|---|
| <ul style="list-style-type: none"> • Cellulosic fibres <ul style="list-style-type: none"> - cotton - viscose - best fibres (linen, ramie, jute, coconut) • Animal fibres <ul style="list-style-type: none"> - wool - silk • Synthetic fibres <ul style="list-style-type: none"> - polyamide | <ul style="list-style-type: none"> • Dyes for cellulosic fibres <ul style="list-style-type: none"> - reactive dyes - directy dyes - pigments • Dyes for animal fibres <ul style="list-style-type: none"> - acid dyes - 1:2 metal complex dyes - reactive dyes - pigments • Dyes for synthetic fibres (polyamide) <ul style="list-style-type: none"> - acid dyes - 1:2 metal complex dyes - reactive dyes - pigments • Dyes for synthetic fibres (polyester, CA, CTA) <ul style="list-style-type: none"> - disperse dyes - pigments |
|--|---|

Figure 7. Dye classes

	Fixation chemicals	Energy
• Reactive dyes on cellulose	bicarbonate soda ash caustic soda	dry heat saturated steam time
• Direct dyes on cellulose	-	saturated steam
• Pigments on all fibres	binder	dry heat
• Acid/metal complex/reactive dyes on Wo, PA, S	ammonium salts, pH buffer acid, bicarbonate (reactive) acid doner	saturated steam
• Disperse dyes	fixation accelerant pH buffer	superheated steam dry heat

Figure 8. Fixation of the dyes

Compared to inks which are used for paper printing, inks for textile printing must contain much more colorant. The concentration of colorants within an ink jet ink for textile printing can or must be up to 15%. If the concentration can not be reached because of solubility reasons, sometimes only pale prints are obtained, even if the fabric was printed several times. After the textile printing process the colorants have to be fixed on the fabric to avoid bleeding during the following washing process. Figure 8 describes common fixation chemicals and energies for different colorants.

Finally depending on its use, a textile must fulfill different requirements which are described in figure 9.

Figure 9 also indicates that for different textile requirements different colorants are necessary. This is one reason why the traditional textile printing industry uses a lot of colorants, commonly more than 100. For each color at least three colorants are mixed together and with a modern printing machine more than 20 colors can be printed. For this type of use, an ink jet printer is limited at present. But is it really necessary for an ink jet printer? With a good color

matching system nearly all shades should be reached with 7 colors – yellow, magenta, cyan, black, orange, red and blue.

• Clothing textiles	<ul style="list-style-type: none"> • light • water • perspiration • washing • rubbing • chlorinated water • ironing • dry cleaning
• Household textiles	<ul style="list-style-type: none"> • light • rubbing • perspiration • stain removal • nitrogen oxide, gas fumes, ozone • dry cleaning
• Transportation textiles	<ul style="list-style-type: none"> • light • hot light • stain removal • dry cleaning

Figure 9. Requirements in use (end use fastness properties)

Conclusion

With the existing ink jet printing technology textile printing is possible in a sufficient quality, without doubt. Depending on the market segments which figure 10 describes, different requirements must be fulfilled.

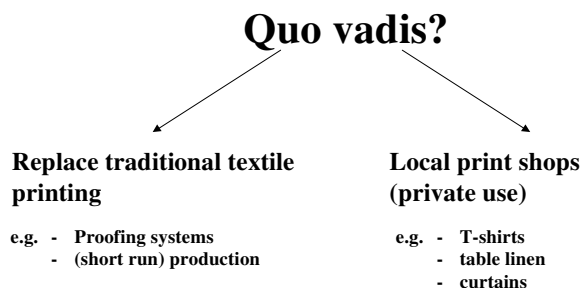


Figure 10. Future of the textile ink jet printing

For the so called "private use market" in local print shops the installation of the logistics for the different pretreated textiles must be done. Additional equipment for the fixation and aftertreatment processes must be installed.

For the most attractive market, the proofing system and (short run) production within the traditional textile printing companies, this equipment is already in place. The barriers here are the traditional ways of thinking and their wish to be independent from the ink supplier. For the future, with the desire to apply this technology, and with ink jet equipment and support which permit users to prepare inks themselves, the acceptance and success for textile ink jet printing will increase.

References

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Biography

Josef Geisenberger received his Ph.D degree in Inorganic Chemistry from the Ludwig Maximilian University at Munich in 1985. Since 1986 he has worked in the textile business unit for different departments at Hoechst AG in Frankfurt and has been with Clariant GmbH at Works Cassella-Offenbach, Germany for the last three years. His work has primarily focused on the development of colorants for ink jet applications. E-mail: Josef. Geisenberger@clariant.com