Digital Printing on Textiles; A User's Story

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Abstract

The digital printing of textiles is a market-niche in the digital printing business which only recently has been developing. Although digital printing techniques exist for quite some time for paper printing, one can say that only since the last two years there has been serious development of the digital printing for textiles. The main reason for this delay lies in the fact that only recently the right dyestuffs have become available and in some cases still are under development to make digital printing on most kinds of textile fibres possible.

If we may believe the suppliers of printing machines, software developers or even suppliers of special fabrics for digital printing, then one can conclude that the digital printing on textiles is very easy.

In this paper, I will point you out some of the possible problems which may occur during this easy operation and will let you conclude for yourself if the claims of those companies are right or wrong.

Introduction

Recently I read in a brochure of a supplier of fabrics for digital printing the following sentence:
"Just change the media … Load textiles instead of paper! Use standard printers. Use standard inks."

This may be possible if one wants to print a fabric with following "features":

- The fabric may not be washed.
- Clothes made with this fabric may not be weared.
- On all fastness tests the fabric will score very bad.
- Not all colours can be reached, in fact only 45 to 50 % of all existing colours can be printed.

These features change remarkably when the correctly pre-treated fabric has been printed with reactive dyes, steamed (fixed), washed and dried.

- The fabric has become washable.
- Other fastnesses as rubbing, dry cleansing, … score very good.
- Nearly 95 % of all existing colours can be reached.

But the above claim out of this brochure then does no longer apply, because to do this, one requires some more machines than just a printer/plotter. For the pre-treatment, one needs a stenter with a pad mangle, for the fixation, one needs a steaming unit and for the washing out a continuous or discontinuous washing machine. Furthermore, the fabric needs to be dried and brought back to the right dimensions. All this needs to be done in the right circumstances to obtain optimal results.

This is the reason why not just anyone can start doing digital printing on textiles.

In all available literature, there has been some mentioning of the digital printing on textiles, but mostly it comes down to the advantages of digital printing for the textile market such as sampling and quick response in comparison with rotary screen or flatbed printing. There is not much information available on the specific problems of digital printing on textiles.

A User's Story

During our short experience (start-up in august 2000), we have concluded that following topics are important characteristics in digital printing on textiles:

Fabric Pre-Treatment

Depending on the dyestuff-class applied and the substrate on which the print is being made, the textile material needs a certain pre-treatment before being digitally printed. The recommendations of most of the dyestuff suppliers can be followed in working out a pre-treatment for digital printing. Nevertheless, our experience learned us that nearly every fibre class needs to be divided into sub-classes. Depending on certain factors such as weight, construction (binding) and yarn number, we made 3 sub classes per fibre type (cellulose/polyester/polyamide/wool/silk)

The logic behind this was trying to get a coverage of minimum 200 % on all kind of material to be printed.

On every fabric we receive, we first try 3 different thickener concentrations and choose the concentration which allows minimum 200 % coverage or as close as possible. The lighter the fabric, the higher the thickener concentration we use. Of all other products (urea, alkali, fixing agent, …) we change the concentration accordingly. The concentration is then adopted to the pick up of the fabric in the padding pre-treatment process.

Hairiness

Because of the construction of the printing heads and the transversal movement along the width of the fabric, there is a small static charge being built on the printing head. This causes an attraction to all loose fibres which cling on to the printing head. On our printers, we have a wiping system which occasionally wipes the printing head, but is not very effective.
The closer the printing head moves to the fabric, the bigger the problem with blocking of the nozzles.

As for conventional printing, the necessity for a singeing operation remains.

Self Edges

Depending on which kind of loom the fabric has been woven on, and the binding which has been used, or in the case of knitwear, the stitch and the yarn that has been used, the sides (self edges) of the textile material do not always behave in the desired way.

Many ink jet printing machines have no self edge holders, which are to our experience a necessity to the machine. Once the printing head catches the fabric, this can be the cause of second choice in printing because of the friction of the fabric against the printing head and thus causing the blocking of some ink channels, or in some cases even serious damage to the printing machine when the fabric gets stuck against the printing head end thus prevents it from moving along.

The faster the machines get, the more serious this problem becomes.

Warp End Weft Alignment

It is not only important to keep the fabric feeding flat into the printing machine. The cloth needs to remain straight during the printing process so that a line remains a line and not becomes a curve after fixation and washing off.

One can not print with a bow or a skew unless the design is concipated so, but if the fabric warp and weft alignment is not straight during printing, even the best stenter operator can not get it straight again during the drying operation in the after treatment.

Therefore it is very important to print on straight fabric and to keep the fabric straight on the printing machine.

Once the speed of the printers will increase, the necessity to align on the printing machine will present itself.

Fabric Alignment

For fabrics with thick selfedges, the fabric is mostly rolled alternating from left to right and back again with a variation of about 2 cm. This to prevent the sides from curling up and so forming floating edges.
When printing on such a roll of fabric, it is necessary to have fabric alignment on the printing machine to ensure that the print does not vary from left to right and back again.

It has to be taken under consideration to install the same device on the winding equipment if needed.

Tension

It is commonly known that the substrate needs to be flat during printing. In digital printing, this is mainly done by putting a bit of tension on the substrate when guiding it through the machine. Many elastic fabric constructions, do not allow to be stretched during printing. Therefore, a lot of attention needs to be going to minimise the tension and to keep the fabric as flat as possible.

We have a construction with weights which can be changed and give more or less tension on a guiding bar in the feeder and the winder system. This is a system that still can be improved.

The faster the machines will get, the more important this factor will become.

Because digital printing is a printing method in which there is a movement each time followed by a pause, there is a risk in formation of printing stripes coming from tension followed by relaxation. To minimise this again the question of tension control comes up again.

Shrinkage During Printing

Digital printing techniques are non-contact printing methods where the fabric is being printed without being touched. This eliminates image distortion and does not put a lot of strain on the material being printed. Therefore digital printing does not require an aggressive fabric hold down method as encountered in rotary screen of flatbed printing.

Nevertheless, when the pre-treated fabric is being printed, this comes down to a local wetting of the fabric. Most natural fibres tend to swell upon being made wet, which causes a local shrinkage. The deeper the colour being printed, the wetter the fibres get and the more the phenomenon of shrinkage becomes visible.

Colour Standards

In comparison with dyeing, when one wants to get a colour right, for every type of fabric, it is necessary to make a separate colour standard. Recipes for colour are not transferable from one quality to another without correction.

This means that for each change of quality (and/or preparation) the algorithms used by the computer to calculate a recipe for a certain colour need to be changed. The way of calculation for the colour will stay the same, but the data on which the calculations are based are substrate dependent.

A lot of energy in software development goes into the field of colour management and in the future the approach to this will be one of the bigger differentiators for comparing software suppliers.

Steaming Conditions

Reactive Dyes

During our few months of production, we tried out different fixing conditions for reactive dyes. Dry heat fixation was one of the options because of its simplicity, and is a fixing method which may be useable for continuous dyeing and maybe even for normal reactive printing. Out of experience we can conclude that for digital printing this fixation method is not possible.

During dry heat fixing the cellulose yellows at temperatures above 120 °C. This yellowing increases with higher temperature and higher pH of the fabric. Normal dry heat fixation conditions are 5 minutes at 150 °C.

In the preparation for digital printing the fabric has been padded with alkali. The alkali on the fabric and especially on the white or light coloured parts in a design causes a yellowing during dry heat fixation that even in the subsequent washing out process never can get washed away.

At the end we settled on fixing at 102 °C during 8 minutes with saturated steam.

To our experience fixing polyester with disperse dyes, gives the best and most reproducible result with high temperature steaming. Disperse dyes tend to sublime at certain temperatures, each varying dependent from the type of molecule the dyes are made of. This means that any variation in time and/or temperature during dry heat fixation can result in slightly different colours.

With HT steaming the conditions are so that small variations of the fixing conditions do not tend to give very big differences in the end-result.

Pigments

Most digital printing technologies deposit a very thin ink-layer onto the fabric. These limits necessitate layering or several passages of the printing head over the same position before the desired image has been totally formed.

This also includes the fact that there hardly is any penetration of the ink into the fibre or around the fibre.

In pigment printing we have the experience that the film which is formed lies too much on the surface and can very easily be broken by mechanical action or a washing cycle, which results in a fabric which has very bad fastness against washing off or rubbing off.

There have been several attempts to improve these fastnesses, but without result. We have padded the printed fabric with binders, we have reconsidered the pre-treatment trying to improve the penetration of the pigment film into the fibres or at least between the fibres, but until now we have not come up with a solution to improve the washing fastness of digitally printed pigment prints.

In wet printing (rotary or flatbed), the mechanical action of the squeegee and the viscosity of the printing paste are two means of assuring the printing paste is correctly applied and surrounds more or less the printed fibres. This results in much better fastness against rubbing and even washing.

The solution for this problem in digital printing will have to be sought in the correct formulation of the printing paste, together with an adjusted pre- and post-treatment of the printed fabric.

Digital printed: surface spray

Conventional printed: Fibre is surrounded

Future

With the development of faster machines, there will be a necessity to improve the way of material transportation through the machine. Drying of the fabric after printing will become more and more important as the printing speed increases as well as warp and weft alignment .

The basic construction of a textile digital printer will consist of several appendages before and after the printing head construction.

For mixed fibre-combinations the combination of different dyestuff-classes could become possible. Maybe the possibility to print with different heads and so simultaneously print reactive and disperse dyes on the fabric will enable the printing of polyester/cellulose blends with “dyes” and thus have a print with very good fastnesses. The fabric pre-treatment and fixation conditions will have to be adapted to these changed circumstances.

Universal machines with for example multiple heads or changeable printing heads will facilitate the use of different dyestuff classes on the same machine.

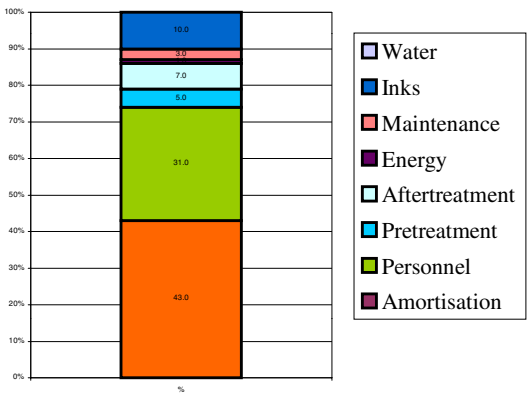
Printing Costs

A real breakthrough of digital printing on textiles will only come when the total cost of printing comes down to acceptable levels and more comparable with the costs of traditional printing methods.

The amortisation, ink costs and labour costs will seriously have to decrease and come more to the same proportions as with e.g. rotary screen printing.

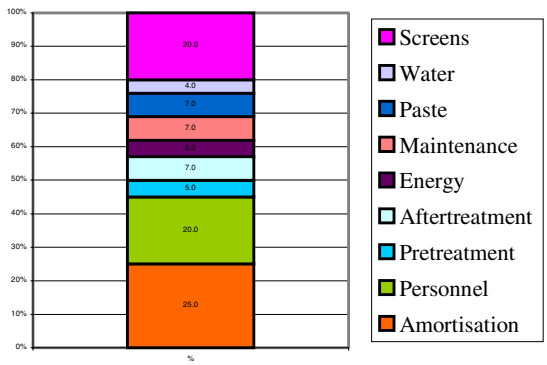
In digital printing following cost division can be made:

Relative cost of Digital printing



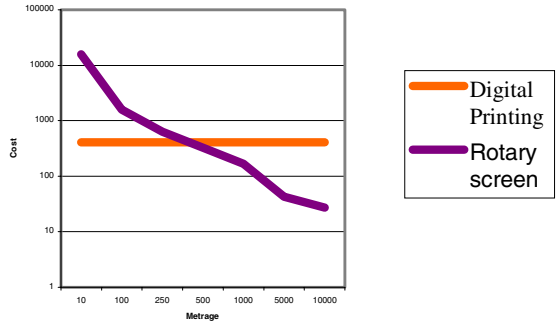
For rotary screen printing this looks totally different:

Relative cost of rotary screen printing



When comparing the cost between rotary screen printing and digital printing, for an average 10 colour print job and in function of the total printing length, following figures can be compared:

Cost Comparison in relation to total run length



Here one can see that the breakpoint between rotary screen and digital printing lies around 400 meters. If the speed of the machines in digital printing increases faster than the price of the digital printing machines, then the amortisation and labour costs will become less important in relation to the other costs, which will very quickly push the break even point over 1000 meters.

This comparison is made without taking into account the costs for warehousing and keeping of stock which is very much the case with rotary screen printed designs.

Conclusion

Market demands for reduced inventory risk, quick response, personalisation and customisation will ensure the breakthrough of the digital printing on textiles. Nevertheless, this technique will not be adaptable by anyone who wants to join the club of digital textile printers. A certain textile knowledge will be necessary to handle the variety in substrates and to correspond to the demands of the customer!

Analogue printing techniques such as rotary screen and flatbed printing will continue to hold the advantage of production speed for the next decade. Digital printing will open up possibilities which have not been deployed before, such as the printing of very complex one-off designs.

Until now the developments in digital printing were supplier driven and mainly based on the experience gained in the field of printing on paper. From now on the changes in the technology will be market driven and will only be able in close cooperation with people really printing on textiles.

The market will be a market of small series printers which are able to control the full operation including finishing to the desires of the end user.

Biography

Eric Van Tuyckom received his engineering degree in textile in 1991, promoting with a work on the environmental impact of printing with reactive dyes, for which he received the annual ICI award at that time.

After gaining experience as production manager with a commission dyer (Teinturia), he took up the responsibilities at a rotary printing plant Goeters “Ars et Labor” as production manager and started to learn about printing.

After the ITMA in Paris in 1999, the idea was formed to develop knowledge and experience in digital printing on textiles.

In august 2000, he started the first real textile digital printing factory in the Benelux under the name S.PrinT and in association with Colortex, a commission dyer in Sint Niklaas, Belgium.