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Selecting the right ink and process for digital printing –

1) Ink types an overview

Introduction

Digital inkjet technology currently accounts for roughly 1% of every meter printed in the textile industry. However, this figure is expected to rise as an increasing number of end users begin to run digital and analogue technology side by side or switch over to digital completely. Digital technology has already become an attractive choice for major textile applications, such as printing flags, banners, apparel fabrics, garments, technical textiles and point of purchase displays. While screen printing remains dominant in the textile industry, digital has particular advantages such as reduced setup costs, dramatically improved lead times and environmental benefits. Variable data, short runs and fast turnaround times are being demanded more frequently which plays to the strongest attributes of digital. As prepared for print fabrics and digital printing systems and inks continue to improve it is reasonable to assume demand for the technology will increase. To get the best results from a digital textile printer, considerations for the production process and its distinct but related stages are essential. This article covers the entire process from start to finish, including ink selection, fabric selection, pre-treatment and fixation, with ink selection covered first.

Ink Selection

Textile inks are split into four main categories, each with chemical and physical properties specific ally designed to work with the target fabric.

1) **Reactive dye-based inks** (or reactive inks) are ideal for printing cotton, linen, silk and plant derived fibers such as hemp and jute. Reactive inks have good light fastness as well as typically bright colors. Wash fastness is also good due to the chemical bond created between the dye and the fabric. Readily available and inexpensive pre-treated fabrics are often used when printing with reactive inks, although major manufacturers often do their own pre-treatment. After printing, these inks need to be post-treated by steaming and washing.

2) **Acid dye-based based inks** (acid inks) are designed for printing nylon, silk, wool and even leather. They are used to manufacture sportswear, swimwear, lingerie, flags, banners and

accessories including ties and scarves. Like reactive inks, acid based inks are also bright but typically have better light fastness. Wash fastness is also good due to the strong bond created between the substrate and dye stuff. Pre-treated fabrics and post-process steaming and washing are also a necessity.

3) **Disperse dye-based inks** (disperse inks) are used for printing polyester fabrics. They are generally not as bright as acid and reactive inks. When heated to high temperatures the dye becomes gaseous and is absorbed into the polyester fibers. As the dye cools and condenses it gets trapped in the fibers, making fabrics printed with disperse inks highly resistant to laundering. Disperse inks are typically divided into low and high energy inks. The former (also known as dye sublimation inks) have good light fastness and can be printed onto paper and then transferred to polyester or printed directly on the polyester itself and heated in an oven or transfer press. Due to their excellent light fastness, high energy direct disperse inks are often chosen for the most taxing outdoor applications such as lawn furniture. All high energy disperse inks must be printed direct to fabric and then undergo heat fixation.

4) **Pigmented inks** use a pigment (insoluble in the ink carrier) rather than a dye (soluble in the ink carrier) to provide coloration. They contain resin binders, which help the pigment particles to adhere to the fabric, meaning that the inks can be used across a very wide range of fabric types. However, the inclusion of resin in the composition can limit the amount of pigment possible, as both components raise the ink viscosity. Typically inks with high amounts of color have low amounts of resin and thus low wash fastness. Conversely, pigment inks with good wash fastness often have higher resin and lower color intensity. The binder properties and concentration also need to be chosen carefully to avoid affecting the ‘feel’ of the fabric. Pigment inks typically have very good light fastness and the ability to be used on a wide range of fabrics is a significant advantage. UV curing or heating is sufficient for fixation, and so the inks are simple to use.

2) The process from design to completed fabric

We will now follow the process through to the complete printed fabric, looking at fabric selection, pre-treatment and post-treatment/fixation.

Fabric Selection

Choosing the right fabric can be a daunting task since there are so many available. Making sure you have the appropriate fabric and ink combination is essential for high print quality. To attain the best print quality, fastidious attention must be paid to the quality of fabric since errors at this stage can lead to bigger problems further along in the production process. Surface defects can not only worsen the print quality but can be detrimental to printhead life. Undesirable fabric attributes include broken fibers or filaments, wrinkles or creases, the presence of lint and non-uniform surface tension throughout the fabric. There are also dimensional issues to consider such as shrinkage. Distortion can occur during post-treatment if the fabric has not been preshrunk at the

beginning of the production process. Knitted fabrics are particularly susceptible to stretch distortion during both printing and coating so maximum dexterity is recommended. Many other fabric defects can occur.

Pretreatment

Before printing can take place, the fabric must be coated in a solution specific to the ink technology being used (except pigment inks which usually do not require pre-treatment). This is an essential process to maximize the substrate's absorption levels and reactivity to the ink, while also minimizing lateral bleeding, which may impact color definition and intensity. While pre-treated fabrics are becoming more readily available, specific chemical formulations are usually patented and confidential. Chemical solutions range from simple to very complex. Simple formulations use soda ash, alginate or urea, while complex formulations can be made from combinations of polymers, inorganic particulates, cationic agents and softeners. Regardless of the particular formulation, the process for applying the pre-treatment is the same: the fabric is fully submerged in a vat of the pre-treatment solution and subsequently hung out to dry in the open air.

(http://www.issr-journals.org/ijias/)

Fixation

Once inkjet printing is complete, dying exhaustion must take place in order to completely fix the ink to the substrate. Each ink technology has different fixation requirements.

1) **Reactive ink** printed substrates are fixed by steaming in atmospheric steamers for 8-10 minutes at temperatures of 100-101˚C (212-214˚F). In pressurized steamers the duration is usually 20-30 minutes. When printed on a cellulosic fiber (e.g. rayon), the colorant is fixed to the fiber by covalent chemical bonding. The fabric must then undergo a washing procedure, which consists of at least two cycles of differing water temperature. Each wash cycle removes an amount of extraneous unfixed dye left over from the printing procedure (loose dye can 'backstain' the fabric if not removed).

2) **Acid inks** are also fixed by steaming. The temperatures are the same as reactive based inks but the times are longer. In atmospheric steamers the duration is about 20 minutes and in pressurized steamers around 40-60 minutes. Several wash cycles are also necessary for this type of ink.

3) **Disperse inks** require different fixation methods depending on whether they are transferred from paper or printed directly onto the fabric. For the former, the paper is transferred in a press at 193-210˚C (380-410˚F) for 30-90 seconds. When disperse inks are directly printed on the fabric they must be cured or thermosoled (at the same temperature). Washing is also necessary.

4) **Pigment inks** are the easiest to fix, needing to be cured in an oven at 162-176˚C (325-350˚F) for 30-90 seconds. In some cases, UV curing rather than thermal curing is used, and the ink can be exposed to UV light during printing, giving a very simple production process.

Summary

With so many inks and textile fabrics to choose from, all with different properties, it is essential to select the right combination dependant on your application. To ensure optimal print quality, all stages of the production process must be carried out stringently. As market demands continue to change, digital technology has become more desirable as a method for printing onto textiles. The pros and cons of analogue vs. digital will depend on the requirements of the job at hand. However, digital printing's unique advantage is the rapid introduction of new designs produced economically at shorter run lengths. Print houses are already offering digitally printed clothing items (both high and low quality) at an affordable rate. Digital production speed may not be as fast as analogue in most cases, but this gap is expected to close significantly in the future. As chemical, hardware and software technology continue to evolve, it is likely that the current application of inkjet printing in the textile industry is only the tip of the iceberg.

Further Reading

http://www.tx.ncsu.edu/jtatm/volume4issue3/articles/Bae/Bae_full_141_05.pdf

http://www.provost-inkjet.com/resources/SDC++Ink+JetPretreatment+4th+Dec+03.pdf

http://www.indiantextilejournal.com/articles/FAdetails.asp?id=2635

http://articles.textileclass.com/pretreatment-of-fabric-for-dyeing-singeingdesizingscouring/

http://www.just-style.com/analysis/digital-textile-printing-on-growth-trajectory_id97071.aspx

http://www.it-strategies.com/individual/03.htm