



Distinguishing Digital Textile Printing Colorants

Key considerations for selecting the right colorant technology for different applications

Growth In Digital Adoption

Digital printing for textiles has seen a significant growth in recent years, with adoption having been estimated at 6% of all printed textiles at the end of last year. While this may seem a low figure, 6% accounts for 2.6 billion square meters of printed fabric according to World Textile Information Network's (WTiN) report on the industry¹.

WTiN commented that 2018 also saw a 10% growth in installed systems for digital textile printing, estimating 43,000 systems operating globally. The growth in printed output, estimated at 23%, was accounted for by the increase in numbers of higher-productivity machines. This increased digital adoption for textile decoration is facilitated by the advancement of ink printhead technologies and printers with greater speed, quality and reliability easing the transition from traditional printing techniques. Adding to this is the growth in fast-fashion concepts where on-demand and short-run production is required,

making digital the mainstream technology of choice for textile printing for new and existing businesses.

When digitally producing textiles, a critical choice for printers is the selection of the ink and colorant, which dictate production and end-user performance. Selecting the right ink can be the difference between profit and loss and is often based on the textile to be printed as well as the printer and printhead technology. However, quality, consistency over time, printing performance and cost are all also significant factors.

Colorant and Ink Technologies

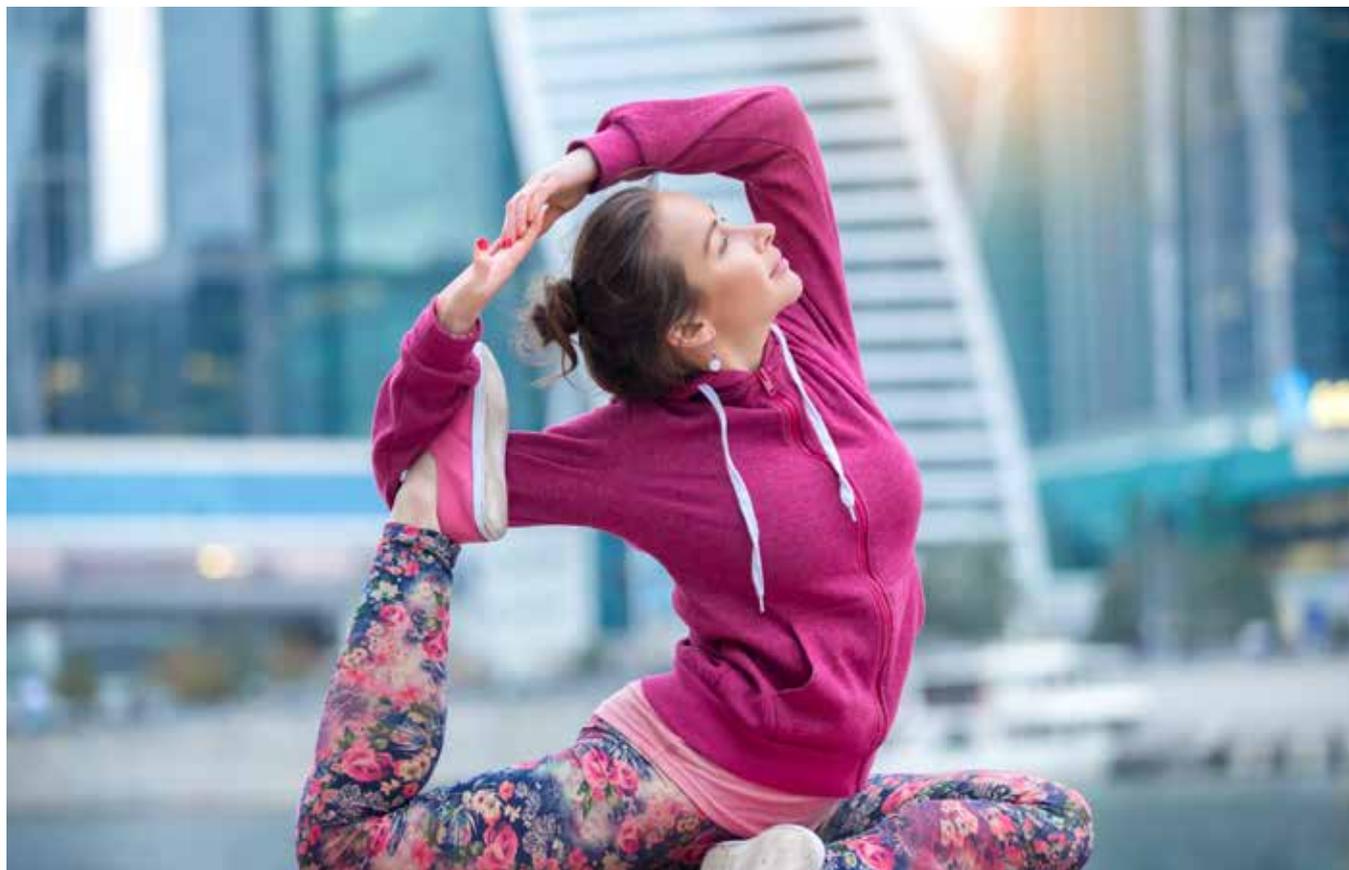
Selecting the right colorant technology and ink typically depends on the selected fabric. While providing outstanding results, some colorants are limited in use. However, many textile printers specialize in specific segments of the market, so this is usually not seen as a limitation.

Before selecting the colorant to use in an ink, there are many technical

Selecting the right ink can be the difference between profit and loss.



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considerations, including shade, purity, solubility/dispersibility, temperature stability, lightfastness, water fastness and toxicity, as well as regulatory aspects like country registration, impurities and compliance with required standards. The requirements of a product for printing children's clothing will differ from the needs in sign and display markets. Colorant choice is typically limited to four main types: reactive dyes, acid dyes, disperse dyes (including sublimation dyes) and pigments. Almost all options for digitally printing textiles are water based.

Reactive Dyes

Inks using reactive dye as the colorant are ideal for decorating natural and cellulose-based fibers, such as cotton and viscose, with the option to print fabrics such as silk, linen, rayon and wool. Reactive inks are widely used in fashion and home textile applications. To ensure the right performance, the fabrics require a pre-treatment to control the fixation environment of the dye and ensure bonding to the textile fibers. When fixed, reactive dyes form a chemical bond with the fiber, giving excellent color and fastness performance. Pre-treated fabrics are widely available, although major manufacturers often do their own pre-treatment in-house.

After printing, these inks need to be fixed by steaming, and then washed to remove excess pre-treatment chemicals and any unfixed dye. The steam fixation of reactive dyes helps swell the fibers, allowing deeper ink penetration and bonding. The fixation conditions are typically atmospheric steaming for eight to 10 minutes at temperatures of 100 - 101 degrees Celsius (212 - 214 degrees Fahrenheit).

Acid Dyes

Acid dyes are the base for inks designed for printing silk and nylon-based fabrics including polyamide. Other "fabrics" printed with acid dyes include wool and leather. Due to the smaller market share for such fabrics, acid dye inks are not as widely used as other colorants. Typical applications for acid dyes are swim and sportswear, nylon flags, fashion and intimate apparel. Acid dyes can have extended gamut with the option of using neon colors in the range. Acid dyes typically offer strong color and fastness performance with the dye creating an ionic bond with the textile after fixation. As with reactive dyes, acid dyes require the textile to be pre-treated before printing to ensure the right environment for the fixation reaction. Fixation of acid dyes

occurs under atmospheric steam at 102 - 104 degrees Celsius (216 - 220 degrees Fahrenheit) for 30 - 40 minutes. Again, like reactive dyes, acid dyes require a washing process after fixation. It is important to control the temperature, pH and soaping ingredients in this step to ensure the color is not degraded.

Disperse Dyes

Disperse dyes are typically used in two forms within digital textile printing. Depending on the specific dye molecule (high-energy dye or low-energy dye), they are classed as disperse dyes (high energy) or sublimation dyes (low energy). Although both dyes are predominantly used to decorate polyester, sublimation dyes are often used to color hard surfaces and, in some cases, polyamide. Unlike other dyes, disperse dyes are insoluble in water — requiring dispersion — and are applied as solid particles.

Disperse (High Energy)

With their high-energy form, disperse dyes inherently have excellent fastness properties, especially in lightfastness, so they are often used in applications such as automotive, indoor and outdoor furnishings. They also have a strong presence in fashion printing. These dyes are printed directly to the polyester and



fixed by steam or thermosol heat setting. There is no pre-treatment required for fixation promotion, but the polyester is often treated to control the drop spread on the surface at the point of printing.

Sublimation (Low Energy)

Low-energy disperse dyes are known as sublimation dyes. Currently, sublimation printing accounts for 48% of digitally printed textiles. These dyes offer outstanding color intensity and strong fastness properties. Such inks are used widely in fashion, sports, and sign and display applications. Sublimation dyes are printed onto a specialized paper and then transferred to the polyester fabric by contact heat and pressure. Because the ink is printed to paper as the imaging step, the polyester does not need a pre-

treatment. The image is printed in mirror view to ensure the correct orientation after fixation.

Typical transfer conditions are 210 degrees Celsius (410 degrees Fahrenheit) for 30 seconds; however, this pressing time is usually increased to 40 seconds if fluorescent dyes are used. During the heat pressing process, the solid dye particles sublime to a gas phase, penetrating the polyester before the temperature cools, locking the dye within the fibers. Critical to the final performance is the transfer rate of dye from the paper to the fabric, and ink selection can have a large impact on this. Recent developments in sublimation inks are opening up the use of lower weight and uncoated transfer papers, helping to reduce cost, waste and environmental impact.

Pigments

Inks containing pigments are starting to gain markets within digital textile printing. Although less vibrant than dyes, pigments have the advantage of excellent lightfastness and reduced limitation in substrate specificity. Pigment inks dominate the direct-to-garment segment and are particularly being adopted in home textiles markets.

Pigments do not bond chemically to textiles, so they normally require a resin or binder to physically stick to the substrate. Dry heat fixation promotes a cross-linking of the binder, forming a film and trapping the pigment to the fibers. This can impact the final feel of the fabric and can have limitations in rub fastness. Being solid particles, pigments must be incorporated into inks as a dispersion,

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which is a complex process of stabilizing the pigment and limiting the tendency to sediment. Because of this risk and the need to incorporate a resin into a low-viscosity liquid, the amount of pigment that can be used in an inkjet ink is limited. There are also limits to the pigment's particle size to avoid clogging small inkjet nozzles. Getting the right balance of materials to ensure good color and fastness with good stability is a challenge.

Other pigment-based ink technologies, such as latex inks and UV-curable inks, have emerged in the digital textile market. While the colorant is predominantly the same, the fixation method differs between these ink types. Latex inks are similar to other water-based inks in that they are based on a resin technology that binds the pigment to the textile, and they need the application of heat. While these inks are becoming more common, they are mainly used in canvas and sign-and-display markets and are emerging in home textiles.

In some cases, a pre- or post-treatment is required to ensure the required durability. There has been some adoption of UV-curable inks in textile applications, but their use is limited. UV inks can contain skin sensitizers, and confirming 100% cure and no hazardous unreacted materials on a porous 3D structure is difficult. Although UV has seen some adoption within outdoor textile applications such as sunshades, it is not expected to penetrate into other textile applications.

As there are a number of colorants and associated inks available for digitally printing textiles, it is important to understand the fabric and application needs to ensure the right selection. The ink options for each colorant type are growing, so paying attention to the detail and the quality is important when considering the best ink for one's business. As the textile market evolves and digital printing increases its market share, there is also an opportunity to reduce the

environmental impact of textile printing. Newer technologies will have a focus on sustainability and value more than ever before.

Reference

¹Orozco, Mutlu Chaouch and Masuwa, Stephanie. WTIN Digital Textile Ink Market Review – 2018. July 2019. wtin.com/article/2019/july/080719/digital-textile-ink-market-review-2018/

Simon Daplyn, Ph.D., is the Marketing Manager for Sensient's global inks business having joined the company in 2015 as part of their acquisition of Xennia Technology Ltd. He has experience in development of digital inks and processes, commercial implementation and direct sales across a number of applications and industries. Before joining Xennia, Simon earned his Ph.D. for work on Inkjet Printing onto Textiles from the University of Leeds, U.K. Simon then went on to work for Nanojet Ink, based in Newcastle upon Tyne, where he was Technical Manager of ink developments focused on garment printing.