Developments in Jet Inks for Textile Printing

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Introduction

As anticipated, several ink jet textile-printing systems were presented at the ITMA in Paris this June. The majority of those being shown used reactive dye or disperse dye inks and are intended for use as design or strike off tools to be used along with screen printing production equipment. Where were the production printers? Where were the pigmented inks from the major players? What does this all mean? Will these inks and the printers that use them truly offer a significant alternative for strike offs? Will this lead to short run production? Here is one perspective.

Ink Technologies

The four principle technologies considered here are:

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<td>Acid Dyes</td>
<td>Silk, Nylon, Wool</td>
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<td>Reactive Dyes</td>
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Acid reactive dyes provide the ink maker with the least difficulties in that they are water-soluble dyes. Purification of the dyes and formulation into inks designed to work well in the printhead of choice has been achieved with relative success and several products are available which will function successfully for samples and strike offs. In cases were new dyes have been synthesized specifically for ink jet, care must be taken that their fastness meets the end use needs where functional performance is required. Specially developed dyes may be offered in place of traditional textile dyes in order to achieve higher process color gamut and to allow for ink jet friendly performance. If the printed fabric is to be used for more than sampling, tests should be run to determine the dye's suitability.

Disperse dyes and pigments present a more difficult set of problems for the ink maker. Both exist in water as dispersions of small particles. These inks must be prepared with a high degree of expertise so that the particles will not settle or agglomerate (floculate). Very few good examples of these types of inks have been proven in the market.

Process Color

Textile printing is primarily a spot color process and most ink jet printer implementations utilize process color. These two approaches to color differ in that the colorants used to color the textile are premixed, in the case of spot color and mixed on the fabric, in the case of process color. Process color printing is generally composed of black, cyan, magenta and yellow inks that are mixed in varying proportions by jetting droplets onto the fabric to create the colors in between. The colors achievable by mixing only four colors of the same chemistry cannot come close to the colors obtainable in spot color printing from a well-selected set of "mother" colors numbering between 10 and 12. In an attempt produce more colors with process color printing either dilute 4-color process inks or up to 8 different colors have been used. While this gives improvements it still does not reach the combination of color correctness and functionality of spot color printing in color critical applications. Another technique used to try to simulate the colors
between the colors in process color is "dithering". This is an attempt at achieving more colors by choosing a "super pixel". It is made up of a block of 4 or more ink jet drop printing locations, which are treated as a single location. Varying the number of drops of each process color printed within this "super pixel" allows for a simulated gray scale in the printing. An unwanted side effect of this technique is a reduction in sharpness and frequently an unevenness in color. In many prints this is objectionable. Another difficulty with process color printing is the "gray" contribution to the color. The mixing of two or more inks with very different colors causes this. As a rule of thumb the larger the difference in color between two colors (the hue angle) the larger the gray component in the resulting color. The gray component dulls down the color making it less attractive in many applications.

Quality and Productivity

Additional points should be considered in the effort to achieve the desired color, resolution, quality and productivity. From the printer standpoint spot color can be printed at adequate resolution with accurate color at the lowest potential number of ink jet nozzles, largest ink drops and simplest software solution. This is particularly important to the role the ink must play since the larger the drops and the fewer the nozzles the easier it is to provide reliable ink. To achieve good color match with process color, very small drops from very small nozzles must be used. To achieve reasonable throughput the frequency of drop firing and the number of nozzles must be high. High frequency, larger numbers of nozzles and very small nozzles place a very difficult burden on the ink designer. In comparison with office or wide format ink jet on the market today the amounts of ink required to be fired from a high speed, high quality textile ink jet printer are several orders of magnitude higher. No ink jet inks have yet been commercially demonstrated which provide defect free performance at the rate necessary for short run productions.

Agile Manufacturing/Mass Customization

The dream of the ink jet industry and to some extent the textile industry is to develop suitable products for the sample and strike-off application and then proceed to short run printing and demand printing needed for "Agile Manufacturing". "Agile Manufacturing" is printing to order verses printing long runs. Is this achievable and will we be around to see it? For sample and strike-off in non-color critical applications this is doable. Good enough color may be available from existing printing devices like those from Mimaki and Stork. Today they are limited in the inks they can use. We believe good inks of all types will be available for some of these printers and new ones under development, which will be available in the near future. Stork continuous flow printheads cannot utilize inks with particles in them so they are limited in their chemistry choices. Pigments and sublimation/disperse dyes offer the best potential in our opinion for true agile manufacturing and mass customization. They require no wet post processing to achieve the suitable color and durability. Thermal ink jet and piezo impulse ink jet printers, like Encad and HP, and like Mimaki and Epson, offer the best chance to achieve the required performance and reliability. The inks will be there but will the quality/productivity/reliability/cost trade-offs make it a viable option for the textile industry? We believe they will.

Future Developments

We have been working to develop the pigmented inks needed to enable digital strike-off printing, short run printing and mass customization. Today I will show samples of process color pigment printed cotton sheeting that demonstrates our stage of development. These samples were printed using a desktop Epson printer. One set of samples utilized inks which contain no significant binder. These inks could be used for non-functional pigment strike-offs and optimized for either thermal ink jet or piezo ink jet printers. The other contains a self cross-linking binder, which cross-links after heating to give improved crock fastness. Work is continuing on these inks and our target is to begin serious beta evaluation next year. Our developments to date have demonstrated color gamut comparable with traditional screen-printed pigmented inks.

To address the needs of the silk printer we have announced commercialization and have in beta testing a set of 7 colors of acid dye inks especially chosen for use in the high end designer market. Two versions will be available, one set is optimized for piezo printheads like those used in the Mimaki printer and one set is optimized for thermal ink jet printheads. A clear solution product is offered which enables the user to mix any combination of the 7 colors together and dilute to match any spot color in the wide color gamut provided. A silk fabric pretreatment solution is also being made available which is optimized for these dye inks and silk. Traditional steaming and washing is required to achieve
the required color and durability.

In conclusion, the traditional chemistries used in textile printing are becoming available as ink jet inks for several of the printing systems being offered. Dye inks tailored to the end use and pigmented inks offering good functional performance will soon be available to the market.