

Pigment Printing's Role in Ink Jet Textile Printing

Dr. Ray A. Work, III
New Business Development Manager
DuPont Ink Jet Enterprise
Wilmington, DE 19880-0030 USA

Abstract

Ink jet technology is emerging as a digital method of printing textiles for sample, design and coupon printing and for outdoor applications such as signage, flags and banners. The challenge for printer manufacturers, ink manufacturers and the textile industry is to develop and install systems which can replace existing analog printing in a production environment. Pigment printing of textiles, while more than 50% of all analog textile printing today, offers different benefits when implemented into digital ink jet textile printing well beyond the obvious applications requiring pigment durability. When productized, concepts such as on garment personalization and agile manufacturing offer the soft goods industry a disruptive technology substitution and extraordinary value well beyond that traditionally associated with pigment printing. This presentation will include some of these concepts and indicate progress being made in the development of technology which will allow demonstration and productization of them. In addition, potential scenarios for future products will be presented with a prediction of their potential influence on the textile printing industry.

Introduction

Since the late 1970's progress toward development of both continuous flow ink jet and impulse or drop on demand ink jet has been astounding. The ink jet market now exceeds \$10 billion annually. Most of these systems have used dye based aqueous ink jet inks. In 1993 the first pigmented impulse ink jet ink was introduced into the office printer market by Hewlett Packard. Since that time significant technological development has resulted in numerous implementations of pigmented and dye based inks for continuous flow and impulse ink jet printers to meet a variety of end user needs. Up until now only a small number of companies have leveraged this paper based printing technology into the production of ink jet printers capable of printing textiles. Stork and Iris have introduced Hertz continuous flow ink jet printers that utilize dye based aqueous ink jet ink which are used for printing on textiles and paper for textile design and proofing applications. These provide state of the art process color but are slow, expensive, sheet feed ink jet printers. Canon has developed an expensive impulse ink jet printer exclusively for textile printing based on their BubbleJet technology. It prints full

width fabric roll to roll utilizing process color and a variety of dye based inks. Perhaps the most exciting development to date has been Seiren's development of an integrated design and printing system utilizing spot color and process color printing with dye based inks matched to the substrate to produce limited run textile production material. All of these systems use dye based ink jet inks that require conventional post-processing steaming and washing to prepare them to be cut and sewn into finished garments. Pigmented systems under development may offer an attractive alternative for some applications.

Pigmented Ink Jet Inks on Textiles

Compared to dyes, the incorporation of pigments into ink jet inks is a much more difficult task. The pigments must be ground into very fine particles of the order of 200 nanometers or less so that they will remain suspended in the ink vehicle and be transparent to light. Larger particles will settle and cause light scattering which cause the colors to be dull. An excellent pigment dispersion system must be provided to avoid flocculation which then causes settling and potentially clogging of the orifices of the ink jet printhead. This dispersion system must be very stable. It must be highly tuned to the pigment and the ink vehicle to enable the highest degree of stability so that it enables a robust highly reliable printing system. Once a good quality ink jet ink is designed the problem becomes how to bond it to the fabric. In paper printing the ink will dry on the paper and provide a durable enough image. On fabric the durability requirements are much more demanding. A mechanism for attaching the very fine pigment particles must be provided to satisfy these needs. Binders are used in pigmented screen printing inks. Some use cross linking by heat or UV light. The result is usually stiff hand and dull opaque color. Thickeners and binders and excess pigment are needed as dictated by the screen printing process. In ink jet printing this is not the case. Inks must be only a few centipoise in viscosity, close to water thin, verses the thousands of centipoise required of the paste-like inks for screen printing. This low viscosity and other restrictions of the ink jet jetting process favor employing a fabric pre treatment as an aid in the bonding process. In screen printing dry on dry printing and the high viscosity of the pastes help control bleeding of one color into the next. In ink jet these control mechanisms are not present so the pre

treatment must aid in controlling the ink bleeding on the fabric. Fabric pre treatments utilizing novel bonding techniques are being developed in through cooperation between ink designers and fabric treatment providers in order to achieve the fastness required without compromising the hand of the fabric. The challenge is to accomplish this while maintaining the finished product durability characteristics dictated by the intended end use. A commercial example of a unique pre treatment is the Asahi Glass Company's Pictorico(R) fabric treatment. Asahi Glass offers a soft polyester knit cloth product. It is coated with a very thin layer of proprietary materials composed of binders and specially developed, manufactured and patented alumina particles. This Pictorico treatment will bond dispersed pigments in specially designed ink jet inks very strongly to the surface of the fiber. This is demonstrated by excellent washfast in repeated washings. Since very little binder is added with the ink the hand of the printed fabric is nearly unchanged. This technology when developed should allow ink jet to provide superior pigmented ink printing performance without the need for wet post processing required of dye systems.

Finished Garment Printing

One important application for ink jet printing is finished garment printing, more specifically T-shirt, Imprinted Sportswear and one piece knit garment printing. In these cases a major component of the value of digital printing is printing variable information on a garment as close to the retail sale in the supply chain as practical. The garments are produced without differentiation in long runs for maximum efficiency by conventional means. The variable information is then printed just before stocking in a store or on a customized printing basis. The inventories are simplified and reduced, the variety of designs offered can be increased and design changes can be implemented without marking down excess stock. To capture these efficiencies and increased manufacturing flexibility inks must be provided which 1) require no wet post processing, 2) must bond to the fabric without a special fabric pre treatment and 3) the printing operation must be capable of production in a location near or in a retail outlet. This may be provided by paint-like inks. Ink jet inks are in development which contain binders that will enable printing for this application. Flat bed printers are appearing on the market with the ability to adjust the height of the printhead from the garment enabling this type of printing. T-shirt printing will be commercially viable with these inks when the systems integrators provide the complete solutions. Imprinted Sportswear providers anxiously await the availability of devices which will replace pad or screen printing operations. Providers of full garment production knitting machines are striving for ways to print knitted garments to add value and provide the designs not achievable prior to production since no flat fabric is utilized in the manufacturing process.

Agile Manufacturing

This term, coined by the Textile Technology/Clothing Corporation of Cary NC, refers to a complete demand activated apparel manufacturing process. The printing component of agile manufacturing is just now being demonstrated. In the optimum execution of this concept, when a printed article of apparel is purchased at retail an electronic order is placed for replenishment of that stock. When the order is placed the unprinted fabric required for a replacement garment is printed, cut, sewn and shipped within a only few days directly to the retail store. This replenishment scheme would enable the store to maintain stock in virtually each size and pattern without huge inventories. In addition this process enables new designs to be implemented without the long supply chain currently in use. To be viable the printing component of this idealized process must be compatible with a cut and sew operation. Chemical processes with steaming and washing and effluent disposal are difficult to envision for this environment. A "dry" system of printing and fixing would fulfill this need. Pigmented ink jet printing on prepared for print fabrics may provide this capability and meet both the designer and the end users needs. The incentives are huge, many millions of dollars could be saved and new design change flexibility enabled through these innovations.

Conclusion

The opportunities are large and the technical tasks are well understood. Many more applications will arise as the technology is more fully developed. We are looking forward to playing an important part in the revolution this our ink capabilities will present to the textile industry and encourage the other component developers to work with us in achieving this objective.