SGIA
Screenprinting & Graphic Imaging Association International

Sublimation Heat Transfer Printing

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Al was one of the foremost technical authorities in the screen printing industry. Before the SGIA had a technical staff, he fielded questions for screen printers around the country. After a start in the Chicago public schools, where he taught screen printing, Al became a prolific writer and technical resource to the industry. He authored several books and hundreds of papers on the screen printing field. He was a member of Academy of Screen Printing Technology. A winner of the SGIA's Parmele award for service to the industry, and the Pioneer award for lifetime achievement in screen printing.

Academy of Screen Printing Technology

Although the first screen printing job in the United States was produced in 1903 on textile material (felt banners) by Francis Willette, a Detroit felt banner manufacturer, it is interesting to note that commercial screen printing on textiles developed about 30 years later. Until the 1930's, textile screen printing was confined to direct printing on continuous yardage or webs on long printing tables, employing dyes or inks formulated into paste form for screen printing. It is amazing to observe the progress developed in textile screen printing since then. With the development of materials, equipment and techniques, today's screen printer can furnish new ideas, colors and patterns for distinctive styling. Textile screen printing is being done directly on web or bolt material, on cut fabric pieces, on finished garments such as T-shirts, blouses and the like, and also by means of a textile printing process known either as textile heat transfer printing, sublimation printing or vapor phase transfer dyeing. The latter printing method differs from conventional direct textile printing.

Transfer textile printing is a method of printing on synthetic fibers, blends and materials such as carpeting or vinyls by preprinting the design or pattern with "sublimation" or "disperse" dyes on paper called a transfer or release paper. After the colorful patterns have been printed on the paper with special dyes, the patterns are transferred from the paper to knit, woven and non-woven fabrics using machines with dry heat and pressure. The process represents an entirely new market which is dependent on textile printing, printing on paper and printing with dye inks.

The transfer process goes through a process known as "sublimation"; that is, the dyes or inks sublime or change directly from the solid state to the gaseous state with the aid of heat and without becoming a liquid. Sublimation or heat transfer printing requires the use of a dye or ink which will sublime (form a gas or vapor) when heated at temperatures below the temperature which may damage the fabric to which the design is transferred. So that the dye, which is in gaseous form, will transfer directly from the paper to the fiber, the fabric used must be one for which the dye has an affinity.

The process is also known, as Sublistatic printing, after the Swiss based firm (Sublistatic, S.A.) which pioneered it, and as "dry dyeing" described by the Frenchman N. De Plasse (French patent 1,223,330; 16.6.60). Although the concept of transfer printing dates back to the 1920's, it was not until 1956 that commercial sublimation heat transfer printing developed as we know it today.

Apparel manufacturers, textile printers, knitting mills, converters and screen printers are very interested in this challenging method of textile decorating. Although the printing is being done mechanically with sophisticated rotary and flat screen printing machines and with gravure and flexographic equipment, it may also be done manually and semi-automatically in screen printing shops on sheet fed presses. Because the process does not require pretreatment and prints dry, it may be done in the general screen printing shop with manual or mechanical equipment.

In spite of the fact that this printing is being accomplished by other printing processes, screen printing offers bolder and larger pattern printing (especially that being done on textile screen printing machines), varied designs for small runs, detail and halftone work which may be printed on paper for subsequent transferring to fabric. The constant obsolescence of designs and styles and possible shorter runs make transfer screen printing practical.

Generally, standardized transfer printing offers outstanding quality for printing, lower cost of stocking paper as compared with that of stocking printed fabric, flexibility of designs and speed of printing, especially with the newer type rotary screen printing machines. Intricate designs can be reproduced on paper with perfect register and without overlap and bleeding of color. Paper on which designs are printed, unlike directly printed fabric, has dimensional stability and printed paper may be stored and applied as needed in or outside the local shop. Also, since there is no steaming and rinsing after transferring of designs, there is no dimensional loss due to shrinkage. It must be noted that the cost of direct printing on fabrics varies with the fiber; in heat transfer printing the cost of the paper may be the same for the various fibers printed. In addition, a more durable fabric design is achieved by screen printing as contrasted with alternative methods of printing, since the amount of color generally is much heavier when screen printed.

In spite of the fact that transfer printing has penetrated the high quality fashion market internation-

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ally and is adding new dimensions to textile printing, at present it is not suitable for printing on all fabrics. Brilliant colors and highest degree of fastness are obtained by transfer printing on polyesters. The process is also used on polyamides, acetates, triacetates and blends of polyesters and cellulosic (cotton), providing the proportion of the synthetic fiber in the blend is in excess. Where the transfer printing onto a fabric may produce doubtful results, complete testing must be carried out by the screen printer.

To standardize procedures before attempting commercial work, the beginning screen printer will need some form of heat transfer equipment or unit in which the paper printed design may be transferred to the fiber. Varied heat transfer machines are available from the simple, inexpensive manually operated ones consisting of two heated plates for forcing the paper transfer and fabric together under a given temperature and time, to the completely automatic heat transfer unit having heated rollers or calenders through which the paper web and fabric web may pass in perfect contact.

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Besides a heat transfer unit, the process generally requires a transfer paper, sublimation dyes or inks, printing equipment, a general knowledge of textile screen printing, some practical screen printing experience, research and testing. Since this is a relatively new technology, the screen printer doing this type of printing must be research-minded because he is dealing with printed dyes, exact control of heat, pressure and dwell time in the transfer period, he must produce designs having sales appeal and should be able to train personnel. In mechanically transferred designs, there must be balance between heat, pressure and dwell time. If these three are not in balance, the design may not transfer at all, it may transfer partially, or the design may be smeared or spoiled. Since the average screen printer has experienced printing on paper, it has been suggested that one going into transfer printing print the paper in his shop.

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Paper

The paper printed on is important, since it must accept the print during the printing step and must release the pattern during the transferring stage. The final choice of a suitable paper is important, as a paper that may perform well for polyester fibers may not give adequate fastness and results when printed or transferred to other synthetic fibers or blends of fibers. Specially made or coated papers are used to facilitate the sublimation of the printed colors. Some papers which have been used include uncoated, single-coated, double-clay coated, bond paper, machine glazed, parchment papers made especially for this type of printing, and bleached Kraft paper which is smooth on one side. The printing is done on the coated side of the paper so that prints may be transferred more easily to the fabric with the aid of heat and pressure. The printed pattern on the paper may bear little resemblance to the final color on the fabric after transfer. Therefore, the screen printer must match and test the color on the final printed fabric.

Paper should have dimensional stability and should not be too flexible so that it does not have to be preshrunk before printing in humid or warm climates. Printing properties should be similar to standard coated papers used by the screen printer. It should not blister and the color printed should not penetrate into the paper; however, color should adhere. The barrier coating on paper and/or release medium on the paper is important, since these prevent the printed image from impinging on the fibers of the paper carrier during the transfer process. The continuity of the "hold out" layer is more important than the porosity or density of the paper stock itself. Paper should be wrinkle-proof, whether printed on rotary or flat screen printing machines or printed manually. In rotary screen printing machines where water based inks are used, a more porous paper may be required to prevent smudging of colors. However, the printer should test completely this type of printing, since a poorer color transfer may be obtained where a porous paper is used.

Papers are available for printing and transferring onto varied synthetic fabrics. Also polyvinyl chloride and polyurethane may be printed in the form of sheets; polyester coated metals, polyester films, acrylic coated metals and acrylic finished leather may be transfer printed to standards of varying acceptability, depending on the end use. The process is still not as practical for screen printing on cotton, wool or silk, although research is being done and work is being accomplished in captive type plants.

Inks Or Dyes

Dyes or inks for sublimation textile heat transfer printing are available in the United States and abroad. Although, like plastisol inks, sublimation inks are heat transferred, they are not plastisol inks. Generally, sublimation inks are disperse types and are thermoplastic, which sublime at temperature ranges from about 177° to 230° C (350° to 445°F). Disperse dyes are generally used for dyeing man-made fabrics and are formulated to be readily absorbed in the vapor state by varied synthetic fabrics. They also have the property of having no affinity for papers used as the substrate or support for the dye print. As has been mentioned, the heat sensitive dye changes almost instantly from the solid to the vapor state and is absorbed and diffused throughout the fiber.

Screen printing dye inks of this class generally consist of a dye or a finely ground pigment dye, a resin system and solvents or additives formulated specifically for heat transfer printing. It is suggested that dye inks be purchased and if any color mixing is done, that it be carried out specifically as directed by the ink or dye manufacturer.

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The type of fabric printed, type of heat transfer machine, temperature, pressure and dwell time control the transfer of the pattern to the fabric. It is best that the fabric be devoid of sizing and the like before heat transferring takes place. The importance of the interrelationship of temperature, pressure and dwell time must be stressed again. Increasing any of the three elements may require a reduction in the other two. The combination of the three elements must ensure ink sublimation.

The dwell time or transfer cycle may vary from about 5 to 40 seconds, depending on color of print, fabric and thickness of print. The thickness of the print varies with the printed paper, ink viscosity, mesh of screen fabric and thickness of emulsion coating on printing screen. While other printing screens may be used, direct emulsion coated screens which will resist the dyes are ordinarily employed. Although the printed transfer paper on rotary and flat screen printing machines may pass through a drying chamber, the prints on the transfer paper may be dried naturally in about 10 to 15 minutes. If warm air is used to hasten drying, it should not exceed 80˚C (175˚F), since greater heat may force the print to sublime prematurely and decrease fastness and other print qualities.

The screen printer must make it a practice to test final prints of batches completely, especially if he should attempt to print on other fabrics such as nylon or acrylics. Although polyester fabrics are dyed readily and have wash fastness and light fastness, it must be realized that the end use of a fabric will govern whether it may be practical to print.

In summary, transfer printing is an important technology and neophobia, or fear of the new, has never been one of the problems of the screen printer. It must be realized that heat transfer printing will not replace machine textile printing, but it does supplement it.