TECHNOLOGY OF MAKING THERMAL TRANSFERS

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Abstract: *Nowadays, there are several ways to print images on textiles used by modern manufacturers. The choice of technology for applying the image depends on many factors: the number of products, area of the image, the number of colors in the picture, the raw material composition of the fabric, fabric colors. This work is devoted to studying the quality and stability of thermal transfer on fabrics made by screen printing. This method of applying images to textile materials in many ways is similar to screen printing. The difference lies in the fact that the idea is applied directly to the cut details or garment with direct screen printing. In contrast, transfer printing might be used to an intermediate carrier that is transferred. A study of the technological parameters of applying thermal transfer, which we made by screen printing on materials of various compositions, was carried out. The technology of applying the thermal transfer performed by the method of screen printing was developed. Recommendations for the use of equipment were developed.*

Keywords: *images, textile materials, printing methods, screen printing, digital printing, sublimation printing, thermal transfer printing, printing cost, performance.*

1 INTRODUCTION

The light industry of Ukraine and some European Union countries is developing rapidly. Unlike metallurgy, mechanical engineering, and other branches of the national economy, fair industry products are aimed at the end consumer, who constantly follows fashion trends. With this in mind, every clothing company tries to compete with other industries in different ways. One way to increase product competitiveness is to improve product quality while maintaining the final retail price or slightly to increase it.

To improve the quality of the product, manufacturers use various finishing methods, namely: decorating products with prints [1], applications of artificial stone [2], finishing with fake pearls, the use of complicated elements, and so on. Finishing products with different patterns focused on a particular brand, different age categories, gender, and youth movements significantly improves the appearance of products. Methods of drawing on garments or finished products include direct digital printing, screen printing, sublimation, thermal transfer of films, flock coating, as well as the application of thermal transfer [1]. Drawing images by direct digital printing using DTG technology or direct screen printing requires costly specialized equipment, so companies with low production capacity turn to contractors specializing in decorating clothing. The disadvantage of such cooperation is the high cost of transporting large volumes of cut or finished products. The use of thermal transfers, which contractors can also manufacture, significantly reduces logistics costs, and the task of the manufacturer is only to apply a finished pattern on the product in its production.

The described general technological process of screen printing [3] is printed on knitted, textile materials, artificial and natural leather, and other complex and elastic surfaces. In the light industry, the so-called "indirect printing" technology is used - transfer, which is partially described in [1], but this technology requires independent research. The essence of the technological process is to apply to the surface of the intermediate carrier – a particular paper or film of a single or multicolor image, followed by transfer to the fabric. The working surface of the middle page - transfer has low adhesive properties with printing inks and undergoes antistatic treatment.

1.2 Discussing ideas

The research aims to identify differences in drawing images by thermal transfer printing in contrast to direct screen printing on textile materials, natural and artificial leathers, rolled materials.

The main tasks to be solved:

- analyze the main methods of making transfers;
- identify the technological features of different methods of making transfers.

2 METHODS

Today we can identify several excellent technological processes of making transfers:

- screen printing;
- a combination of offset and screen printing;
- DTF (direct to films) printing;
- laser printing.

Each of these methods of making transfers involves applying the image on an intermediate medium - transfer (paper or film) and its subsequent transfer to the material of the workpiece. Not only knitted and textile materials can is used as blanks. Application is possible on artificial and natural leather, plastic and metal surfaces, wood, etc. The transfer is a specially treated paper or film. Typically, the print surface is coated with low adhesion to the transfer, for example, silicone, which significantly facilitates the extraction of the media after image transfer. Some manufacturers achieve common adhesion properties between the paint and the transfer surface by machining the latter (polishing) or combining machining and coating. Also, for carriers, antistatic treatment is performed by applying a special coating that prevents the accumulation of static charge or simply removing static stress from the surface of the page during its machining. Consider in more detail each process.

3 EXPERIMENTAL

The technological process of applying the image to the transfer surface by screen printing contains some differences from the direct screen printing method [1, 4]:

- design preparation - mirror image;
- drying transfer (used for paper media, to remove excess moisture and prevent further deposition, the film, unlike paper, is non-hygroscopic, so it does not require this operation);
- applying colors of multicolor images in the opposite direction;
- application of a layer of paint - an adhesive base that covers the entire image to create a unique adhesive surface (usually performed with white paint or anti-migration paint, which then acts as a barrier when applied to colored and black fabrics);
- application on the prepared film of paint special powder glue (as a rule, powder glue was made of polyester (Diethylene glycol phthalic anhydride polymer CAS # 32472-85-8) or polyurethane crushed to the sizes from 1 to 600 microns);
- cleaning the surface of the transfer from the powder glue on the surface free of paint, because despite the special antistatic treatment of the transfer surface, the powder glue particles, during the application, receive a significant static charge, which leads to their adhesion to the surface of the carrier free of paint;
- drying of the transfer workpiece (this technological operation takes place at the melting temperature of the polymer adhesive; the manufacturers recommend a range of 105 to 115°C for these materials [5]);
- image transfer from the transfer surface to the workpiece surface for which press equipment is used (transfer temperature modes depend on the type of media, paint, and material on which the drawing is applied, and range from 170 to 190°C, exposure from 10 to 15 s, under pressure in the range from 35 to 40 psi (from 0.24 to 0.31 N/mm^2) [6]. In cases of low-temperature resistance, the workpiece material is allowed to reduce the temperature, but not less than the melting point of the polymer adhesive, while increasing the processing time.

To apply the image to the transfer surface by screen printing, special liquid adhesive mixtures of transparent or white color are used. White is used for colored and black fabrics and fine only for white.

In the case of liquid adhesives, applying a layer of paint and applying powder glue is not present in the process, but taking into account surveys of manufacturers and users of transfers, the use of powder glue has advantages due to better adhesion abrasion resistance, washing.

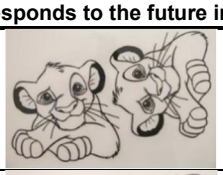
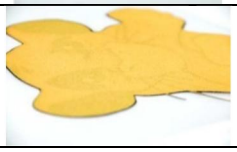
4 RESULTS

For screen printing, the preparation of vector and raster images also has specific differences and features.

Table 1 (as an example) shows photos of the stages of the technological process of applying a vector five-color image. When using a multicolor image, it is necessary to dry the intermediate colors to prevent the pre-applied color from sticking to the next printing plate.

At the moment of paint drying, its insignificant deposition - deformation owing to fast evaporation of moisture is observed. To avoid shrinkage of the carrier, its pre-drying or deposition in tunnel-type dryers or drying chambers are used. To prevent the residue of the ink layer, manufacturers use grid numbers on printing plates in the range from T61 to T100 (Glamor, TM Gektor, ltd Ornament Print-F). As the grid number increases, the thickness of the paint layer decreases and, accordingly, the probability of significant deposition. Another way to combat the undesirable phenomenon of deposition of media and paint is a unique design preparation. Table 1 shows an example of applying an image containing five colors (black contour, brown, pink, yellow, and orange), which are used with a slight overlap.

Table 1 Technological stages of making a vector image

The name of the stage	Photo of the print side	Photo from the side of the film (corresponds to the future image)
Application of the first color of the image		
Applying a second color image		
Applying the third color		
Applying the fourth color (pink nose)		
Apply the fifth color, which is the basis of the image		
Applying an adhesive base (plastisol or powder)		
Drying of the adhesive base		

This design and application scheme prevents the formation of "gaps" or substantial overlaps of colors when performing multicolor images. Such overlaps are permissible from the printing side (photo of the printing side in Table 1) but invisible in the finished painting (picture from the film side, Table 1). As a rule, the last turn put the color occupying the extensive drawing area, which further put powder glue. If the future transfer is planned to be applied to black or dark fabrics, then on top of the whole image, use an anti-immigration base or white paint and then powder glue.

In the case of raster image application, it is necessary to divide the image into a certain number of channels following the color scheme (RGB, LABColor, CMYK, or according to the pontoon of the available colors [7-9]). The division into one or scheme and the verification of the conformity of the received transfer to the original deserve more attention and are not considered in this work.

The CMYK color scheme was chosen as the image's color scheme, as it is the most common in the printing industry and full-color direct screen printing.

The technological process of preparing a raster image contains the following stages (Figure 1):

- translation of the image into the appropriate color scheme (Figure 1b);
- division into channels according to the color scheme and creation of separate images corresponding to each channel (for the CMYK color scheme, it is four channels, respectively and four photo templates) (Figures 1c-1f);
- translate each image into raster. When converting to a raster, separate raster angles are used for each channel, and the ruler, according to the screen number of the printing plate, is taken into account. The use of different angles during rastering prevents the appearance of moire (Figures 1c-1f);

- production of the control image in the CMYK color scheme (Figures 1c-1f). The control image is performed by creating a new file in the CMYK color scheme and then placing the corresponding raster image in the channel of the same name. This image makes it possible to control the appearance of moire, as well as the correspondence of color reproduction to the reference image;
- making a photo template of the base of the drawing, which acts as an adhesive base. As in the previous process, it can be made with an outline of white or black. As a rule, white paint is used as a basis, which allows you to transfer to light and dark fabrics. The peculiarity of making the basis for raster images is the possibility of its manufacture in two ways. The first method is to convert the image to grayscale with its subsequent rasterization or to a black and white photo of the control image in the color scheme CMYK (Figure 1i). This method is more suitable for light colors of fabric. The second method is to select the entire area of the figure and fill it in black (Figure 1j). This method is better for black and dark fabrics.

The following CMYK channels are accepted in polygraphy: Cayan - 150, Magenta - 750, Yellow - 00, Black - 450. Since textile and knitted fabrics have a specific weave pattern, and more, as a parasitic pattern, occurs due to interference of raster grids of patterns division into colors and alignment during printing [7-11], the probability of the moire itself on textile materials increases significantly. Therefore, when translating split images into raster, they also experiment with the shape of the raster dot and the ruler, followed by applying the test image to the fabric.

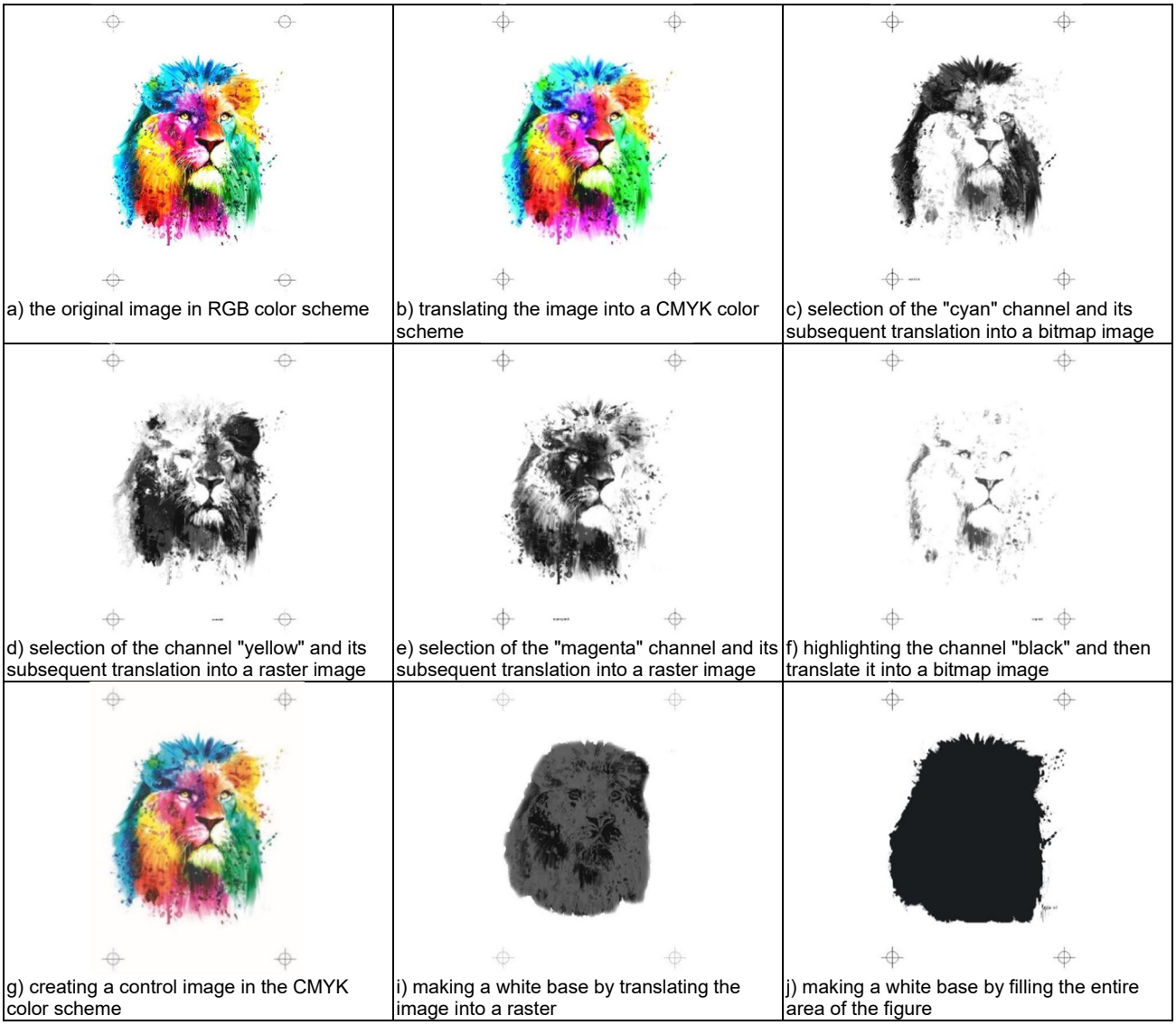


Figure 1 Technological process of making photo templates for raster image

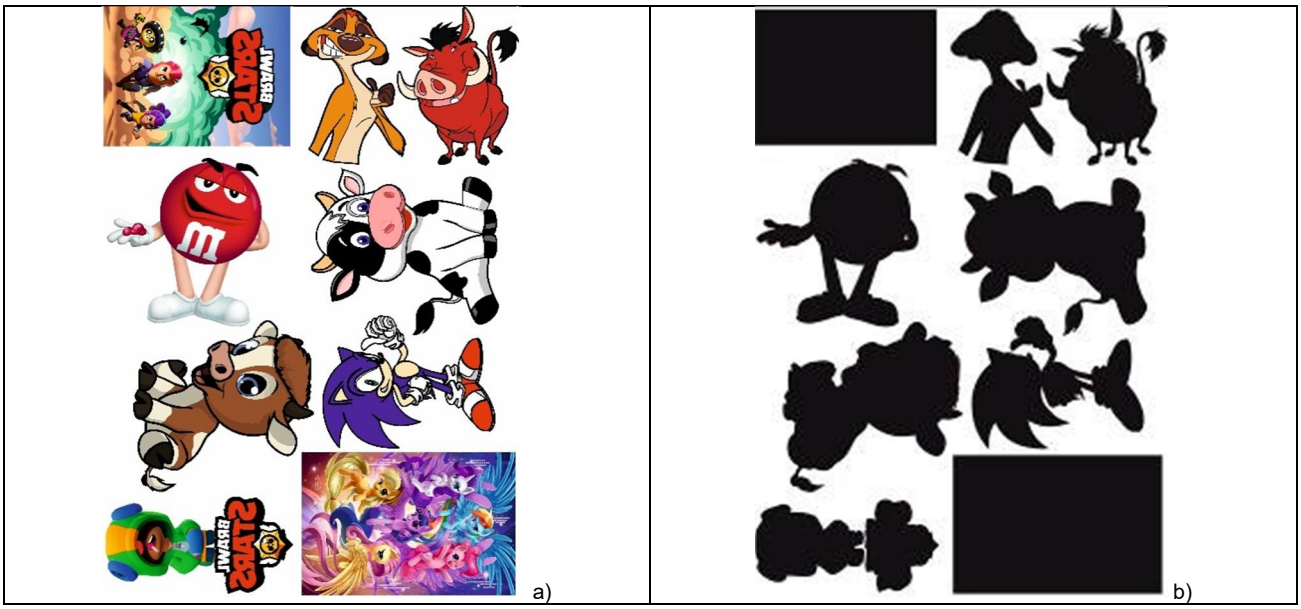


Figure 2 Production of transfer by offset printing a) offset printing b) a photo template for making a transfer

The next type of transfer, which, in our opinion, deserves attention, is obtained from a combination of two methods - offset image printing and screen printing. The technological process of manufacturing the transfer contains the following steps (Figure 2):

- drawing the image on the transfer medium on special offset machines used in the printing industry (Figure 2a). The most similar paints used in printing to plastisol are oil-based paints. After their transfer to the fabric surface, they retain elasticity, unlike other types of stains. Because offset machines are highly productive and require special prepress, which takes a long time, so printing small batches of images becomes impractical. Service firms work with minimum orders of 1000 sheets. The most common print formats are A2 and A1, while A3 and A3 + machines are less popular, so to reduce the cost of making the transfer on the print format, place an array of the same type or several different images (Figure 2a);
- preparation of a photo template and production of a printing form. Depending on the type of drawings, the desired effect, and the color of the fabric of the workpiece or product, the photo template (Figure 2b) is made with a black or white outline. In the case of a white design, the area of the photo template will be smaller than the area of the image, otherwise – large;
- overlap the picture with paint. As a rule, overlappings provide white color that will give a qualitative light basis. Using a photo template with a black outline, a white outline is obtained, respectively. Such a transfer is better to apply to white fabrics if the manufacturer does not intend to intentionally get the effect of a white outline on black and colored fabrics. If you use a photo template with a white design, then the paint that overlaps the pattern does not protrude beyond its contour, and such a transfer can be applied to white and black fabrics;
- application of powder glue on the surface of the paint;
- removal of adhesive residues from the free surface of the transfer;
- drying of the glue.

Production of DTF transfer by printing (direct to films) involves the application of special ink on the surface of the transfer on an inkjet printer. Paints have the same name DTF, which is resistant to high temperatures (up to 200°C), essential when transferring the image from the transfer surface to the material. The main feature of these printers is the ability to print with CMYK inks and overlap the entire image with white ink, which acts as a basis for the glue. In the case of applying white paint on top of a color pattern, the transfer can be used to black fabrics without losing image quality.

Other technological stages of transfer manufacturing are similar to the previous technology: application of glue and its drying. The operation of sprinkling the bond is done manually and drying in special dryers.

Today, there are automated transfer systems, including a DTF printer, a roll holder, an adhesive application system (Figure 3a), a dryer (Figure 3b), as well as a mechanism for winding the finished transfer into a roll (Figure 3c).

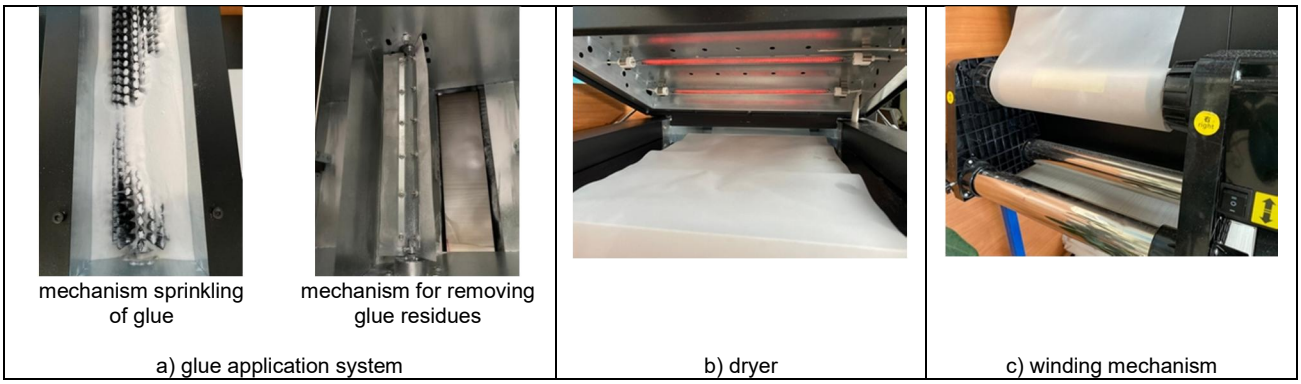


Figure 3 Automated transfer systems

Making transfers by laser printing has two options:

Option 1 Print on particular media on a laser printer, which allows you to print both CMYK and white toner. Different media are used for dark and white fabrics. After printing, the patterned media is transferred to the transfer. The image transfer from the transfer is similar to the previous cases on the press equipment or with an iron. The disadvantage of this technology is the need to manually cut the pattern along the contour of the transfer.

Option 2 The image is printed on a laser printer, which allows you to print CMYK colors on the transfer, used in screen or offset printing. After that, a photo template is made, and operations similar to offset transfer making are performed.

5 CONCLUSIONS

As a result of the carried-out work, technological features of processes of drawing by thermo transfer methods of the press are considered: by a screening method of the media; a combination of offset and screen printing; DTF (direct to films) printing; laser printing.

The differences between these methods from direct screen printing on textile materials are established.

The main methods of making transfers are analyzed, their technological parameters are revealed, and the peculiarities of transferring images made in different ways to textile materials are established.

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