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Evaluation of Various Printing Techniques for Cotton Fabrics

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Abstract

Textile printing is the process of applying ink to textile surfaces using specialized printing processes and machines. This is a discussion of the most popular printing methods. One of India's traditional arts that has been passed down through the ages is block printing. Because of their versatility, flat and rotary screen printing may produce at incredibly high rates. The most exciting developments in the industrial and textile industries are digital printing and burnout printing, which both produce distinctive designs. Direct printing draws attention because its pattern appears with a variety of colors on a dark backdrop. Examples include resist printing and discharge printing. Because the poisonous reducing and oxidising agents employed in the discharge printing technology harmed the environment, they have been replaced with eco-friendly enzymes. This study demonstrates the use of several natural materials and methods to print cotton, including direct printing with natural dyes like Madder ink jet, resist printing with reactive dye and transfer printing of Cotton Fabrics.

Keywords: Textile printing, “cotton fabric", printing techniques) Inkjet, Discharge, Resist and Transfer Printing).

Textile printing

The printing textile coloration is a wet process consisting of water, dye or pigment, thickening agent and other textile auxiliary agents for the printing of the paste.

As a result, the textile effluent has been severely contaminated by unfixed color or by materials from the printing paste that have been washed off. The development of new techniques, the development of chemical substitutes, and the application of new technology have all contributed to an increase in the environmental consciousness of textile printing. [1]

Due to their ability to respond quickly, the textile and apparel sectors solve environmental challenges. When it comes to water and energy-saving features, quality is more apparent. [2]

The freshly green prepared cotton fabric of this piece was printed with madder natural dye (CI Natural Red 9), continuing our interest in the green coloring of cotton fabric with natural dyes. Since it has hydroxyl groups that are both carboxylic and acidic, the natural color madder was used for this investigation. As a result, unique and straightforward printing paste compositions are proposed, which include madder natural dye and various thickeners without binder or other common printing paste ingredients like urea and ammonium sulfate.[3]

Textile printing is a controlled process that uses specialized printing methods and equipment to color cloth in predetermined patterns or motifs. It also refers to the technique of painting or sketching a pattern in color on textiles.[4]

With correctly printed fibers, the color is connected to the fiber to resist washing and crocking. [5]

Localized dyeing is a term used to describe textile printing. In contrast to dyeing, printing allows the dye to reach particular areas of the substrate. The main contrast between textile dyeing and printing techniques is how color is applied to the fabric. The

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fabric is submerged in a diluted dye-bath solution while being dyed, and the extra color is sucked out of the dye-bath. Contrarily, printing is frequently carried out by smearing thicker pastes with dyes or pigments and other auxiliary materials on a fabric surface following a color pattern.[6, 7]

Particularly significant is a printing paste's viscosity. [4, 7] It regulates how much paste is dispersed throughout and into the surface yarns of the fabric as well as how much is transferred to the fabric. The paste must deeply infiltrate the structure of the yarn to color all visible fibers on the printed surface.[8]

As a result, the wastewater burden is reduced. The development of current cotton coloring technology with low dye usage and low chemical use, such as digital inkjet printing, has been at the forefront of advances in safer garment production technologies. When compared to conventional screen printing, digital inkjet printing was hailed as a technological advance with several features and benefits, including non-contact printing, the absence of a printing screen, excellent image quality, creative design, flexible output, minimal electrolyte usage, etc. [9, 10]

Cotton Fiber

The most significant and ancient textile fiber is cotton. It has been put to use for countless years. The exact composition and structural characteristics of the fiber determine its properties.[11] The approximate composition of raw cotton is given in Table 1

Chemical structure

Cellulose is a linear natural polymer constructed from the condensation of β-glucose molecules linked together through e s1 and 4 positions.[7, 12] The chemical structure of cellulose can be represented as shown in Figure 1.

TABLE 1. Components of cotton fiber

Cellulose	85.5
Oil and Wax	0.5
Protein, Pectoses, and coloring matter	5
Mineral matter	1.0
Moisture	8.

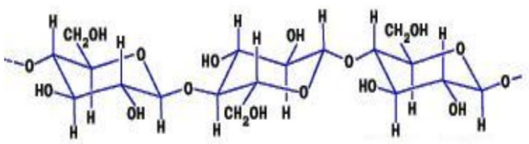

Fig.1. Chemical structure of cellulose.

The hydroxyl groups (OH) of the glucose unit are linked to the chemical reactivity of cellulose fibers. With moisture, dyes, and certain finishes, these groups react. By attacking the oxygen atom between the two ring units or within the ring and rupturing the chain or ring, chlorine bleaches rupture the cellulose molecular chain. A lengthy, linear chain of glucose molecules makes up the cellulose molecule. Fiber strength is influenced by chain length. [4, 7]

Classification of printing techniques

In general, there is a distinction between printing methods and printing aesthetics. Direct printing and indirect printing are the two main types of conventional textile printing techniques.[13]

Direct printing

The most common way to add a color pattern is by direct printing. The process can be carried out on white fabric or over already colored fabric, in which case it is known as overprinting. [14] It is sometimes referred to as "print-on" and is the most popular and simple method of printing on fabrics in the contemporary market. The word "direct" originally meant that there was no preceding mordanting or dyeing process involved. [15]

The dyes used to dye a fiber may potentially be used to print on the same fiber, and printing pastes come into direct touch with the fabric surface without undergoing any extra processing changes. [7, 16]

However, the most widely used coloring agent in textile direct printing is pigment, which accounts for about 75–80% of all printing processes. This is because pigment printing is a straightforward and inexpensive process that uses little equipment, doesn't need to be washed, and generates a small amount of waste.[13] And to produce fibers with the proper colorfastness properties, the dye materials used in the printing paste are selected based on a variety of elements, including the chemical makeup of the fiber.[17]With the knowledge that fixing and cleaning may be necessary, the final result is produced utilising the direct printing approach in a single step.[15, 18]

In the manufacturing and textile industries, digital printing is one of the most intriguing developments. An endless variety of colors and hues may be reproduced with digital textile printing, and the print quality is superb.[19, 20]

Inkjet printing of cotton fabrics

Reactive dye inkjet printing on cotton fabrics with the use of tiny nozzles, digital (inkjet) printing employs tiny droplets of colored liquid ink on the surface of precise points. Computers analyses the specific color inkjet, ink quantity, and position of the minute droplets. Digital printers use the four primary colors yellow, magenta, cyan, and black, which pose special color-mixing problems for textiles. [21]

Digital printers include numerous kinds, including continuous inkjet (CIJ) and fall-on-demand (DOD). [7]

Researchers have been at the forefront of developing sophisticated cotton coloring techniques in recent years that utilise few chemicals and few dyes, like digital inkjet printing. Digital inkjet printing has several features and benefits over conventional screen printing, including non-contact printing, no need for a printing screen, outstanding image quality, artistic design, variable output, and less electrolyte usage. [22, 23]

Although digital inkjet printing can somewhat improve the performance of dyes and chemicals, the dye problem was not fully solved due to the extensive usage of water and power. The limitations of inkjet digital printing on cotton, theoretically, result from the reactive coloring procedure. To enhance the diffusion and attachment of reactive dyes to cotton fibers, many thickeners (for example, sodium alginate), urea (about 100 g/L), sodium carbonate (about 25 g/L), and sodium bicarbonate (about 25 g/L) must be applied to the pre-treatment. In addition, steaming.[22]

Although there are many advantages of digital textile inkjet printing, such as high quality and scalable processing, there are also some challenges, such as the potential for dyes and chemicals to have serious adverse effects on the environment.[22]

By adsorbing C. I. Reactive Red 218 dies (RR218), a novel type of cationic poly (styrene-butyl acrylate-vinyl benzyl trimethylammonium chloride) (PSBV) Nano sphere was created as a solution to this problem, and used in inkjet printing on woven cotton fiber.[24]

The outcomes show that the RR218@PSBV nanosphere primed for ink preparation has a homogenous size and high stability. When compared to the dye RR218 solution, the color depth of printed RR218@PSBV material has increased by 1, 4 times, and the amount of dye leftovers in printing effluent has decreased by about 45%. Meanwhile, consumption of urea and sodium carbonate has lowered by about 3.3 mg/cm2 and 22.8 respectively in conventional inkjet prints mg/cm2, and a printing method that uses 30% less energy. In the study of the color enhancement procedure, nanosphere RR218@PSBV was found to improve the absorption coefficient and decrease the dispersion coefficient.[24] Figure 2 shows the inkjet printing machine.[19]

Indirect printing

Direct printing and indirect printing are distinct from one another. Indirect printing techniques include resist and discharge printing. Since the beginning, these methods have been utilized in textile printing.[15]

These styles will always be significant since the outcomes are frequently unique and visually superior, even though contemporary technology has enabled the use of direct printing possible for many more designs and reduced the need to employ them in recent years.[25]

Figure2: inkjet printing machine

Discharge printing

When using discharge printing for on-demand printing, the fabric is first dyed a solid color before being printed with a paste containing chemicals that can wash out the color during the subsequent steaming procedure. Is a backdrop color. The printed portions will be colored if the paste contains illumination colors, also referred to as dyes resistant to the discharging agent used.

Importance of Discharge Printing in the Industry

- Large swaths of the ground color are possible, and delicate colors and intricate patterns can be achieved on a dark foundation color with exceptional depth and clarity.
- A highly creative method of taking color out of clothing.
- The shirt's pattern is vague to nonexistent, and the colors shine.
- The best technique for printing with unconventional inks on dark clothing.
- Something different from screen printing's "norms."
- Upholding a high standard of detail.
- We provide discharge printing at no additional expense. Higher production costs but durable, unique designs; frequently less expensive than standard ink.[26, 27]

Printing cotton fabric with nature dye (madder) and (bio-mordant)

Gelatine-tannic acid (bio-mordant) treated cotton cloth was printed with both natural and artificial thickeners after being dyed with madder and a bio-mordant. Several variables were examined, including pH, steaming temperatures, time, and auxiliaries (urea, salt, and binder). Data showed that natural thickening and no auxiliary materials produced prints of higher quality than synthetic thickeners. [2]

Continuing from our worry about the green hue of natural cotton garments. For this research, the natural color madder was chosen since it contains both carboxylic and hydroxylic acid groups. To avoid using binders or other conventional printing pastes like urea and ammonium sulfate, a new, straightforward formulation of printing paste is provided. It contains natural madder color and several thickeners. The imprint ability of cotton fabrics was tested using comparison output under various printing circumstances. Also, the printed materials' overall fastness characteristics were evaluated.[28]

The color solution was created by combining 10 g of madder (Natural dyes; CI Natural Red 9) powder with 100 ml of distilled water at room temperature and stirring for 30 minutes. The mixture was filtered using a mesh cloth under pressure.[2] The above-mentioned amounts of urea and diammonium sulfate were then dissolved in 50 ml of dye solution (A). The quantity given was dissolved in 50 ml of distilled water to create a thickener solution (B). The print paste was then created by combining A and B with a 12 ml binder and swirling for 10 minutes at room temperature. Finally, a few drops of glacial acetic acid were added to the paste to bring the pH level to the appropriate level. To make the print paste without auxiliaries, the same technique was followed except for adding auxiliaries.

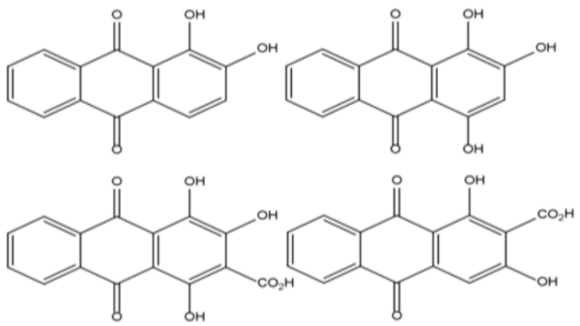

Fig.2. Chemical structure of madder natural dye[2]

Paste recipe printing

The following printing paste compositions were created for printing cotton garments with natural colors both with and without printing aids: print and paste auxiliary files 50 ml of natural dye solution (10% w/v) plus 50 ml of thickener (x% w/v) plus 4 g of urea, 1.25 g of diammonium sulphate, and 12 ml of binder (liquid) BD. Meypro gum's X value is equal to 8%; sodium alginates is 4%; synthetic thickeners are 3%, and CMC's is 4%.

Print and paste without any helpers:

Thickener (50 ml, x% w/v) and natural dye solution (50 ml, 10% w/v). Meypro gum has an X value of 16%, sodium alginate of 8%, synthetic thickener of 6%, and CMC of 8%.[27]

The impact on cotton (bio-mordant samples) fabrics of the formulation of print paste with a madder natural dye. The bio-mordant technique increases the color strength value for both printed formulations, indicating that more binding sites for dye fixation were formed as a result of the biological mordanting process. However, in bio-mordant samples, the print paste's improved value of color intensity (535%) is significantly higher than those obtained from a print paste using auxiliary items (27 percent).

The outcome indicates that the printing mechanism will adopt a pigment fixing mechanism for the sample and ionization control and bio-mordant sample ionization methods when the printed paste contains auxiliary components. The fact that the color intensity value of the bio-mordanted samples with the printing paste without auxiliary material was significantly higher than that of the control paste supports this. This shows that among all thickeners, an ionic mechanism between the dye (negatively charged) and the material (positively charged) was the best, and the data obtained is organised as follows. [10]

Sodium alginate > Meypro gum (non-ionic) > CMC > Synthetic thickening (anionic). This outcome might be explained by the thickener's charge because the more negatively charged the thickener's surface is, the less dye the cloth will absorb. Surprisingly, the control cotton cloth had poor printability and reckless usage of the thickening, indicating the results suggest that when the printed paste comprises auxiliary components, the printing mechanism will adopt a pigment fixing mechanism for the sample and ionization control and bio mordant sample ionization procedures. This is supported by the fact that the bio-mordanted samples with the printing paste without auxiliary material had color intensity values that were much greater than those of the control paste. The data acquired is organised as follows, demonstrating that an ionic mechanism between the dyes (negatively charged) and the materials' (positively charged) charges were the best among all thickeners.[10]

In place of urea CO $(NH_2)_2$, use CO to make the traditional reactive dye print pastes. Environmental issues arise when reactive dye print pastes are reduced or eliminated from urea. Because printing effluent has a significant nitrogen content, using urea poses environmental concerns. The removal or substitution of urea in cellulose printing has been done using a variety of methods. It has been demonstrated that using organic molecules from inorganic salt is an effective fix. These substances reduce the effluent burden because the majority of them tend to biodegrade.

Betaine, an organic substance, reduced the amount of inorganic salt.[9]

Numerous variables can affect cotton's ability to be printed. The period of vapor in prints, urea fixation, dye, and the absence or presence of alkalis. The qualities of fastness, leveling, and dye penetration.

In the procedures for making printing paste the sodium alginate had been soaked overnight. Warm water and dye paste Instead of urea, sodium acetate was added and mixed into the dyer solution. Resistant salt and sodium carbonate were added and thoroughly combined. Add sodium alginate gum to this dye paste after it has been prepared.

A steaming state of superheated steam was used to install print cotton samples that had been dried in air at room temperature for 24 hours before being superheated steam at 100°C for five minutes.

All samples showed greater values of color strength (K/S), except for the Urea-treated Green printed cotton samples. Other printed samples, except for Green, displayed lower reflectance levels (RFL). The least total color difference was achieved by blue. It is possible to cure dyed fibers by using stable, non-toxic organic salt in place of urea in reactive dye pastes. Black saw the greatest color loss.0

The outcome shows that organic salts/alkali, as opposed to conventional printing with urea/alkali, had the most beneficial effects. [10]

The obtained prints have high quality, sharp outlines, low penetration with significant dyestuff savings, and thus low demands on the printing of washing clothes, resulting in a decreased wastewater load. This is in addition to the low cost of organic salts and their use in reactive dyes cotton printing. This research advances the production of more environmentally friendly textiles.[21]

Application of different natural dyes

Four natural dyes were used to color the untreated and bio-mordanted cotton fibers under the ideal dyeing conditions determined from the investigations mentioned above. and how, based on the chemical structures of the colors, the procedure given proved effective for all dyes. The overall findings show that the degree of dye acidity, which would result in a higher dye absorption, determines how well natural dyes are fixed on bio-mordanted materials.

Interestingly, the K/S values follow the sequence madder> rhubarb> alkanet> curcumin, and the results are in good agreement with the acidity of the dyes.

The differences in the cotton fabric before and after tannic acid-gelatin bio-mordanting were demonstrated using FTIR of the bio-mordant cotton ATR-FTIR analysis. The hydrogen bonding between the OH and N-H groups after bio-mordanting reduced the bandwidth compared to the band of cotton alone before bio-mordanting, as indicated in the spectra in the range between 3500 and 3100 cm^{-1}. The characteristic pyranose C-O-C stretching vibration of cotton fabric shows this effect of bio-mordanting on narrowing the bandwidth.

The bandwidth of FTIR is in the order C (cotton) > CT (cotton-tannic) > CTG (cotton-tannic-gelatin).

This suggests that bio-mordanting starting with tannic and ending with gelatin increases the hydrogen bonding process with dehydration possibility upon curing at 120°C. The gelatin-specific amide bands may be seen at both 1660 cm^{-1} (C=O stretching) and 1554 cm^{-1} (N-H deformation).[29]

These peaks are interestingly displaced to lower wavenumbers and are seen in the CTG sample, showing that gelatin was involved in a reaction with fabric that had been exposed to tannic acid through the production of an imine bond (Schiff base).

Given that C=O amide also appears close by at 1640 cm^{-1}, the imine band vibration band may overlap with it. The entire finding points to the creation of a crosslinked layer between gelatin and the cotton-tannic sample to create the stable, non-washable CTG sample. Thus, in the aforementioned Schemes 2 and 3, a rough outline of the mechanism of the bio-mordanting process of cotton fabric with tannic acid-gelatin can be found.

Fastness properties

The fastness qualities of the bio-mordanted cotton fibers that have been colored using various natural dyes. The samples that were dyed with madder and alkanet natural dyes showed very well to outstanding fastness capabilities, and the samples that were dyed with rhubarb and curcumin natural dyes showed good to exceptional fastness properties. Because of the chemical connections formed between the dye molecule and the cotton fabric that has been bio-mordanted, all of the dyes' light fastness properties were remarkably good, demonstrating the suitability of bio-mordanting for improved dyeing.[28]

Discharge Printing Recipe on Cotton Fabric Dyed with Eco-Friendly Reactive Dye

Discharge printing is one of the printing styles, which is frequently referred to as the "ground" shadow and involves printing on a previously dyed textile. The color of the dyed cloth should always be locally decolored to create a "White" patterned look by using a suitable printer paste. The dyes should be chosen with care. On dark textiles, the un0load print can create delicate designs that are translucent and glossy. Through the use of the original color that has been chemically destroyed, the unloading style transfers the patterns of the material to the printed areas. In the context of this study, an effort has been made to improve the discharge printing recipe by optimising the dye and discharging agent concentration, as well as the physical and aesthetic characteristics of printing samples for cotton cloth dyed with environmentally friendly reactive dye.[27]

Reactive dye

Reactive dye was used in cotton fabric printing because it is harmless to the environment, easy to discharge, and good for the cellulose of the fabric.

Pre- treatments of the fabrics

To remove any natural impurities that would inhibit dyeing and printing, the entire length of the fabric was soaked in water the night before dying.

The detergent and sodium hydroxide were mixed in a 1:30 ratio with the right amount of soft water. Over the course of one to two hours, the tissue was immersed in the solution and occasionally boiled. After that, it was thoroughly cleaned and rinsed. The material was then ironed after drying in the shade for a portion of the time. Finally, the tissue was ready for dying.

To enhance dye concentration using the provided recipe, the reactive dye was applied to the scoured fabric.

Reactive dye =	1, 2, 3, 4, % (o.w.f)
Urea =	50 % (o.w.f)
Glauber's salt =	10 % (o.w.f)
Sodium carbonate =	10 % (o.w.f)

The paste needed to add the required amount of color was made with a tiny bit of water. Lukewarm water was used to create the paste, which contained the ingredient in a 1:30 liquor-to-substance ratio. Urea and glauber salt was added to the solution at 50°C and kept there until boiling at 100°C.

After adding the textiles, the mixture was agitated for ten minutes. Sodium carbonate was added to the dye bath, and 30 minutes was added.

When the dye bath boiled, the fabric was removed from the dye liquid and thoroughly washed under running water. Next, the cloth was set up in a shady area to dry. One of the best concentrations of colored samples was chosen based on visual evaluation and dye color speed.

Optimization of Rangolit C concentration The following recipe was used to make a discharge printing paste utilizing Rongalite C as a discharging agent.

Rongalite C =	5, 10, 15, 20g
Gum Tragacanth (paste form) =	50g
Zinc Oxide =	10g
Egg Albumin =	5g

All of the ingredients were properly combined to create the paste, which was then printed using the screen-printing technique on cloth that had already been dyed using widely available reactive colors. The printed cloth was allowed to dry for ten minutes. 5 minutes of steaming in a steamer at 100–102°C. The sample was then rinsed to get rid of the thickener, any leftover chemicals, and the colors. The optimal Rongalite C concentration was selected based on design clarity (strength and purity) and whiteness index.

Results optimized thickener concentration

Gum Tragacanth at varied amounts, i.e. 15g, 20g, 25g, 30g, and 35G, were chosen separately to make discharge paste for application on cotton samples that had previously been colored with 2 percent reactive dye. All samples had been discharged using these pastes, thus it was necessary to visually determine the ideal gum track agent concentration for producing discharge paste**.** Table 1 displays the outcomes. The printed sample with a 25g thickness was found to be the best option for reactive colors.

Gum Tragacanth has been dissolved completely when used at this concentration, resulting in a thick and smooth paste, making it the best concentration for sample discharge. It enables the paste to stay on the fabric's surface and to fill the space between the warp and the thread. Prints are also generated that are crisp and smooth.

Effect of chitosan on resist printing of cotton fabrics with reactive dyes

Resist printing: The fabric is initially treated with a composition that resists both dye penetration and fixing to prevent printing block color absorption during fabric dying or color application. The portions free of the resistive ingredient could be dyed during the dyeing process.

After cellulose, chitin is the most prevalent natural polymer and can be converted to chitosan, a cationic natural biopolymer, by alkaline N-deacetylation. N-acetyl glucosamine and glucosamine are present.

Copolymers demonstrate a variety of distinctive qualities, including non-toxicity, biocompatibility, and biodegradability. The resist printing agent was chitosan. Chitosan is used in acetic acid to create a high-coverage, insoluble membrane that exhibits exceptional chemical resistance. To evaluate its effect on resistant cotton textiles, a variety of chitosan concentrations, resistance agent types, cure temperatures, and cure times were used. The ideal chitosan concentration of 1.6 percent had the best resistance effect on imprinted cotton textiles. Chitosan had the greatest resistive effects when a mixture of 6:4 citric acid and 8:2 tartaric acid was utilized. 150°C was the appropriate curing temperature for 180 seconds.

Procedure for printing

In screen printing, a 200-mesh screen was used. When flat screen-printing cotton fabric samples, resistor paste is applied with a squeegee. To stop the paste from migrating, the samples were then pre-dried for three minutes at 80°C.

Following that, the samples were fixed with thermos-sol for a variety of times and temperatures (130 - 170°C) (120 - 240 s).

The printed material is cleaned for 15 minutes in 90°C cold water and then for 10 minutes in 80°C NP-9 solution. After being soaped, the samples were cleaned and dried. For comparison, a more durable print paste that contained 1.6 percent chitosan consistently was prepared and mixed separately with citric acid and tartaric acid (10:0, 8:2, 6:4, 4:6, 2:8, and 0:10).

The resistance printing of processed cotton fabrics was enhanced by the addition of chitosan to the paper-resistant paste. The impact of resistance printing changed nonlinearly with chitosan content and was very good at 1.6 percent chitosan. When the procedure was optimized, tartaric acid printing agents were used, and the impact was more than what could have been obtained separately with each agent. Resistance printing's consistency was normally acceptable on processed cotton textiles. Additionally, a variable amount of tartaric acid washes cotton that has been treated swiftly.

Products: Chitosan is capable of Grade 4. The wet rubbing fastness and dry rubbing speed of produced cotton textiles can both reach grades 3 to 4.[28]

Transfer Printing on Cotton Knits

Utilization of Acrylic Polymers in Cotton Fabric Transfer Printing

Sublimation printing is a well-liked indirect method currently utilized for textile coloring. Its primary drawback is that only synthetic materials can be dyed; as a result, fabrics must contain at least 65% synthetic fiber (mostly polyester). The cause is that dispersed dyes with the best affinity for synthetic fibers are used in sublimation printing techniques.

Comparative research was done on the aqueous dispersions of acrylic polymers utilized in textile pigment coloring methods. The objective was to investigate the effectiveness and suitability of locally made acrylic polymer modifiers as primers for thermal transfer printing applications.

For example, urethane polymers from foreign suppliers were employed extensively in the Russian textile industry for finishing fabrics. To determine which modifier most successfully increased the degree of transfer of dispersed dyes from the transfer paper to cellulose-containing textile materials, a selection of film-forming agents from among domestic polymers was conducted.[30]

A method of chemical modification of cotton fabrics

Water-dispersed acrylic (co)polymers can be used to treat fabrics with polymer modifiers, which is a way of chemically altering textiles that may be effective in increasing cotton fabrics' sensitivity to disperse dyes.

Applying sublimation inks (dyes) to the pretreated textile surface is how digital and/or transfer printing of fabrics containing cellulose is done.

Colorfastness, fabric handle softness, and color faithfulness are mostly determined by surface pretreatment and, to a greater extent, the polymer modifier utilized. Hanif Langer and Chavan.[31]

They recommended pretreating cotton polyester fabrics with a resin based on the reaction product of melamine formaldehyde with polyethylene glycol 200 in their study on transfer printing of cotton fabrics. Dispersed dyes were chosen for their capacity to interact with the resin because they allowed for good dye transfer and high wash and light fastness. The color fastness to laundering was ultimately due to the free NH2 group in the dispersed dye's structure. Resin modifier drawbacks include degradation of the fabric handle, potential for fabric yellowing during heat treatment, and unsustainable use.

Modern acrylic polymers make it possible to deal with environmental issues and create fabrics with pleasant handles. The potential for using both acrylic and urethane polymers for digital transfer printing on cotton products was specifically proven by Bemska and Szkudlarek.[32]

However, the lack of disclosure by developers regarding the chemical makeup of the polymeric agents and compositions used for fabric pretreatment makes it more difficult to substitute imported goods and drives up the price of the complete coloring technique.

In the work, modified versions of the domestically produced acrylic and urethane polymers were preferred. These are a group of lacrotene, ruzin, and larus polymers as well as aqua pools, which are urethane-based polymers. Comparatively, polymers from foreign manufacturers were utilized, which were widely employed in both Russian textile industries and sublimation printing for the finishing of textile materials.

The success of utilizing the aforementioned modifiers as thermal printing primers was assessed using several qualitative color indicators, including color saturation (intensity), color resistance to friction, and the amount of dye transfer from the paper substrate to the fabric.

A thermal press, model SFS-MO4B, was utilized for the sublimation transfer of colors to the cloth. Bleached cotton knit fabric served as the research's primary study material. The best domestically produced dispersed dyes for sublimation were chosen as coloring agents.[11]

These dispersed dyes include dark green, blue K p/e, yellow 6Z, and scarlet p/e, which were utilized for printing on paper as well as for determining the best conditions for dye transfer and fixing on fabric.

In the first stage, several tests were conducted, including altering both the temperature and time of the thermal transfer process, to choose the most effective polymers as modifiers of textile material for transfer printing. [33]

Illustrate how different acrylic polymers from different manufacturers affect the saturation of the colors that are produced when employing the aforementioned dispersed dyes (in the article, dispersed blue K is used as an example).

The observed patterns show that the highest quantity of dye is transferred to the canvas after 10 seconds of processing at all heat treatment settings.

However, at 180°C, the maximum color saturation (215–220 units) is reached with a 10-s duration of heat treatment, and further extension of this time is impractical. At 200°C and 210°C, the maximum color saturation (215–220 units) is achieved with a 60–s duration of processing.

Such designs were also created on a variety of urethane polymers, known as aqua pools, in addition to acrylic polymers.

The generated patterns demonstrate that less technologically sophisticated polymers like Larus-35, Ruzin-14I, and Ruzin-17B, which have residual stickiness, Rustan-14, and polyurethane C-612, which do not allow for the achievement of high color saturation and aid in the achievement of a stiff stamp.

In terms of color saturation, Larus-21I, Lacroten-E64, Aquapol-10, and Aquapol-11 are the best polymers. These polymers aid in the creation of high-quality colors with a soft stamp and high intensity (more than 220 units).

The Larus-21I polymer can be suggested for implementation based on the data acquired, taking into account the simplicity of use and its accessibility as well as economic and environmental factors.[33]

Polyurethanes cost significantly more money but have also demonstrated good outcomes. The choice of dye mixes to broaden the color spectrum of paintings from the trio of scattered dyes was the writers' greatest accomplishment.[34]

The author's evaluation of the compatibility of the chosen colors when used in conjunction with one another is interesting.

Conclusion

Scientists will be further inspired by the current ecological dyeing method for cotton fabric using natural dyes to continue their successful work in the field of textile colors. The impact on cotton (bio-mordant samples) fabrics of the formulation of print paste with a madder natural dye. The bio-mordant method raises the color strength value for both printed formulations. The outcome shows that organic salts/alkali, as opposed to urea/alkali printing traditionally, had the greatest beneficial benefits.

The obtained prints have high quality, sharp outlines, low penetration with significant dyestuff savings, and thus low demands on the printing of washing clothes, resulting in a decreased wastewater load. This is in addition to the low cost of organic salts and their use in reactive dyes cotton printing. This work demonstrates a development in the creation of cleaner textiles.

Significant advantages of digital textile inkjet printing are its excellent quality and scalable processing. Compared to the dye RR218 solution, the color depth of printed RR218@PSBV material has improved by 1.4 times, and the amount of dye leftovers in printing effluent has decreased by around 45%.Meanwhile, the consumption of urea and sodium carbonate in conventional inkjet prints has dropped by 22.8 and 3.3 mg/cm2, respectively, and a 30% energy saving printing technique has been streamlined. Discharge printing using a 3% eco-friendly reactive dye and cotton cloth. 20% rongalite C and 25% gum tragacanth. The addition of chitosan to the resist-printing paste improved the ability to print resist on treated cotton fabrics. Concerning chitosan concentration, the resist-printing effect had a nonlinear relationship and was best at 1.6% chitosan. When the printing process was optimized with tartaric acid, the results were better than what could be achieved using each chemical independently.

For the first time, full green dyeing of cotton fabric that has been bio-mordanted using various natural dyes is displayed. The pH-dependent dyeability, which is maximum at pH 4.5, points to an ionic interaction between the dye and the fabric that has been subjected to bio-mordants. The finest natural dye for highlighting the significance of having a high number of acidic groups in the dye molecule and the effect of the chemical structure was madder since it had a high dye absorption and very good to exceptional fastness qualities. Therefore, the current ecological dyeing method for cotton fabric using natural dyes instead of metal ion salts will further motivate scientists for further environmentally friendly successful work in the field of textile coloration in the future.

The regularities of the fixing processes of dispersed dyes on knitwear in the presence of polymer modifiers were taken into consideration, and Larus-21I was chosen as the most effective one based on its ability to provide a dye sublimation transition with the greatest dye yield on the knitted fabric and obtain good dye strength. The following circumstances were ideal for the thermal transfer of colors to the fabric: At a processing temperature of 200°C, 10–20 seconds.

The assessment of the dispersion dyes' compatibility in the chosen triad when combined shows the dyes' strong compatibility in terms of sublimation qualities.

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تقييم تقنيات الطباعة المختلفة للأقمشة القطنية

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الملخص

الطباعة الموسعة هي عملية تطبيق الحبر على أسطح النسيج باستخدام عمليات وآلات طباعة متخصصة. هذه مناقشة لأساليب الطباعة الأكثر شيوعًا. إحدى الفنون التقليدية في الهند التي تم تناقلها عبر العصور هي الطباعة بالقوالب. نظرًا لتعدد استخداماتها ، قد تنتج طباعة الشاشة المسطحة والدوارة بمعدلات عالية بشكل لا يصدق. أكثر التطورات إثارة في الصناعات النسيجية والصناعية هي الطباعة الرقمية والطباعة المحترقة ، وكلاهما ينتج تصميمات مميزة. تجذب الطباعة المباشرة الانتباه لأن نقشها يظهر بمجموعة متنوعة من الألوان على خلفية داكنة. تشمل الأمثلة مقاومة الطباعة وطباعة التفريغ. نظرًا لحقيقة أن عوامل الاختزال والأكسدة السامة المستخدمة في تقنية طباعة التفريغ أضرت بالبيئة ، فقد تم استبدالها بأنزيمات صديقة للبيئة ، وتوضح هذه الدراسة استخدام العديد من المواد والطرق الطبيعية لطباعة القطن ، بما في ذلك الطباعة المباشرة باستخدام الأصباغ الطبيعية مثل الفوة الناقثة للحبر ، تقاوم الطباعة باستخدام الصبغة التفاعلية وطباعة نقل الأقمشة القطنية.

الكلمات المفتاحية: طباعة المنسوجات ، "نسيج قطني" ، تقنيات الطباعة) نفث الحبر ، تفريغ ، مقاومة ونقل الطباعة).