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3,454,347

FABRIC DYEING BY TRANSFERRING BY HEATING OR SOLUBILIZING A DYE FROM AN ELECTROSTATICALLY DEPOSITED, HEAT OR SOLVENT FUSED WATER SOLUBLE DIELECTRIC CARRIER

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12 Claims

This invention relates to a process for printing textile fabrics without contact or pressure and more particularly, it relates to a process for electrostatically transferring patterns of dye to fabrics.

The electrostatic method of printing on paper has been recently developed. In this process areas of an electrically charged conductive fine-mesh open screen are masked in a desired pattern. The paper being printed may be backed by a conductive plate with an opposite charge relative to the charge of the screen. The printing powder is transferred to paper under the influence of the electrostatic field which is produced between the screen and the conductive plate by passing through the open meshes of the screen. As this process is carried out, the screen does not actually contact the paper to which the printing powder is transferred.

It would be desirable to print patterns of colors on textile fabrics by this electrostatic process; however, if a permanent printed pattern is to be obtained on the fabrics the specific dyes for the textiles must be fixed into the textile fibres. Of course, it is known to fix pigments to textile fibres by means of appropriate binding agents, such as artificial resins, but this method has not generally been satisfactory because it adversely affects the hand of the textile material and other properties of the fabric while it is in use.

Another difficulty which has prevented the electrostatic printing of fabrics has been that the usual textile dyes which have been used successfully in the past are unsatisfactory for electrostatic printing because they lack the necessary dielectric properties. Moreover, it has been recognized that the use of an electrostatic process for printing the fabrics necessitates a special sequence of steps for transferring the dye composition to the fabric and fixing the dye on the fabric which in turn requires special properties in the dye composition.

I have conceived by my invention a process by which I am able to overcome the objections to and disadvantages of the prior art so as permit electrostatic deposition and fixation of dye patterns on fabrics.

An important aspect of my invention resides in a process for printing dye on textile fabrics without contact or pressure which comprises electrostatically depositing the dye composition, or material, in a pattern on the fabric temporarily fixing said dye composition to the fabric, permanently, fixing the dye to the fabric, and removing the ancillary substances and excess dye from the fabric. The dye composition comprises at least one textile dye which is suitable for the particular fabric being printed and at least one dielectric carrier substance for the dye. The composition can also include auxiliary chemical substances which aid in the fixation of the dye to the fabric or improve the properties of the dielectric carrier.

The process of this invention is applicable to the printing of all manner of textile fabrics, and "fabrics" herein is used to include any cloth, woven, knitted, or non-woven. The process is applicable to printing natural and regenerated cellulose, cellulose derivatives, wool,

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synthetic fibres such as polyamides or polyesters, and mixtures of any of the aforementioned types of fibres.

In the process of this invention, the desired patterns are transferred to the fabric by electrostatic means, i. e., a pattern of particles of the dye composition is produced by means of a screen, the screen is placed in proximity to the fabric, and a strong electrostatic field is produced between the screen and the fabric so as to cause transfer of the particles through the open meshes of the screen to the fabric. As is known in the art, the screen can be, for example, in the form of a plane or cylinder.

The dielectric carriers used in the practice of this invention can be any natural or synthetic resins, or polymers, which are soluble in water. Particularly desirable in the practice of this invention are those resins or polymers which may be hydrolyzed by acids or alkalies so as to become water-soluble. Exemplary of natural resins especially suited for use as dielectric carriers in the practice of this invention are rosin (also known as colophony) and derivatives thereof, such as rosin esterified with glycerin or pentaerythritol, dimerized and polymerized rosin, unsaturated or hydrated rosin or derivatives thereof, rosins or derivatives thereof modified with phenolic or maleic resins and phenolic or maleic resins modified with rosin or derivatives thereof. Other natural resins with properties similar to rosin, such as dammar, copal, sandarak, shellac, and talloel, can be successfully used in the practice of this invention.

Many synthetic resins, or polymer materials, are also suited for use as dielectric carriers in the practice of this invention. Examples of said synthetic resins which are particularly suited for the practice of this invention are vinyl polymers such as polyvinyl alcohol, polyacrylic acid, and polyacrylamide; non-hardening phenol polymers (also known as "novolacs"); polyester resins, such as linear polymers prepared from dicarboxylic acids, e.g., phthalic acid or sebacic acid, and a diol such as ethylene glycol; and polyamides, such as condensation products of sebacic acid and hexamethylenediamine.

The dielectric carriers for use in carrying out the process of this invention should possess a high electrical resistance for good transfer in the electrostatic field. They should also have the quality of not interfering with penetration of the dye into the textile fibres during the final fixation operation. Moreover, after the dye has been fixed these dielectric carriers should be completely removable by a washing operation. Another desirable property of the dielectric carriers is that of coagulating under suitable conditions. Further, under some circumstances it is desirable that they counteract capillary forces which arise in the fixation operation and thereby prevent "bleeding" of the dye pattern with resultant loss of sharpness of the pattern at the edge of the printed area.

While the foregoing dielectric carriers can satisfactorily be utilized alone in the process of this invention, it is frequently desirable to combine the carrier with auxiliary chemicals which will facilitate penetration of the dye into the textile during the final fixation operation. Further, auxiliary chemicals can assist in prevention of "bleeding" of the dye pattern by preventing the swelling or coagulation of the dielectric carrier. Exemplary of desirable auxiliary chemicals are cellulose ethers, such as methoxycellulose, organic acid-cellulose ether derivatives, polyvinyl alcohol, starch, starch derivatives, sodium alginate, and locust bean flour and its derivatives.

It is generally preferred in the practice of this invention to use the dye composition in the form of a very fine powder, preferably with a particle size in the range of from about 1 to about 10 microns. The composition can be prepared from an aqueous solution or a slurry and then dried by evaporation. The resulting mixture is

ground and sieved to obtain the requisite particle size distribution.

In order to maintain the dielectric properties of the powdered dye composition, it may further be desirable to encapsulate the dye and the auxiliary chemicals in the dielectric carrier. For example, this encapsulation may be accomplished by distributing the materials to be encapsulated, together with the components which are to act as the encapsulating agent, as fine droplets or particles in an immiscible liquid, so that by coacervating the materials through an interface condensation or an interface surface polymerization a shell is formed. For example, the dye with the auxiliaries (if these latter are desirable) can be distributed in a solvent, for example carbon tetrachloride, in which an acid chloride, such as sebacyl chloride is dissolved. This mixture is subdivided in water to obtain very fine droplets and by the addition of an amine, such as hexamethylenediamine, at an elevated temperature, the integument is formed. The resulting particles of encapsulated material can, thereafter, be separated by filtration or centrifugation and then dried.

The dye may be temporarily fixed to the fabric by melting it with the application of heat, by partially dissolving it with water, either in the form of an aqueous spray or as steam, or by partially dissolving it with an organic solvent, either in liquid form or as vapor. Final permanent fixation may be accomplished in a number of different ways, according to the type of fibre and the dye which is used. For example, a steaming process or dry heat may be used to fix the dye to the fabric. Depending upon the nature of the dye, it may also be necessary or desirable to treat the material with aqueous solutions before final fixation of the dye. For example, it may be necessary to impregnate the fabric with an aqueous solution of alkali, such as sodium hydroxide or sodium carbonate, and also a reducing agent for the dye.

The transfer of the dye composition to the surface of the fabric in the electrostatic field, as well as the temporary fixation, must be carried out in a continuous, i.e. in immediate sequence operation. The final fixation and the concluding washing out operation to remove the residue of unused dye, dielectric carrier, and auxiliaries may be done separately in a later operation. Where multi-colored patterns are to be produced on the fabric, the various color compositions are transferred to the fabric surface sequentially, with a temporary fixation being used immediately after the application of all colors.

A number of specific examples of the practice of the process are set forth below in order that those skilled in the art may become familiar with some specific embodiments of this invention, and these are not to be considered as representing the entire scope of this invention.

Unless otherwise indicated, all parts and percentages herein specified are by weight.

EXAMPLE I

A powdered dye composition was prepared by mixing into 200 parts of molten rosin 40 parts of Indanthrene Brilliant Blue 3 G C.I. No. 69,840 and 40 parts of "Tylose DKL" methoxycellulose. After thoroughly mixing and milling the foregoing ingredients, the mixture was cooled, solidified, ground and sieved to obtain a powder having a particle size of from about 1 to about 10 microns.

This powdered dye composition was transferred in the form of a pattern onto a cotton fabric. The pattern was obtained by transferring the composition through the open meshes of fine-mesh screen in which the non-printing areas are suitably masked to the cotton by means of an electrostatic field, which was produced by applying one pole of a high voltage direct current source to the screen and the other pole to a plate underlying the fabric, the plate and fabric lying parallel to the screen. The resulting electrostatic field produced between the screen and the plate caused the electrically charged particles of powdered dye composition to be drawn to the fabric.

The cotton fabric with the pattern of dye composition was temporarily fixed by heating for one minute in an infrared heating oven at 140° C., whereupon the dye composition melted into the textile. The fabric was then rolled up. Prior to the permanent fixation of the dye in the fibers the fabric was impregnated with a solution which consisted of 8 kg. "Rongal A" dithionide composition, 6 l. of 38° Baumé sodium hydroxide, 4 kg. of calcined sodium carbonate and 1 kg. sodium tetraborate in 100 l. of water. Thereafter, the fabric was subjected to superheated steam at 120° C. for 30 seconds for the final dye fixation, and then washed in boiling water to remove any excess dye, rosin, and methoxycellulose. To re-oxidize the dye, the fabric was treated with an aqueous solution of 2 g./l. of 40% hydrogen peroxide and 4 cc./l. of concentrated ammonium hydroxide solution, then washed with water, and dried.

The printed fabric so produced showed very good color fastness to light and laundering.

EXAMPLE II

A dye composition was prepared by dispersing 40 grams Indanthrene Yellow 6 GK 100% vat dye C.I. No. 56,080 in 960 grams of water into which dispersion 200 grams of "Elvanol 51-05" polyvinyl alcohol, were stirred to form a paste. In order to obtain small particle size, the mixture was passed through a color mill and then dried in a vacuum so as to be essentially water-free. Preparation of the dye composition was completed by grinding it to a powder with a particle size in the range of from about 1 to about 10 microns.

The composition was printed onto a cotton fabric as described in Example I. The dye composition was temporarily fixed to the fabric by a fine spray of water, and the fabric was dried. The impregnation with aqueous alkaline solution and a reducing material the permanent fixation, and the reoxidation of the dye took place as described in Example I.

The pattern-printed cotton fabric showed excellent color fastness to light and laundering.

EXAMPLE III

A dye composition was prepared by stirring 200 grams of a rosin-glycerinester with an acid number of 10-20 into a mixture of 40 grams of Cibacron Brilliant Red BD powder, reactive monochlorotriazinyl azo dye, C.I. Reactive Red 24, 40 grams "Lamitex" sodium alginate, 40 grams urea and 880 grams water. This mixture was passed through a color mill, dried under vacuum, and ground.

The spun rayon fabric to be printed was pre-impregnated with an aqueous solution containing 100 g./l. sodium carbonate and dried. The dye composition was printed on the fabric as described in Example I.

Temporary fixation of the dye composition was accomplished by heating the fabric for 30 seconds in an infrared heating oven at 150° C. The fabric was heated with hot air at 150° C. for four minutes for permanent fixation; washed with a large excess of water at 50-60° C. to remove excess dye, the auxiliaries, and the dielectric carrier; and dried.

The printed spun rayon fabric showed excellent color fastness to light and laundering.

EXAMPLE IV

The dye composition was prepared by grinding a molten mass of 40 grams Irganol orange GRLS, acid diazo dye, C.I. Acid Orange 94, 200 grams rosin, and 50 grams urea. The solidified mixture was then ground to a powder with particles having a size of about 1 to about 10 microns.

This dye composition was printed on a nylon fabric according to the procedure described in Example I. The dye composition was fixed temporarily to the fabric by heating for 30 seconds in an infrared oven at a temperature of 140-150° C. The permanent fixation was carried out by subjecting the fabric to a saturated steam at 110°

C. for 60 minutes. Thereafter the fabric was washed with water at 50–60° C. to remove the excess dye, the auxiliary, and the dielectric carrier, and was dried.

While the foregoing example shows the use of an acid dye, dyes chosen from the group of metal complex dyes can be used equally satisfactorily.

Although certain particular embodiments of the invention are herein disclosed for purposes of explanation, further modifications thereof, after study of this specification, will be apparent to those skilled in the art to which this invention pertains. Reference should accordingly be had to the appended claims in determining the scope of my invention.

What I claim is:

1. A process for printing textile fabrics without direct contact or pressure which comprises the steps of electrostatically depositing at least one dye composition in a pattern on a fabric, said dye composition comprising a fabric dye in the form of a fine dry powder and encapsulated in a water soluble resinous dielectric carrier, immediately subsequent to said depositing, temporarily fixing said dye composition to said fabric by partially dissolving the deposited carrier without releasing the dye therefrom with the result that said carrier mechanically binds the dye to the fabric, thereafter releasing said dye from said carrier by converting the dye to a soluble form and permanently fixing said dye to said fabric, and removing said water soluble carrier by full dissolution thereof.

2. The process of claim 1 wherein the dielectric carrier is chosen from the group consisting of polyvinyl alcohol and polyacrylamide.

3. The process of claim 1 wherein the dielectric carrier is chosen from the group consisting of rosin, esterified rosin, dammar, copal, sandarak, shellac, talloel, polyacrylic acid, non-hardening phenol polymers, polyesters and polyamides.

4. The process of claim 1 wherein the dye composition is a powder having a particle size on the order of from about 1 to about 10 microns.

5. The process of claim 1 wherein the dye composition is temporarily fixed to the fabric by partially dissolving it with water.

6. The process of claim 1 wherein the dye composition is temporarily fixed to the fabric by partially dissolving it with an organic solvent.

7. The process of claim 1 wherein said dielectric carrier is a resin which has been hydrolyzed to become water soluble.

8. A process for printing textile fabrics as in claim 1 wherein said fabric is subjected to an aqueous solution to enhance the final fixation, such treatment taking place following said temporary fixation.

9. A process as in claim 1 wherein said dielectric carrier includes auxiliary chemicals which facilitate the penetration of dye into said textile.

10. A process for printing textile fabric without direct contact or pressure which comprises the steps of electrostatically depositing at least one dye composition in a pattern on a fabric, said dye composition comprising a fabric dye in the form of a fine dry powder and encapsulated in a water soluble resinous dielectric carrier, immediately subsequent to said deposition temporarily fixing said dye composition to said fabric by partially melting the carrier without releasing the dye therefrom with the result that said carrier mechanically binds the dye to the fabric, thereafter releasing said dye from said carrier by heating and permanently fixing the dye to the fabric, and removing the water soluble carrier by full dissolution thereof.

11. The process of claim 10 wherein the dielectric carrier is polyvinyl alcohol or polyacrylamide.

12. The process of claim 10 wherein the dye composition is a powder having a particle size on the order of from about one to about ten microns.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

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It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, after line 10 insert --Claims
priority Swiss Application No. 5970/63,
filed May 13, 1963--

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(SEAL)

Attest:

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