This invention pertains to inkjet printing on textile including using a pretreatment solution containing poly(acrylic) acid, hydrophilic copolymers of poly(acrylic) acid or mixtures thereof to control bleed.
PRETREATMENT OF TEXTILE FOR INKJET PRINTING

CROSS REFERENCE TO RELATED APPLICATIONS


BACKGROUND OF THE DISCLOSURE

[0002] This invention pertains to inkjet printing on a pretreated fabric with pigmented inkjet inks, and to a pretreatment solution for the fabric that allows high quality printing thereon.

[0003] Digital printing methods such as inkjet printing are becoming increasingly important for the printing of textiles and offer a number of potential benefits over conventional printing methods such as screen printing. Digital printing eliminates the set up expense associated with screen preparation and can potentially enable cost effective short run production. Inkjet printing further allows visual effects such as tonal gradients and infinite pattern repeat sizes that cannot be practically achieved with a screen printing process.

[0004] Bleed of one color into another is a typical problem in inkjet printing because inks have relatively low viscosity and tend to spread especially for inkjet printers having capability of printing three or four primary colors in a simultaneous (or near simultaneous) fashion. Such bleed of one printing liquid into an adjacent printing liquid results in production of indistinct images with a poor degree of resolution.

[0005] Various methods have been proposed to prevent bleed of adjacent printing liquids. One method is to apply the two printing liquids at a distance from one another so that no intermingling or mixing of the printing liquids can occur. However, this method produces images of poor resolution. Another method involves a delay in applying the second printing liquid until the first printing liquid is completely dry. This method is disadvantageous due to its inefficiencies. Yet another approach to control bleed is to increase the rate of penetration of the printing liquid into the substrate, but this causes a reduction of optical density.


[0007] U.S. Pat. No. 5,785,743 discloses the use of an organic acid component in one ink to pair with another ink containing a pH sensitive colorant to reduce bleed for printing on paper.

[0008] A need exists for a textile pretreatment composition that can accommodate all the various factors such as weave, weight and any other applied treatment from manufacturer that impact image quality. The present disclosure satisfies this need by providing a textile pretreatment composition to reduce bleed on natural and unnatural fibers.

SUMMARY OF THE DISCLOSURE

[0009] An embodiment provides a method of digitally printing a textile comprising the steps of:

[0010] (a) pretreating said textile with an aqueous pretreatment solution comprising a bleed control agent selected from the group consisting of poly(acrylic) acid, hydrophilic copolymers of poly(acrylic) acid and mixtures thereof;

[0011] (b) drying the pretreated textile; and

[0012] (c) digitally printing the dried, pretreated textile with a colored ink jet ink; wherein said bleed control agent is present in an amount less than 5% by weight based on the weight of said pretreatment solution, and said ink jet ink comprises a pigment, a dispersant to disperse said pigment, and a polymeric binder, and said binder is cross-linked with a cross-linking agent or cross-linking groups present in said textile.

[0013] Another embodiment provides that the method optionally comprising an additional post printing step of curing with melamine at a temperature greater than 180° C.

[0014] Another embodiment provides that the bleed control agent has a pH of between 2 and 5.

[0015] Another embodiment provides that the textile is a synthetic material.

[0016] Another embodiment provides that the cross-linking agent is an epoxide.

[0017] Another embodiment provides that the pretreatment solution further comprises a surfactant.

[0018] Another embodiment provides that the pretreatment solution has a viscosity of less than 4 cP.

[0019] Another embodiment provides that the polymeric binder is a polyurethane.

[0020] Yet another embodiment provides that the cross-linking agent is a carbodiimide.

[0021] These and other features and advantages of the present embodiments will be more readily understood by those of ordinary skill in the art from a reading of the following Detailed Description. Certain features of the disclosed embodiments which are, for clarity, described above and below as separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the disclosed embodiments that are described in the context of a single embodiment, may also be provided separately or in any subcombination.

DETAILED DESCRIPTION

[0022] Unless otherwise stated or defined, all technical and scientific terms used herein have commonly understood meanings by one of ordinary skill in the art to which this disclosure pertains.

[0023] Unless stated otherwise, all percentages, parts, ratios, etc., are by weight.

[0024] When an amount, concentration, or other value or parameter is given as either a range, preferred range or a list of upper preferable values and lower preferable values, this is to be understood as specifically disclosing all ranges formed from any pair of any upper range limit or preferred value and any lower range limit or preferred value, regardless of whether ranges are separately disclosed. Where a range of numerical values is recited herein, unless otherwise stated, the range is intended to include the endpoints thereof, and all integers and fractions within the range.

[0025] When the term “about” is used in describing a value or an end-point of a range, the disclosure should be understood to include the specific value or end-point referred to.

[0026] As used, herein, the term “dispersion” means a two phase system wherein one phase consists of finely divided particles (often in a colloidal size range) distributed through-
out a bulk substance, the particles being the dispersed or internal phase and the bulk substance being the continuous or external phase.

[0027] As used herein, the term “dispersant” means a surface active agent added to a suspending medium to promote uniform and maximum separation of extremely fine solid particles often of colloidal sizes. For pigments, the dispersants are most often polymeric dispersants, and the dispersants and pigments are usually combined, using a dispersing equipment.

[0028] As used herein, the term “OD” means optical density.

[0029] As used herein, the term “aqueous vehicle” refers to water or a mixture of water and at least one water-soluble, or partially water-soluble (i.e., methyl ethyl ketone), organic solvent (co-solvent).

[0030] As used herein, the term “substantially” means being of considerable degree, almost all.

[0031] As used herein, the term “dyne/cm” means dyne per centimeter, a surface tension unit.

[0032] As used herein, the term “cP” means centipoise, a viscosity unit.

[0033] As used herein, the term “mPa·s” means millipascal second, a viscosity unit.

[0034] As used herein, the term “mN·m⁻¹” means milliNewtons per meter, a surface tension unit.

[0035] As used herein, the term “mS·cm⁻¹” means milliSiemens per centimeter, a conductivity unit.

[0036] As used herein, the term “EDTA” means ethylenediaminetetraacetic acid.

[0037] As used herein, the term “IDA” means iminodiacetic acid.

[0038] As used herein, the term “EDDHA” means ethylenediamine-dio-hydroxyphenylacetic acid.

[0039] As used herein, the term “DHEG” means dihydroxyethylglycine.

[0040] As used herein, the term “DTPA” means diethylenetriamine-N,N,N′,N′-pentaaacetic acid.

[0041] As used herein, the term “GEDTA” means glycol-ethylenediamine-N,N′,N′-tetraacetic acid.

[0042] As used herein, Surfynol® 465 is a surfactant from Air Products (Allentown, Pa., U.S.A.).

[0043] As used herein, the term “RMSD” refers to root mean square deviation.

[0044] As used herein, the term “jettablity” means good jetting properties with no clogging or deflection during printing.

[0045] As used herein, the term “DTG” means direct to garment.

[0046] Unless otherwise noted, the above chemicals were obtained from Aldrich (Milwaukee, Wis., U.S.A.) or other similar suppliers of laboratory chemicals.

[0047] The materials, methods, and examples herein are illustrative only except as explicitly stated, and are not intended to be limiting.

Pretreatment Solution

[0048] The pretreatment solution used in the method of the present disclosure contains a bleed control agent selected from the group consisting of polyaacrylic acid, hydrophilic copolymers of polyaacrylic acid and mixtures thereof. Typically, the pretreatment solution comprises a solution of a polyaacrylic acid, hydrophilic copolymers of polyaacrylic acid or mixtures of polyaacrylic acid, hydrophilic copoly-mers of polyaacrylic acid in water. Other organic ingredients such as co-solvents, swelling agents, coalescing agents, viscosity modifiers, typically, will not be included in the pretreatment solution. Optionally, the pretreatment solution contains a surfactant. Co-solvent(s) may be present when a surfactant is employed. Ingredient percentages of the bleed control agent and the surfactant herein are weight percent based on the total weight of the pretreatment solution, unless otherwise indicated.

[0049] The bleed control agent is included in the pretreatment solution in an effective amount to control bleed relative to without the bleed control agent. Typically, the bleed control agent is present in the pretreatment solution at a level of at least about 0.2 by weight based on the total weight of the pretreatment solution. The upper level is not limited, but is dictated by considerations such as compatibility with other ink components. In one embodiment, the bleed control agent is present in a range of 0.1% to 5% based on the total weight of the pretreatment solution. In another embodiment, the bleed control agent is present in a range of 0.2% to 4% based on the total weight of the pretreatment solution. The appropriate levels of bleed control agent can be readily determined by one of ordinary skill in the art through routine experimentation.

Surfactant

[0050] The surfactant can be any surfactant that lowers the surface tension of the multivalent salt solution to about 15 to about 10 dynes/cm or preferably about 18 to about 30 dynes/cm. The amount of surfactant is from about 0.05% to about 10% by weight, typically from about 0.25 to about 8% by weight and more typically from 0.5 to 6% by weight based on the as received weight from the commercial supplier. Typically the surfactant may contain some organic solvent components and/or water.

[0051] Up to 5% by weight of organic solvents may be included in the pretreatment solution especially those solvents that are part of the available surfactant.

Textile

[0052] The textile to be pretreated can be any textile suitable for printing with colored inkjet inks. Typically, the textile includes natural material such as cotton and cotton blends, and synthetic material such as polyester.

Pretreatment of Textile

[0053] Application of the pretreatment to the textile can be any convenient method and such methods are generally well-known in the art. One example is an application method referred to as padding. In padding, a textile is dipped in the pretreatment solution, then the saturated textile is passed through nip rollers that squeeze out the excess solution. The amount of solution retained in the textile can be regulated by the nip pressure applied by the rollers. Other pretreatment techniques include spray application wherein the solution is applied by spraying on the face or back of the textile. Spraying can be limited to the digitally printed area of the printed textile. An example of where this limited spraying would be particularly applicable is in the digital printing of an image on preformed textile articles such as, for example, a T-shirts, caps, undergarments and like clothing articles.

[0054] After application of pretreatment, the textile may be dried in any convenient manner. The textile is preferably substantially dry at the time of printing, such that the final
percent moisture is (approximately) equal to the equilibrium moisture of the pretreated textile at ambient temperature. The absolute amount of moisture in the textile, of course, can vary somewhat depending on the relative humidity of the surrounding air.

Colored Inkjet Inks

[0055] The colorant used for printing the colored image may be a dye or a pigment. Dyes include disperse dyes, reactive dyes, acid dyes and the like. The colored inkjet inks are preferably aqueous and do not contain components that are UV curable.

[0056] Pigmented inks are preferred. Pigmented inkjet inks suitable for use in the present method typically comprise a pigment dispersed in a vehicle. Typically, the vehicle is an aqueous vehicle. More typically, the pigment ink comprises an anionically stabilized pigment dispersed in an aqueous vehicle.

[0057] The selected pigment(s) may be used in dry or wet form. For example, pigments are usually manufactured in aqueous media, and the resulting pigments are obtained as a water-wet presscake. In presscake form, the pigment does not agglomerate to the extent it would in dry form. Thus, pigments in water-wet presscake form do not require as much mixing energy to de-agglomerate in the premix process as pigments in dry form. Representative commercial dry pigments are listed in U.S. Pat. No. 5,085,698.

[0058] Some examples of pigments with coloristic properties useful in inkjet inks include: cyan pigments from Pigment Blue 15:3 and Pigment Blue 15:4; magenta pigments from Pigment Red 122 and Pigment Red 202; yellow pigments from Pigment Yellow 14, Pigment Yellow 95, Pigment Yellow 110, Pigment Yellow 114, Pigment Yellow 128 and Pigment Yellow 155; red pigments from Pigment Orange 5, Pigment Orange 34, Pigment Orange 43, Pigment Orange 62, Pigment Red 17, Pigment Red 49:2, Pigment Red 112, Pigment Red 149, Pigment Red 177, Pigment Red 178, Pigment Red 188, Pigment Red 255 and Pigment Red 264; green pigments from Pigment Green 1, Pigment Green 2, Pigment Green 7 and Pigment Green 36; blue pigments from Pigment Blue 60, Pigment Violet 3, Pigment Violet 19, Pigment Violet 23, Pigment Violet 32, Pigment Violet 36 and Pigment Violet 38; white pigments such as TiO₂ and ZnO; and black pigment carbon black. The pigment names and abbreviations used herein are the “C.I.” designation for pigments established by the Society of Dyers and Colourists, Bradford, Yorkshire, UK and published in The Color Index, Third Edition, 1971.

[0059] The range of useful particle size after dispersion is typically from about 0.005 micrometers to about 15 micrometers. Typically, the pigment particle size should range from about 0.005 micrometers to about 5 micrometers; and, specifically, from about 0.005 micrometers to about 1 micrometer. The average particle size as measured by dynamic light scattering is less than about 500 nm, typically less than about 300 nm.

[0060] The amount of pigment present in the ink is typically in the range of from about 0.1% to about 25% by weight, and more typically in the range of from about 0.5% to about 10% by weight, based on the total weight of ink. If an inorganic pigment is selected, the ink will tend to contain higher percentages by weight of pigment than with comparable inks employing organic pigment, since inorganic pigments generally have higher densities than organic pigments.

Aqueous Vehicle

[0061] Selection of a suitable aqueous vehicle mixture depends on requirements of the specific application, such as the desired surface tension and viscosity, the selected colorant, drying time of the ink, and the type of substrate on which the ink will be printed. Representative examples of water-soluble organic solvents which may be utilized in the present disclosure are those that are disclosed in U.S. Pat. No. 5,085,698.

[0062] If a mixture of water and a water-soluble solvent is used, the aqueous vehicle typically will contain about 30% to about 95% of water with the remaining balance (i.e., about 70% to about 5%) being the water-soluble solvent. Compositions of the present disclosure may contain about 60% to about 95% water, based on the total weight of the aqueous vehicle.

[0063] The amount of aqueous vehicle in the ink is typically in the range of about 70% to about 99.8%; specifically about 80% to about 99.8%, based on total weight of the ink.

[0064] The aqueous vehicle can be made to be fast penetrating (rapid drying) by including surfactants or penetrating agents such as glycol ether(s) or 1,2-alkanediols. Suitable surfactants include ethoxylated acetylene diol (e.g., Surlyn® series from Air Products), ethoxylated primary (e.g., Neodol® series from Shell) and secondary (e.g., Tergitol® series from Union Carbide) alcohols, sulfosuccinates (e.g., Aerosol® series from Cytec), organosilicones (e.g., Silwet® series from Witco) and fluoro surfactants (e.g., Zonyl® series from DuPont).

[0065] The amount of glycol ether(s) or 1,2-alkanediol(s) added must be properly determined, but is typically in a range of from about 1% to about 15% by weight, and more typically about 2% to about 10% by weight, based on the total weight of the ink. Surfactants may be used, typically in an amount of from about 0.01% to about 5%, and specifically from about 0.2% to about 2%, based on the total weight of the ink.

Polymeric Dispersant

[0066] The polymeric dispersant for the non-self-dispersing pigment(s) may be a random or a structured polymer. Typically, the polymeric dispersant is a copolymer of hydrophobic and hydrophilic monomers. The “random polymer” means polymers where molecules of each monomer are randomly arranged in the polymer backbone. For a reference on suitable random polymeric dispersants, see: U.S. Pat. No. 4,597,794. The “structured polymer” means polymers having a block, branched, graft or star structure. Examples of structured polymers include AB or BAB block copolymers such as the ones disclosed in U.S. Pat. No. 5,085,698; ABC block copolymers such as the ones disclosed in EP Patent Specification No. 0556649; and graft polymers such as the ones disclosed in U.S. Pat. No. 5,231,131. Other polymeric dispersants that can be used are described, for example, in U.S. Pat. No. 6,117,921, U.S. Pat. No. 6,262,152, U.S. Pat. No. 6,306,994 and U.S. Pat. No. 6,433,117.

Polymeric Binders

[0067] Polymeric binders are polymers that improve the durability of a pigment dispersion once it is deposited onto a surface. Unlike a dispersant, binder usually do not have the functionality or structure to adequately stabilize a pigment dispersion. Binders are often added after a pigment dispersion has been made.
The binders can be soluble in the vehicle or in a dispersed form, and can be ionic or nonionic. Soluble binders include linear homopolymers and copolymers or block polymers. They also can be structured polymers including graft or branched polymers, stars and dendrimers. The dispersed polymers may include, for example, latexes and hydrogels. The polymers may be made by any known process including, but not limited to, free radical, group transfer, ionic, condensation and other types of polymerization. They may be made by a solution, emulsion, or suspension polymerization process. Typical classes of polymeric binders include anionic acrylic, styrene-acrylic and polyurethane polymer.

A polymeric binder is typically present at a level between about 0.01% and about 10% by weight, based on the total weight of an ink. The upper limit is dictated by ink viscosity or other physical limitations.

Cross-linking of Polymeric Binder

The polymeric binder can contain cross-linkable functional moieties. Such polymeric binder is thus capable of reacting with a cross-linking agent. Identified in the table below are equilatable cross-linkable functional groups that can be included in the polymeric binder and the companion cross-linking groups that may be present in the cross-linking agent.

<table>
<thead>
<tr>
<th>Cross-linkable Moieties</th>
<th>Cross-linking Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOH</td>
<td>Epoxide, Carbodiimide, Oxazoline, N-Methyl</td>
</tr>
<tr>
<td>Hydroxyl</td>
<td>Epoxide, Silane, Isocyanate, N-Methyl</td>
</tr>
<tr>
<td>Amino</td>
<td>Epoxide, Carbodiimide, Oxazoline, N-Methyl</td>
</tr>
</tbody>
</table>

The mole ratio of the cross-linkable moieties on the polymeric dispersant to the cross-linking group(s) on the cross-linking agent is from 1:5:1 to 1:1.5, typically from 9:1 to 1:1.1, and most typically from 8:1 to 1:1. In calculating the mole ratio, all cross-linkable moieties on the polymeric dispersants and all cross-linking groups on the cross-linking agent are included.

Alternatively, cross-linkable functional moieties on a polymeric binder can react with cross-linking groups present in a textile resulting in cross-linking.

Other Additives

Other ingredients, additives, may be formulated into the inkjet ink, to the extent that such other ingredients do not interfere with the stability and jettability of the inkjet ink. This may be readily determined by routine experimentation by one skilled in the art.

Surfactants are commonly added to inks to adjust surface tension and wetting properties. Suitable surfactants include the ones disclosed in the Vehicle section above. Surfactants are typically used in amounts up to about 5% and more typically in amounts up to 2% by weight, based on the total weight of the ink.

Inclusion of sequestering (or chelating) agents such as ethylenediaminetetraacetic acid (EDTA), iminodiacetic acid (IDA), ethylenediamine-di(o-hydroxyphenylacetic acid) (EDDHA), nitrilotriacetic acid (NTA), dihydroxyethylglycine (DHEG), trans-1,2-cyclohexanediiminetricarboxylic acid (CyDTA), diethylenetriamine-N,N,N',N'-pentacetic acid (DTPA), and glycolyletherdiamine-N,N,N',N'-tetraacetic acid (GEDTA), and salts thereof, may be advantageous, for example, to eliminate deleterious effects of heavy metal impurities.

Ink Sets

The term “ink set” refers to all the individual inks or other fluids an inkjet printer is equipped to jet. Ink sets typically comprise at least three differently colored inks. For example, a cyan (C), magenta (M) and yellow (Y) ink forms a CMY ink set. More typically, an ink set includes at least four differently colored inks, for example, by adding a black (K) ink to the CMY ink set to form a CMYK ink set. The magenta, yellow and cyan inks of the ink set are typically aqueous inks, and may contain dyes, pigments or combinations thereof as the colorant. Such other inks are, in a general sense, well known to those of ordinary skill in the art.

In addition to the typical CMYK inks, an ink set may further comprise one or more “gumet-expanding” inks, including differently colored inks such as an orange ink, a green ink, a red ink and/or a blue ink, and combinations of full strength and light strength inks such as light cyan and light magenta. Such other inks are, in a general sense, known to one skilled in the art.

A typical ink set comprises a magenta, yellow, cyan and black ink, wherein the black ink is an ink according to the present disclosure comprising an aqueous vehicle and a self-dispersing carbon black pigment. Specifically, the colorant in each of the magenta, yellow and cyan inks is a dye.

Ink Properties

Jet velocity, separation length of the droplets, drop size and stream stability are greatly affected by the surface tension and the viscosity of the ink. Pigmented ink jet inks typically have a surface tension in the range of about 20 dyne/cm to about 70 dyne/cm at 25°C. Viscosity can be as high as 30 cP at 25°C, but is typically somewhat lower. The ink has physical properties compatible with a wide range of ejecting conditions, i.e., driving frequency of the piezo element or ejection conditions for a thermal head for either a drop-on-demand device or a continuous device, and the shape and size of the nozzle. The inks should have excellent storage stability for long periods so as not to clog to a significant extent in an ink jet apparatus. Furthermore, the ink should not corrode parts of the ink jet printing device it comes in contact with, and it should be essentially odorless and non-toxic.

Although not restricted to any particular viscosity range or printhead, the inventive ink set is particularly suited to lower viscosity applications such as those required by thermal printheads. Thus, the viscosity of the inventive inks at 25°C can be less than about 7 cP, typically less than about 5 cP, and more typically than about 3.5 cP. Thermal inkjet actuators rely on instantaneous heating/bubble formation to eject ink drops and this mechanism of drop formation generally requires inks of lower viscosity.

Printing Method

The present method relates to digitally printing a pretreated textile, where the pretreated textile may have been dried. Typically, this involves the following steps:

1. Providing an inkjet printer that is responsive to digital data signals;
2. Loading the printer with a textile to be printed, in this case the pretreated textile;
(3) loading the printer with the above-mentioned inks or inkjet ink sets; and

(4) printing onto the media using the inkjet ink or inkjet ink set in response to the digital data signals.

After the printing the printed media may be heated to dry the printed image. The heating conditions depend on the media and its maximum temperature before melting, sagging or the like. A mild heating condition can be about 70°C for about 15 minutes. A simple oven may be used for this post printing step.

Printing can be accomplished by any inkjet printer equipped for handling and printing on textile. Commercial printers include, for example, the Dupont™ Arisitri™ 3210 and 2020 printers (Wilmington Del.), the Mimaki TX (Nagano, Japan) series of printers, US Screen Printing T-Shirt Printer (Tempe, Ariz.) and a DTG printer from Impression Technology (Sydney, Australia).

As indicated above, a variety of inks and ink sets are available for use with these printers. Commercially available ink sets include, for example, DuPont™ Arisitri™ P3500 and P5000 series inks.

The amount of ink laid down on the textile can vary by printer model, by print mode (resolution) within a given printer and by the percent coverage need to achieve a given color. The preferred amount of ink in each drop is less than about 35 picoliters, preferably less than about 25 picoliters, and more preferably less than 15 picoliters. The amount of inkjet that can be jetted onto a media is dependent on the media and the printer. For instance, for the DTG printer and transparencies a drop size of less than 10 picoliters produces the best printed image.

The following examples illustrate the invention without, however, being limited Thereto.

### EXAMPLES

**Printing Conditions**

The examples described below were done using DTG printers Belquette Mod 1 and Flexijet. Printing was done with print resolution set to 1440x720 dpi and 720x720 dpi. The textile substrate used were Gildan 50/50 polycotton blend shirts and 100% Augusta polyester shirt.

**Pretreatment Solutions**

Reagent grade poly(acrylic) acid (Aldrich) was mixed with deionized water until the poly(acrylic) acid was completely dissolved in a solution. The surface tension was measured with a Kruss tensiometer with a platinum plate at ambient temperature.

**Evaluation of Color Characteristics**

The L*, a*, b*, C* and h parameters of a CIE L*a*b* color scale were measured for each printed textile with and without a pretreatment using a X-Rite colorimeter, Model SP-64 from X-Rite Inc. The total color difference, ΔE*, was then calculated. Also measured was gamut volume of selected textile print set.

**Various black and color inks from the DuPont™ Arisitri™ P5000 series were used in the examples summarized in Table 1 without further modification. Each test was carried out in duplicate and the averaged result was tabulated. Printing was done with print resolution set to 1440x720 dpi. As shown in Table 1 below, printing conducted on textiles, Gildan 50/50 polycotton, treated with the pretreatment (PT) solution of the instant disclosure showed significant total color differences when compared to printing conducted on textiles without the pretreatment.**

<table>
<thead>
<tr>
<th>Examples</th>
<th>Gildan 50/50</th>
<th>Color measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>polycotton</td>
<td>L*</td>
</tr>
<tr>
<td>Ex. 1</td>
<td>P5000+ Black with PT</td>
<td>34.56</td>
</tr>
<tr>
<td>Control Ex. 1</td>
<td>P5000+ Black w/o PT</td>
<td>27.39</td>
</tr>
<tr>
<td>Ex. 2</td>
<td>P5000+ Cyan with PT</td>
<td>55.09</td>
</tr>
<tr>
<td>Control Ex. 2</td>
<td>P5000+ Cyan w/o PT</td>
<td>56.06</td>
</tr>
<tr>
<td>Ex. 3</td>
<td>P5000+ Magenta with PT</td>
<td>83.61</td>
</tr>
<tr>
<td>Control Ex. 3</td>
<td>P5000+ Magenta w/o PT</td>
<td>84.37</td>
</tr>
<tr>
<td>Ex. 4</td>
<td>P5000+ Yellow with PT</td>
<td>51.89</td>
</tr>
<tr>
<td>Control Ex. 4</td>
<td>P5000+ Yellow w/o PT</td>
<td>45.65</td>
</tr>
<tr>
<td>Ex. 5</td>
<td>P5000+ Process Red with PT</td>
<td>52.77</td>
</tr>
<tr>
<td>Control Ex. 5</td>
<td>P5000+ Process Red w/o PT</td>
<td>46.49</td>
</tr>
<tr>
<td>Ex. 6</td>
<td>P5000+ Process Green with PT</td>
<td>52.46</td>
</tr>
<tr>
<td>Control Ex. 6</td>
<td>P5000+ Process Green w/o PT</td>
<td>50.88</td>
</tr>
<tr>
<td>Ex. 7</td>
<td>P5000+ Process Blue with PT</td>
<td>41.70</td>
</tr>
<tr>
<td>Control Ex. 7</td>
<td>P5000+ Process Blue w/o PT</td>
<td>31.23</td>
</tr>
</tbody>
</table>
As shown in Table 2 below, similar results were obtained printing on a different textile, 100% Augusta polyester.

TABLE 2

<table>
<thead>
<tr>
<th>Examples</th>
<th>Polyester</th>
<th>L*</th>
<th>a*</th>
<th>b*</th>
<th>C*</th>
<th>H</th>
<th>Delta E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex. 8</td>
<td>P5000+ Black Poly with PT</td>
<td>32.59</td>
<td>0.87</td>
<td>0.97</td>
<td>1.30</td>
<td>47.89</td>
<td>6.00</td>
</tr>
<tr>
<td>Control Ex. 8</td>
<td>P5000+ Black Poly w/o PT</td>
<td>38.56</td>
<td>1.02</td>
<td>1.47</td>
<td>1.79</td>
<td>55.22</td>
<td></td>
</tr>
<tr>
<td>Ex. 9</td>
<td>P5000+ Cyan Poly with PT</td>
<td>47.78</td>
<td>-1.99</td>
<td>-43.76</td>
<td>43.80</td>
<td>267.40</td>
<td>9.68</td>
</tr>
<tr>
<td>Control Ex. 9</td>
<td>P5000+ Cyan Poly w/o PT</td>
<td>54.25</td>
<td>-5.94</td>
<td>-37.73</td>
<td>38.20</td>
<td>261.05</td>
<td></td>
</tr>
<tr>
<td>Ex. 10</td>
<td>P5000+ Magenta Poly with PT</td>
<td>51.35</td>
<td>55.36</td>
<td>-7.29</td>
<td>55.84</td>
<td>352.50</td>
<td>6.07</td>
</tr>
<tr>
<td>Control Ex. 10</td>
<td>P5000+ Magenta Poly w/o PT</td>
<td>55.17</td>
<td>52.10</td>
<td>-10.69</td>
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<td>44.04</td>
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<td>7.43</td>
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<td>292.34</td>
<td>348</td>
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<td>29.57</td>
<td>294.66</td>
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What is claimed is:

1. A method of digitally printing a textile comprising the steps of:
   (a) pretreating said textile with an aqueous pretreatment solution comprising a bleed control agent selected from the group consisting of poly(acrylic) acid, hydrophilic copolymers of poly(acrylic) acid and mixtures thereof;
   (b) drying the pretreated textile; and
   (c) digitally printing the dried, pretreated textile with a colored ink jet ink;
   wherein said bleed control agent is present in an amount less than 5% by weight based on the weight of said pretreatment solution, and said ink jet ink comprises a pigment, a dispersant to disperse said pigment, and a polymeric binder, and said binder is cross-linked with a cross-linking agent or cross-linking groups present in said textile.

2. The method of claim 1, optionally comprising an additional post-printing step of curing with melamine at a temperature greater than 180°F.

3. The method of claim 2, wherein said bleed control agent has a pH of between 2 and 5.

4. The method of claim 3, wherein said textile is a synthetic material.

5. The method of claim 4, wherein said cross-linking agent is an epoxide.

6. The method of claim 5, wherein said pretreatment solution further comprises a surfactant.

7. The method of claim 6, wherein said pretreatment solution has a viscosity of less than 4 cPs.

8. The method of claim 4, wherein said cross-linking agent is an epoxide.

9. The method of claim 9, wherein said pretreatment solution further comprises a surfactant.

10. The method of claim 10, wherein pretreatment solution has a viscosity of less than 4 cPs.

11. The method of claim 1, wherein said polymeric binder is a polyurethane.

12. The method of claim 11, wherein said bleed control agent has a pH of between 2 and 5.

13. The method of claim 12, wherein said textile is a synthetic material.

14. The method of claim 13, wherein said cross-linking agent is an epoxide.

15. The method of claim 14, wherein said pretreatment solution further comprises a surfactant.

16. The method of claim 15, wherein said pretreatment solution has a viscosity of less than 4 cPs.

17. The method of claim 13, wherein said cross-linking agent is a carbodiimide.

18. The method of claim 17, wherein said pretreatment solution further comprises a surfactant.

19. The method of claim 18, wherein said pretreatment solution has a viscosity of less than 4 cPs.

* * * * *