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PROCESS OF VAT DYEING

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This invention relates to a process of dyeing textile fibers, and more particularly to an improvement in the continuous Pad-Steam dyeing process for dyeing textiles with vat dyes.

In the Pad-Steam process, as more particularly described in U.S. patent to Stott et al. 2,487,197, textile material, preferably in the open width, is dyed with vat dyes in a continuous manner by padding the vat color onto the cloth in pigment form, then, with or without drying the textile material, it is passed through a reducing solution of a caustic alkali and an alkaline metal hydrosulfite at a temperature below that at which the actual reduction of the dye takes place, and then the goods is immediately passed through an air-free steam chamber whereby a reduction and fixation of the color takes place quickly.

In this process where the textile padded with the unreduced vat dye pigment is dried before it is treated with a reducing agent there is invariably some migration of the dye to the surface of the fabric. This migration may produce white spots under projecting nubs or neps, and differences in the face-to-back strength within the fabric. This uneven penetration and distribution of the dye in it and over the fabric is attributed to a movement or migration of the dye pigment on or within the fabric during the drying operation. To overcome or lessen this migration, various salts or other materials such as sodium chloride, sodium acetate, glue or similarly acting agents are added to the pigment padding solution. Often these agents tend to cause flocculation of the dye particles into larger aggregates and because of this give coarser-appearing dyeings, and it is often difficult or impossible to obtain a proper balance between the migration control and the resulting smoothness of dyeing.

Where the pigment padded fabric is not dried but is passed directly from the pigment pad bath through the reducing pad solution, the migration referred to in the drying step does not occur, but there is movement of the pigment through the fabric and a bleeding of the pigment into the chemical bath which gives rise to non-uniformity in the dyeing. Often the dyeings exhibit a streaked surface appearance, often referred to by the dyers as "hunger," a condition which is particularly noticeable on hard surface mercerized fabrics, often making them unacceptable in commerce. Although the wet process cannot be applied satisfactorily to mercerized cotton material of hard twist construction such as poplins, sateens, broadcloths and the like, it finds use in the dyeing of toweling or terry cloth because the pile of such unmercerized cloth tends to diminish the apparent irregularities on the surface of the dyed goods.

It is therefore an object of the present invention to inhibit the migration of dye pigment in the continuous Pad-Steam process which is caused by drying the pigment-padded fabric before treatment with a reducing agent, thereby improving the uniformity or resulting smoothness of the resulting dyeing. It is a further object of the invention to reduce the bleeding of the pigment from the pigment-padded textile and into the reducing bath in the wet process, thereby providing more level dyeings when the continuous Pad-Steam dyeing process is carried out without drying between the pigment-pad and the chemical-pad. It is a still further object of the invention to provide an improvement in the Pad-Steam

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continuous dyeing process whereby the drying step may be eliminated.

It has been found that dyeings of improved uniformity and smoothness can be obtained by the Pad-Steam continuous dyeing process if after the goods has been padded with the dispersed vat dye pigment it is held in a wet state for from one to fifteen minutes before further processing such as drying or passing the padded textile through the reducing solution. More specifically, the present invention is directed to the continuous Pad-Steam dyeing process for dyeing textile fabrics with vat dyes in which the fabric is first padded with an aqueous dispersion of the unreduced vat dye to a moisture content of from 50% to 100% based on the weight of the fabric, and then either before or after drying passing the pigment-padded fabric through a caustic alkali and alkali metal hydrosulfite reducing and developing solution. The present invention comprises holding the vat dye pigment-padded fabric prior to further processing (such as drying or passing it through the reducing pad) in the moist state for a period sufficient to inhibit the migration of the dye pigment in the fabric during the drying step, and to substantially reduce the bleeding of the pigment from the textile in the reducing bath, the holding period being for from one to fifteen minutes. In either the wet or dry processes mentioned above, the textile after passing through the alkaline reducing solution (ordinarily sodium hydroxide and sodium hydrosulfite) is immediately run into an air-free steam chamber to effect reduction and fixation of the dye in the fabric and then further processed in accordance with the usual practice, namely, by oxidation of the reduced dye to insolubilize it, followed by rinsing, soaping and drying operations.

In the process which is modified in accordance with this invention, the wet pigmented goods are stored or held without drying for a period of about one minute to about fifteen minutes, depending upon the degree of dispersion of the dye. The more highly dispersed dyes require a longer holding time than the less highly dispersed dyes. The preferred holding or dwell period is from about one minute to about three minutes. By introducing the holding step, much less migration occurs during subsequent drying and the dyeing is much more uniform and smooth or level. This dual effect is unexpected because the control of migration of the pigment and attainment of smoothness of dyeing have been in opposition; when one effect was obtained, the other was made worse. Furthermore, when a hold period is provided after pigment-padding the fabric, the drying step may be eliminated and still good quality, uniform, acceptable dyeings are obtained, particularly when dyeings of light shades are being produced. In producing heavier shades, better results are obtained by drying or partially drying the pigment-padded fabric following the hold period in the wet state than by keeping the fabric wet, although in heavy shades acceptable dyeings are obtained when a hold period is employed and the fabric is kept wet.

The controlled hold or delay step of the process is accomplished in various ways. One effective procedure is to pass the pigment-padded fabric over and under a series of rollers for the desired elapsed time through a highly humid atmosphere. High humidity must prevail during the hold period to prevent even a partial drying of the fabric which could be accompanied by migration of the pigment. Another procedure is to run the pigment-padded fabric onto a frame or scray, which is covered to prevent drying, and allow the fabric to remain in this container for the hold period. A still further way to obtain a holding of the pigment-padded fabric in a wet condition is to pass the fabric into a J-box, a J-shaped container sometimes employed for storing plaited goods or for bleaching, and to remove the fabric after the desired stor-

age period. After holding the pigmented fabric in a wet state by any of the above means, it may be completely or partially dried before it is treated with the reducing agent, or it may remain wet for the treatment with the reducing agent.

The temperature to which the wet pigmented fabric may be subjected during the hold period may vary from 33° F. to 180° F., and the improved results of the non-drying dwell period will be attained. Temperatures much in excess of 180° F. lead to decreasingly effective results. The preferred and most practical temperature range for this step of the procedure is that of the usually prevailing room temperature of a dyehouse, i.e., from about 65° F. to 110° F.

From about a one-minute to about a 15-minute hold period accomplishes the purpose of the invention. Time intervals less than 30 seconds are ineffective, and intervals longer than 15 minutes are not necessary and serve only to increase the yardage of fabric required in process. The fabric during the hold period may be under tension or be kept in a relaxed state, and the finished dyed goods will exhibit a levelness of color with the absence of the adverse effects of migration or bleeding of the pigment within or from the fabric.

The present invention is applicable to the dyeing of any vat dyes according to the Pad-Steam continuous dyeing process as more particularly described in the Stott et al. U.S. Patent No. 2,487,197. The indigoid and anthraquinone type dyes, including the thioindigoid, anthanthrone, benzanthrone and indanthrone, and other anthraquinone types, may be used in this process. Usually the vat dyes employed will be in the form of pastes in which the dyes are dispersed with a surface-active agent. The amount of dye usually applied to the goods will vary from 0.01 part to about 5 parts by weight (dry) per 100 parts of fabric.

The following examples are given to more specifically illustrate the invention. The parts used are by weight, unless otherwise specified.

Example 1

Mercerized cotton broadcloth was padded in a pigment pad bath at 80° F. containing 50 grams per liter of C.I. Vat Blue 6 paste, followed by squeezing to a 50% weight pickup. The dye was used in the form of a paste containing 20% by weight of the dye solids dispersed with the sodium salt of a condensation product of naphthalenesulfonic acids and formaldehyde. The wet pigmented fabric was then held for 15 minutes without moisture loss. For convenience, this was done by placing the wet fabric in a polyethylene plastic bag. After the hold period and while still wet, the pigmented fabric was immersed in a bath at 80° F. containing 30 grams per liter each of sodium hydroxide and sodium hydrosulfite and 50 grams per liter of sodium chloride. The chemically treated pigmented fabric was immediately steamed for 20 seconds at 212° F. in an air-free steam chamber, followed by immersion in a bath at 130° F. containing 5 grams per liter each of glacial acetic acid and hydrogen peroxide. The dyeing process was completed by rinsing, soaping, rerinsing, and finally drying the fabric in the usual manner.

Much less bleeding of the dye into the alkaline hydrosulfite bath occurred in the above described procedure than in the same procedure in which the hold period for the wet pigmented fabric was eliminated. The resultant dyeing exhibited good levelness, whereas the dyeing obtained by the same procedure without a hold period between pigment padding and impregnating with the reducing agent was uneven and unacceptable.

Similar acceptable level dyeings were obtained and much reduced bleeding of the dye into the chemical bath

occurred by the above procedure when C.I. Vat Green 1, C.I. Vat Brown 3, C.I. Vat Red 1 and C.I. Vat Blue 18 were employed in place of C.I. Vat Blue 6.

When in the above procedure mercerized cotton poplin fabric was employed in place of the broadcloth and the wet pigmented fabric was held in either a relaxed condition or under tension for two minutes before the treatment with the alkaline reducing solution, the resultant dyeings were of good uniform quality. Similar results were obtained when the fabric was a work clothing mercerized cotton twill.

Dye pastes in which the dye was dispersed with a cationic agent such as polymeric 2-(diethylmethylenammonio)ethyl methacrylate methosulfate and with a non-ionic agent such as the condensation product of 20 mols of ethylene oxide and 1 mol of dodecanol, gave good quality uniform dyeings when employed in the procedure of this invention.

Example 2

Mercerized cotton poplin was padded as described in Example 1, employing 50 grams per liter of C.I. Vat Blue 6 paste. The wet pigmented fabric was held for two minutes under tension under a polyethylene covering without loss of moisture, and then dried in a hot flue. After drying, the fabric was padded at 80° F. with a bath containing 45 grams per liter each of sodium hydroxide and sodium hydrosulfite, followed by steaming at 212° F. for 20 seconds. The customary oxidation, rinsing and soaping completed the dyeing operation. The resultant dyeing showed a marked reduction in migration of the dye through the fabric as compared to the migration which occurred when the hold period was not allowed, and the dyeing was of excellent smoothness. Without the hold period for the wet pigmented fabric, a distinct uneven final dyeing was obtained.

Similar improved results were obtained when the wet pigmented fabric was subjected to a two-minute non-drying dwell period in a relaxed condition before being dried for the treatment with the reducing agent.

I claim:

1. In a continuous process for dyeing textile fabrics with vat dyes in which the fabric is first padded with an aqueous dispersion of the unreduced vat dye to a moisture content of from 50% to 100% based on the weight of the fabric and then either before or after drying the pigment-padded fabric is padded with a caustic alkali and alkali metal hydrosulfite reducing and developing solution, the improvement which comprises holding the vat dye pigment-padded fabric, prior to further processing, in the moist state and under non-drying conditions for a period sufficient to inhibit the migration of the dye pigment in the fabric during subsequent treatment and to substantially reduce the bleeding of the pigment from the textile in the reducing bath, which holding period is for from 1 to 15 minutes.

2. In a continuous process for dyeing textile fabrics with vat dyes in which the fabric is first padded with an aqueous dispersion of the unreduced vat dye to a moisture content of from 50% to 100% based on the weight of the fabric and after drying the pigment-padded fabric is padded with a caustic alkali and alkali metal hydrosulfite reducing and developing solution, the improvement which comprises holding the vat dye pigment-padded fabric, prior to drying, in the moist state and under non-drying conditions for a period sufficient to inhibit the migration of the dye pigment in the fabric during the drying step, which holding period is for from 1 to 15 minutes.

3. In a continuous process for dyeing textile fabrics with vat dyes in which the fabric is first padded with an aqueous dispersion of the unreduced vat dye to a moisture content of from 50% to 100% based on the weight

of the fabric and without drying the pigment-padded fabric is padded with a caustic alkali and alkali metal hydrosulfite reducing and developing solution, the improvement which comprises holding the vat dye pigment-padded fabric in the moist state and under non-drying conditions for a period sufficient to substantially reduce the bleeding of the pigment from the textile in the reducing bath, which holding period is for from 1 to 15 minutes.

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