SOLVENT VAPOR FIBERSET PROCESS FOR DURABLE PRESS FINISHING OF CELLULOSIC FABRICS

Inventors: Norton A. Cashen, Metairie; Robert M. Reinhardt; John D. Reid, both of New Orleans, all of La.

Assignee: The United States of America as represented by the Secretary of Agriculture, Washington, D.C.

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References Cited

UNITED STATES PATENTS


Primary Examiner—Cameron K. Weiffenbach
Assistant Examiner—Ralph E. Varnell, Jr.
Attorney, Agent, or Firm—M. Howard Silverstein; Max D. Hensley

ABSTRACT

Durable press properties are imparted to cellulosic textiles by utilization of this "FIBERSET" process. Polymer fixation is carried out in the vapors of a boiling organic solvent. Single and two-step variations of the process can be employed to fit the specific end goals. The finished goods have good strength, abrasion resistance, and durable-press properties.

6 Claims, No Drawings
SOLVENT VAPOR FIBERSET PROCESS FOR DURABLE PRESS FINISHING OF CELLULOSIC FABRICS

This invention relates to a solvent vapor polymer-deposition process for durable press finishing. Cotton, cotton blends, and other cellulosic fabrics are treated with melamine-type prepolymers and N-methyl crosslinking agents that are applied from aqueous solutions which induce swelling of the cellulosic fibers and facilitate diffusion of the agents into these swollen fibers; the treatment yields a polymerization or “fiber-setting” which is achieved by subjecting the wet-impregnated textile to exposure to the boiling vapors of a relatively low boiling organic solvent, particularly a chlorinated hydrocarbon. Modifications have been incorporated into the process whereby specific effects are produced. Creasing of garments prior to a final curing step can be done to give creases and smoothness durable to repeated laundering.

The main object of the present invention is to provide a new process for polymer fixation within fibers of a cellulose-containing textile material in the vapors of a boiling organic solvent.

A second object of this invention is to provide a one-step durable press finishing treatment through polymer fixation and crosslinking of the cellulosic chains of the textile material that is carried out in the vapors of a boiling organic solvent and is particularly amenable to the treatment of flat goods.

A third object of the invention is to provide a two-step process for polymer fixation and crosslinking to yield durable press textile materials. In this variation of the invention either or both steps of the treatment are carried out in the hot vapors of a boiling organic solvent. Between the first step, in which the primary reaction occurring is polymer fixation with no, or a negligible amount of cellulose cross-linking, and the second step, in which the principal reaction is cellulose cross-linking to set the imposed configuration into the textile material, a creasing operation can be included. This two-step variation of the invention with creasing between the steps gives a wrinkle resistant material with excellent creases and smooth drying properties that are durable to repeated laundering.

It is a further object of the present invention to achieve these goals and yet maintain high levels of the important mechanical properties such as strength, abrasion resistance, and the like in the treated fabrics.

The objects of the invention are obtained through a relatively low temperature solvent vapor finishing system. Durable press fabrics with an improved balance of performance properties result from the treatments. In the finishing system, which has been termed the “Fiberset” process, cotton or cotton blend fabric is impregnated with an aqueous solution containing a cellulosic reactive melamine pre-polymer and an N-methyl crosslinking agent. The cellulosic fibers of the textile material are swollen by the aqueous solution and the finishing components readily diffuse into the fibers. Water content of the impregnated fabric is adjusted by squeezing and, in some cases, partial drying. This is followed by “fiber-setting,” or polymer-fixation and cellulose crosslinking, in the vapors of a relatively low boiling organic solvent, characteristically a chlorinated hydrocarbon, which sets the presswoven cellulosic fibers in an open, relaxed state, prior to crosslinking.

DEFINITIONS

For purposes of this specification the use of the word FIBERSET connotes the finishing system in which polymer fixation within the cellulosic fibers of the textile material being treated is carried out by exposure of the moisture-adjusted, impregnated textile material to the vapors of a boiling organic solvent. Fixation of the polymer within the fiber sets the fiber in the swollen state produced during impregnation of the fibers with an aqueous solution of the finishing agents. With proper selection of the solvent to provide the vapor medium for the solvent vapor curing step, polymer fixation occurs without collapse and complete dehydration of the fiber. The fibers are thus set in an open, relaxed state which contributes to better strength, wear, and appearance characteristics in the final textile products.

DURABLE PRESS is a term widely used in the textile, garment, retail, and associated industries. It is used interchangeably with permanent press to describe the ability of a garment to maintain its shape-retaining properties throughout its life. This means sharp creases, smooth fabric surface appearance, and seams free from puckering.

THE PRIOR ART

Researchers have shown that polymer deposition without a swollen cotton fiber prior to crosslinking has given durable-press cottons with properties superior to those of cottons crosslinked by ordinary oven curing techniques.

The products of the prior art have been produced by processes identified as “Wet Fixation,” “Polyset I”, “Polyset II,” and “Steamset.” Wet Fixation is explained by Hollies, in Vol. 37 (1967), page 277, of Textile Research Journal. Reeves et al discuss Polyset I in Vol. 37 (1967), page 76, of the same journal. Hama-leinen et al, in Vol. 133, (March 1969), page 131 of Textile Industries, present the philosophy of “One-Step DP for Cottons.” Verburg et al. define Steamset in “Low Temperature Steam Setting of Resins,” which appears in Textile Chemists and Colorists, Vol. 1, 1969, p. 595. In general, these processes of the prior art involve the introduction into the cotton fiber of a polymer-former usually a melamine derivative and a crosslinking agent such as dimethyl dihydroxyethyleneurea (DMDHEU). Under conditions of strong catalysis and relatively low temperature the two nitrogenous agents react to form a polymer within the fiber with little or no crosslinking of the cellulose chains. In a second step, crosslinking takes place and the crosslinked swollen fiber is less brittle, has better resistance to abrasion, and better strength properties than oven-cured samples with equivalent wrinkle resistance. Often, the wet wrinkle-recovery angle is higher than the conditioned angle, and the moisture regain is higher. Both of these are indications that crosslinking has occurred while the fiber is in the swollen state.

SOLVENT FINISHING IN THE PRIOR ART

An area of textile finishing that has received a great deal of attention in recent years is that of treatment in organic solvent media rather than in aqueous media. Efficient industrial processes have been developed for fabric preparation and the application of several types of surface treatments from solvents. However, progress in durable press finishing from solvent media has been slow.
There are several incentives which have encouraged the textile industry to pursue the objective of solvent finishing. Among these are the increasing scarcity and cost of high quality water, the demands for effluent control, the problem of steam pollution, the potential of reduced processing costs, and the possibility of innovation to establish proprietary advantages. Because of cost, availability, toxicity, and flammability, serious consideration for solvents for finishing has been limited to three chlorinated hydrocarbons, perchloroethylene, trichloroethylene, and 1,1,1-trichloroethane. The use of any solvent, or course, requires a highly efficient recovery system; recovery of 95 percent is considered a bare minimum. Loss of solvent through partitioning effects with water drawn off during processing can be a problem. Decomposition of the chlorinated solvents to give HCl also is a problem that must be prevented. Furthermore, for serious consideration solvent processing must accomplish the finishing treatment as well or better than the conventional aqueous treatment.

For durable press finishing of cellulosic fibers which depends upon a uniform crosslinking reaction throughout the fiber, solvent finishing is more difficult than conventional aqueous treatment methods. A major problem is that the solvents do not swell cotton sufficiently to permit penetration of finishing agents into the fiber when application is directly from a solvent solution. A brief steaming (perhaps 5 seconds) prior to treatment has been suggested as an aid to penetration of the finishing agent.

There is immediate wetting of the fibers by the solvent, but without swelling of the fiber, penetration of the finishing agent is prevented and a surface treatment results rather than the needed homogeneous treatment. Furthermore, most N-methyl finishing agents are not sufficiently soluble in the organic solvents for use in solvent finishing. Two alternatives have been suggested to circumvent this problem: N-methoxymethyl derivatives, methyl ethers of the N-methylol agents, which are soluble in the solvents have been used; and emulsification (water-in-oil emulsion) of the N-methylol agents have been used. The latter technique permits use of readily available agents and the 5–10 percent water present in the emulsion serves to provide some swelling of the fiber and aids in diffusion of the agent into the substrate.

When solvent finishing first appeared to be gaining in industrial acceptance, it was believed that new agents with functions different than the conventional methyol amide type would be quickly introduced. Although it would seem that whole new families of agents would be applicable in solvent finishing, no radical departures from the traditional N-methylol agents have yet assumed importance.

EVOLUTION OF THE PRESENT INVENTION

Recently, a new method of treatment has been developed in which reaction between cellulose and crosslinking agents is promoted by curing in solvent vapor. A full description of the method has been presented by Cashen, Reinhardt, and Reid, the present inventors, at the A.A.T.C.C. Symposium on Textile Solvent Technology - Update '73 which was held in Atlanta, Georgia on January 10–11, 1973, and is published on pages 79–90 of the Proceedings of this symposium. In this method of curing, cotton, suitably impregnated with finishing agent and catalyst, is crosslinked by heating in the vapors of a boiling solvent, such as a chlorinated hydrocarbon, preferably one such as trichloroethylene, perchloroethylene, or 1,1,1-trichloroethane which form azeotropes with water that have boiling points below that of water. With suitable adjustment of treatment conditions, finished fabrics similar to those of conventional pad-dry-cure processing or of moist cure processing were obtained. Efficiency of vapor cure finishing was very high. Among variables that influenced properties of the finished fabrics were the nature of the solvent, finishing agent, and catalyst, and the amount of water in the fabric at the time of cure. With strong catalysts, very short curing times are needed. Even with moderately active catalysts, curing for a few minutes or less was effective. Similarly, moist cure effects were achieved in minutes instead of hours. Equivalent treatments by vapor cure, pad-dry-cure, and boiling liquid solvent finishing were compared. Strengths and efficiencies of the vapor cured fabrics were better than those of equivalent oven or solvent treatments.

In the above-mentioned presentation, Cashen et al., disclosed the fixation of a methylated methylolmelamine in cotton fabric by the vapors of boiling trichloroethylene which is an important factor in the present invention. It was shown that even after as much as 30 minutes exposure to the vapors of boiling trichloroethylene, the fabric retained about 6–7 percent water content; fixation thus was in the swollen state of the fiber. This type of fixation was termed fibersetting and further investigation revealed a number of advantages of such processing over wet fixation processes of the prior art.

ADVANTAGES OVER PRIOR ART

Among the advantages of the solvent vapor fixation process of the present invention are short fixation times due to the feasibility of using elevated temperatures without the advantage-defeating danger of fixation under drying conditions which cause fiber collapse and the associated well-known consequences (fiber embrittlement, drastic losses of strength and wear resistance, etc.) of conventional pad-dry-cure finishing. Further, since elevated fixation temperatures can be employed without over-dehydration of the fibers, less strong catalyst systems are operable which again contribute to more favorable properties in the fixed fibers. Fixation temperatures in solvent vapor fixation treatments are precisely determined by the boiling point of the organic solvent employed and that of its water-azeotrope. These temperatures are physicochemical constants and are not subject to variation as in thermally controlled processing in hot air, superheated steam, and the like. No pressure equipment is needed for fibersetting in solvent vapors.

The constraint of these advantages and the disadvantages of wet fixation, Polyset I, Polyset II, Steamset, and similar fixation processes of the prior art are obvious. Prior art processes suffer, in particular, from inconsistent results due to the necessity of precise control of processing conditions and from the need of expensive pressure and steam equipment. Processing conditions of fixation must be controlled so precisely that slight variations cause either under-fixation, and consequently inadequate polymer yield to give the needed finish, or over-fixation, and consequently finished fabrics, not with the desired properties produced by wet fixation, but with properties characteristic of finishing in a completely dehydrated state.
The present invention deals with a process wherein the cellulosic textile is impregnated with an aqueous solution of finishing agents and catalyst which induces swelling of the fibers and facilitates diffusion of the agents into the fibers; said treatment solution contains either a methylated melamine prepolymer adjusted to a pH of 2 or a mixture with a crosslinking agent; the water content of the impregnated fibers is adjusted to about 30–60 percent water; and exposing the textile to the vapors of certain boiling chlorinated solvents, and in so doing azetropically lowering the water content of the impregnated fabric to about 5–7 percent, during which time a combination of fixation by polymerization and varying degrees of crosslinking can be achieved. The process is amenable to treatment of flat goods and for use with a creasing step after polymer fixation followed by a curing step to give durably creased, smooth drying, durable press textile products.

The following examples are provided to illustrate the varying facets of the present invention. They are not meant as limitations of the invention in any manner whatever.

EXAMPLE 1

Wrinkle and abrasion resistant cellulosic fabric was produced in a process whereby 80 × 80 cotton print-cloth was padded at 50 p.s.i. in a solution of the following composition: 5 percent solids of methylated melamine (Aerotex 23S), 0.2 percent alkyl aryl ethyleneoxide alcohol (Triton-X-100) in water. The solution was adjusted to pH 2 with hydrochloric acid. After padding the fabric was dried at 60°C to the equivalent of 30 percent retained water, then was exposed to the vapors of trichloroethylene at the boil (87°C) for ten minutes. The fabric was then washed and dried in a homotype washing machine and tumbler dryer (gas). Conditions of treatment and fabric properties are shown in Table I as Treatment A.

EXAMPLE 2

The treatment and materials of Example 1 were repeated, except 10 percent solids of a melamine type prepolymer, methylated melamine (Aerotex 23S) was used. Results are given as Treatment B of Table I.

EXAMPLE 3

The treatment and materials of Example 1 were repeated, except 14 percent solids of a melamine type prepolymer, methylated melamine (Aerotex 23S) was used. Results are given as Treatment C of Table I.

EXAMPLE 4

The treatment and materials of Example 3 were repeated, except the pad bath also contained 14 percent solids of a crosslinking resin, dimethyloctadihydroxyethylenearure (Permafresh 183), and after drying as described, the fabric was exposed to the vapors of boiling trichloroethylene (87°C) for 15 minutes. Results are given as Treatment D of Table I.

EXAMPLE 5

The treatment and materials of Example 4 were repeated, except the padded fabric was dried to 60 percent residual water prior to solvent vapor fixation and cure. Results are given as Treatment E of Table I.

EXAMPLE 6

The treatment and materials of Example 5 were repeated, except that the padding solution contained also 0.6 percent zinc nitrate hexahydrate as catalyst and, after fixation, the air-dried fabric was creased in a hot-head press at approximately 90°C for 30 seconds and then cured in a forced draft oven at 160°C for 3 minutes. Results are shown as Treatment F of Table II.

EXAMPLE 7

The treatment and materials of Example 4 were repeated, except this was followed by re-padding the fabric in an aqueous solution containing 0.6 percent zinc nitrate hexahydrate, then rapid air-drying and creasing in a hot-head press at approximately 90°C for 30 seconds, and post-curing in a forced draft oven at 160°C for 3 minutes. Results are shown as Treatment G of Table II.

EXAMPLE 8

The treatment and materials of Example 7 were repeated, except that the post-cure catalyst was 2 percent aluminum chloride hexahydrate and post-curing was carried out in the vapors of perchloroethylene at the boil (121°C) for one minute. Results are shown as Treatment H of Table II.

EXAMPLE 9

Wrinkle and abrasion resistant cellulosic fabric was produced in a process whereby 8 ounce cotton twill was padded at 40 p.s.i. in a solution of the following composition: 14 percent solids of methylated melamine (Aerotex 23S), 14 percent solids of a crosslinking resin, dimethyloctadihydroxyethylenearure (Permafresh 183), 0.2 percent alkyl aryl ethyleneoxide alcohol (Triton-X-100) in water. The solution was adjusted to pH 2 with hydrochloric acid. After padding the fabric was dried in a forced draft oven at 60°C to the equivalent of 60 percent retained water, then was exposed to the vapors of boiling trichloroethylene (87°C) for five minutes. The fabric was washed and dried, then repadded to about 90 percent pickup with an aqueous solution containing 0.6 percent zinc nitrate hexahydrate, 3 percent of a fiber conditioner, in this instance a polyurethane (Polyurethane E-502), and 0.2 percent alkyl aryl ethyleneoxide alcohol (Triton X-100). This solution, 400 grams, had a pH of 6.0, which was adjusted to pH 5.0 with two drops of diluted hydrochloric acid. This Fiberset fabric was then dried at 60°C in a forced draft oven for ten minutes, and then either held as is for later curing, or immediately cured as follows: creasing of the fabric on a hot-head press at approximately 90°C for 30 seconds, and post curing in a forced draft oven at 160°C for five minutes. Results are shown as Treatment I of Table II.

EXAMPLE 10

The treatment and materials of Example 9 were repeated, except polymer fixation was carried out in vapors of boiling trichloroethylene (87°C) for 15 minutes. Results are shown as Treatment J of Table II.

EXAMPLE 11

The treatment and materials of Example 9 were repeated, except after padding, the fabric was dried in a forced draft oven at 60°C to the equivalent of 30 per-
EXAMPLE 12

The treatment and materials of Example 11 were repeated, except that after padding and drying, the fabric was exposed to the vapors of boiling trichloroethylene (87°C) for 15 minutes. Results are shown as Treatment L of Table II.

EXAMPLE 13

The treatment and materials of Example 9 were repeated, except the fabric was 5.3 ounce per square yard cotton sheeting of special 109w × 58f construction, and that the Fiberset fabric was dried at 60°C in a forced draft oven for seven minutes, and the postcure was for 3 minutes at 160°C. Results are shown under Fabric as 100 percent Cotton of Table III.

EXAMPLE 14

The treatment and materials of Example 13 were repeated, except the fabric was 5.3 ounce per square yard 20/80 Polyester-Cotton sheeting of special 109w × 58f construction. Results are shown under Fabric as 20/80 Polyester-Cotton of Table III.

EXAMPLE 15

The treatment and materials of Example 13 were repeated, except the fabric was 5.3 ounce per square yard 30/70 Polyester-Cotton sheeting of special 109w × 58f construction. Results are shown under Fabric as 30/70 Polyester-Cotton of Table III.

TABLE I

<table>
<thead>
<tr>
<th>Polymer Fixation</th>
<th>Postcure</th>
<th>Fabric Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Brk. Str. % of Untr.</td>
</tr>
<tr>
<td>Sample</td>
<td>Agent</td>
<td>Pad Bath Catalyst</td>
</tr>
<tr>
<td>A</td>
<td>5% MM</td>
<td>pH 2</td>
</tr>
<tr>
<td>B</td>
<td>10% MM</td>
<td>pH 2</td>
</tr>
<tr>
<td>C</td>
<td>14% MM</td>
<td>pH 2</td>
</tr>
<tr>
<td>D</td>
<td>14% MM+ 14% DMDHEU</td>
<td>pH 2</td>
</tr>
<tr>
<td>E</td>
<td>14% MM+ 14% DMDHEU</td>
<td>pH 2</td>
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Note: Refer to footnotes of Table II.

TABLE II

<table>
<thead>
<tr>
<th>Polymer Fixation</th>
<th>Postcure</th>
<th>Fabric Properties</th>
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<tr>
<td></td>
<td></td>
<td>Brk. Str. % of Untr.</td>
</tr>
<tr>
<td>Sample</td>
<td>Agent</td>
<td>Pad Bath Catalyst</td>
</tr>
<tr>
<td>F</td>
<td>14% MM+ 14% DMDHEU</td>
<td>0.6%</td>
</tr>
<tr>
<td>G</td>
<td>14% MM+ 14% DMDHEU</td>
<td>0.6%</td>
</tr>
<tr>
<td>H</td>
<td>14% MM+ 14% DMDHEU</td>
<td>0.6%</td>
</tr>
<tr>
<td>I</td>
<td>14% MM+ 14% DMDHEU</td>
<td>0.6%</td>
</tr>
<tr>
<td>J</td>
<td>14% MM+ 14% DMDHEU</td>
<td>0.6%</td>
</tr>
<tr>
<td>K</td>
<td>14% MM+ 14% DMDHEU</td>
<td>0.6%</td>
</tr>
<tr>
<td>L</td>
<td>14% MM+ 14% DMDHEU</td>
<td>0.6%</td>
</tr>
</tbody>
</table>

1 MM = methylolated melamine, DMDHEU = dimethylol dihydroxyethyleneurea

4 Pad bath adjusted to pH 2 with hydrochloric acid

5 Percent water based upon original weight of the fabric

6 Fixation in the vapors of boiling trichloroethylene (87°C)

7 Curing in the vapors of boiling perchloroethylene (121°C)

8 Scale of 1 to 5 ranging poor to excellent respectively
We claim:
1. A process for imparting durable-press properties to cellulosic textiles, the process comprising
   a. impregnating the textile with an aqueous solution containing a methylated methylenemelamine prepolymel, thereby swelling the textile;
   b. adjusting the water content of said impregnated textile to about from 30 to 60 percent;
   c. and exposing the textile to step (b) to the vapors of a chlorinated hydrocarbon capable of forming an azetropene with water which has a boiling point below that of water, for a sufficient time to azetropically lower the water content of the step (b) textile to about 5–7 percent.
2. The process of claim 1 wherein the aqueous solution of step (a) also contains dimethyldihydroxyethylulrene crosslinking resin and the textile of step (c) is further impregnated with a catalyst for said resin, pressurized to the desired configuration and cured in an oven for about 3 to 5 minutes at about 160°C.
3. A process for imparting durable press properties with improved strength to cellulosic textiles, the process comprising:
   a. impregnating a cellulosic textile with an aqueous solution containing about 5–14 percent of a methylated methylenemelamine prepolymer, adjusted to a pH of 2;
   b. partially drying in an oven at 60°C to about from 30 to 60 percent water content, and
   c. exposing the textile of (b) to the vapors of boiling trichloroethylene for about from 5 to 15 minutes, during which time water is removed azetropically to about from 5 to 7 percent content and fixation by polymerization occurs.
4. A process for imparting durable press properties with improved strength to cellulosic textiles, the process comprising:
   a. impregnating a cellulosic textile with an aqueous solution containing about 14 percent of a methylated methylenemelamine prepolymer and 14 percent of dimethyldihydroxyethylulrene, the solution adjusted to a pH of 2;
   b. partially drying the impregnated textile at 60°C to obtain a water content of about from 30 to 60 percent, and
   c. exposing the textile of (b) to the vapors of boiling trichloroethylene for about from 5 to 15 minutes, during which time water is removed azetropically to about from 5 to 7 percent content and fixation by polymerization occurs.
5. A process for imparting durable press properties with improved strength to cellulosic textiles, the process comprising:
   a. impregnating a cellulose textile with an aqueous solution containing about 14 percent of a methylated methylenemelamine prepolymer, and 14 percent of dimethyldihydroxyethylulrene, and 0.6 percent zinc nitrate hexahydrate catalyst,
   b. partially drying the impregnated textile at 60°C to obtain a water content of about 60 percent,
   c. exposing the textile of (b) to the vapors of boiling trichloroethylene for about 15 minutes to remove water azetropically to a water content of about from 5 to 7 percent,
   d. storing the material until needed for fabrication of garments or other articles,
   e. steam pressing after fabrication at about 90°C to impart the desired configuration and creases, and
   f. oven curing the shaped and creased material for about 3 to 5 minutes at about 160°C.
6. A process for imparting durable press properties with improved strength to cellulosic textiles, the process comprising:
   a. impregnating a cellulose textile with an aqueous solution containing about 14 percent of a methylated methylenemelamine prepolymer, and 14 percent of dimethyldihydroxyethylulrene, the solution adjusted to a pH of 2;
   b. partially drying the impregnated textile at 60°C to obtain a water content of about 60 percent,
   c. exposing the textile of (b) to the vapors of boiling trichloroethylene for about 5 to 15 minutes, to remove water azetropically to a water content of about from 5 to 7 percent,
   d. washing and drying the textile of (c),
   e. impregnating the dry textile with an aqueous solution containing 0.6 percent zinc nitrate hexahydrate, and 0.3 percent polyurethane softener, to a wet pickup of about 90 percent, and
   f. curing the textile for about 3 to 5 minutes at about 160°C.

Table III
A LISTING OF PHYSICAL PROPERTIES OBTAINED WITH FIBERSET® CHEMICALLY FINISHED COTTON AND COTTON-BLEND SHEETING

<table>
<thead>
<tr>
<th>Fabric</th>
<th>Percent Add-Ins</th>
<th>Break Str. %</th>
<th>Stiff Flex°</th>
<th>W.R.A. (Wt-F)</th>
<th>Crease Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% Cotton</td>
<td>5.2</td>
<td>72</td>
<td>35</td>
<td>304</td>
<td>254</td>
</tr>
<tr>
<td>20/80 Polyester-Cotton</td>
<td>5.4</td>
<td>68</td>
<td>10</td>
<td>313</td>
<td>300</td>
</tr>
<tr>
<td>30/70 Polyester-Cotton</td>
<td>5.5</td>
<td>81</td>
<td>38</td>
<td>314</td>
<td>299</td>
</tr>
<tr>
<td>100% Cotton</td>
<td>—</td>
<td>100</td>
<td>100</td>
<td>197</td>
<td>191</td>
</tr>
<tr>
<td>20/80 Polyester-Cotton</td>
<td>—</td>
<td>100</td>
<td>100</td>
<td>226</td>
<td>250</td>
</tr>
<tr>
<td>30/70 Polyester-Cotton</td>
<td>—</td>
<td>100</td>
<td>100</td>
<td>272</td>
<td>253</td>
</tr>
</tbody>
</table>

1 5-min. Fixation in trichloroethylene vapors (87°C)
2 Percent saturated control