

TECHNICAL BULLETIN



6399 Weston Parkway, Cary, North Carolina 27513 • (919) 678-2220

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The STORM DENIM[®] Finish: Water-Repellency Technology for Denim Garments

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INTRODUCTION

The STORM DENIM® finish is a garment-applied finish designed to impart water and oil repellency to 100% cotton denim garments while still maintaining breathability and comfort. The finish is also suitable for garments made with cotton-spandex denim blends. The STORM DENIM finish is an innovative and functional denim finish that does not sacrifice the inherent fashionability or comfort of denim.

Garments finished with STORM DENIM technology are treated with a fluorochemical that can be applied by the garment-dip or the metered addition (spray) process. Fluorochemical water repellents have been shown to provide a host of benefits to the wearer, such as protecting from rain and snow, staying clean longer, and drying faster (Cotton Incorporated, 2004, Technical Bulletin ISP1007, *Water and Stain Repellent Finishing of Cotton Fabrics*).

Although fluorochemical finishes usually are applied to products in fabric form, the STORM DENIM technology was specifically designed to treat denim products in garment form. Because the STORM DENIM finish is applied at the end of garment processing, it does not interfere with the chemical washes, mechanical abrasion, or surface styling effects typically used to give denim garments a trendy or worn look. The results are a finish with more consumer benefits and garments with greater marketability for specific end uses.

This technical bulletin outlines all the procedures necessary for successful application of the STORM DENIM finish, from garment preparation to finishing. Detailed instructions for the test methods used to qualify the STORM DENIM technology are included, along with results from Cotton Incorporated's testing of laboratory-scale treated garments. For information on recommended preparation and finish formulations for the procedures described in this bulletin, contact Cotton Incorporated.

GARMENT PREPARATION

Denim products typically are sewn into garments and then desized, stone-washed or washed down by other means, and finished with a softener. For the STORM DENIM finish, the process is altered slightly:

- The STORM DENIM finish is applied at the end of the process instead of the softener (a softener is included in the formulation).
- The garments must be thoroughly desized, to ensure the best durability of the finish to home laundering. For starch-based sizes, an alpha amylase enzyme should be used during the desizing process, because the fluorochemical treatment in the STORM DENIM finish will react with starch. Thorough starch removal is important to ensure that the finish reacts with the fabric and not with residual starch.
- An acid rinse is added immediately before application of the finish, to ensure that the pH and alkali content are in acceptable ranges. High fabric pH or alkali content will decrease the performance of the finish and its durability to home laundering.

The following procedures are used at Cotton Incorporated. Mills should adjust the liquor ratios as necessary for their own equipment.

Suggested Desizing Procedure

1. Load the garments into the machine.
2. Fill to a liquor ratio of 10:1 and begin heating to 140°F (60°C).
3. While heating, add the following:
 - 1 g/L anti-redeposition agent for cotton (to reduce deposition of dyestuff onto filling yarns and pockets).
 - 1 g/L anti-redeposition agent for synthetics (to reduce deposition of dyestuff onto synthetic size labels, leather patches, and pockets).
 - 1 g/L lubricant (to minimize crease edge abrasion and streaking).
4. When the temperature reaches 140°F (60°C), add 2 g/L alpha amylase enzyme.
5. Run for 15 minutes, then drop the bath.
6. Fill to a liquor ratio of 20:1, heat to 120°F (50°C), rinse for 3 to 5 minutes, then drop the bath.

Sample Stone-Washing Procedure

1. Load pumice stones or other abrasive into the machine.
2. Begin filling with water at the maximum temperature recommended by the cellulase enzyme supplier to a liquor ratio of between 5:1 and 10:1.
3. While filling, add the following:
 - 1% on weight of the goods (o.w.g.) anti-redeposition agent for cotton.
 - 1% o.w.g. anti-redeposition agent for synthetics.
4. When the liquor ratio is achieved and the temperature is set, adjust the pH to meet the requirements of the enzyme supplier and add buffered neutral cellulase enzyme.
5. Run at the enzyme supplier's recommended temperature for 30 to 90 minutes (or set time and temperature to achieve the desired effects), then drop the bath.
6. Fill to a liquor ratio of between 10:1 and 20:1, heat to 100°F to 120°F (38°C to 50°C), rinse for 3 to 5 minutes, then drop the bath.
7. De-rock the garments.

Acid Rinse Procedure

Acidify no. 1 (required):

1. Fill to a liquor ratio of 10:1 and heat to 120°F (50°C).
2. When the machine is full, add 5% o.w.g. 56% acetic acid (2.5% o.w.g. 100% citric acid [powder] can be substituted).
3. Run for 7 minutes, then drop the bath.

Acidify no. 2 (use with very alkaline fabrics):

1. Fill to a liquor ratio of 10:1 and heat to 120°F (50°C).
2. When the machine is full, add 5% o.w.g. 56% acetic acid.
3. Run for 10 minutes, then drop the bath.

Rinse (recommended):

1. Fill to a liquor ratio of between 10:1 and 20:1, heat to 100°F to 120°F (38°C to 50°C), rinse for 3 to 5 minutes, then drop the bath.
2. Extract and tumble dry.

Check of pH and Alkali Content

For best results, it is strongly recommended that the pH and residual alkali content of the garment be tested before finishing — especially for first-run fabrics — to ensure that the garments have been prepared properly and are ready to absorb the STORM DENIM finish. A properly prepared garment should meet the following specifications:

- Fabric pH between 5.5 and 7.5 (AATCC 81).
- Percent (weight) total alkali as sodium hydroxide (NaOH) less than 0.05% (AATCC 144).
- Drop absorbency (AATCC 79) less than or equal to 5 seconds.

GARMENT FINISHING

The recommended finish bath and finishing procedures (by the garment-dip or metered addition procedure) are described below. The STORM DENIM finish must be properly cured to achieve the maximum durability to laundering; a curing procedure also is described. Optional components of the finish bath may be used to boost the performance of the STORM DENIM finish and its durability to home laundering. For specific product recommendations for the finish bath, please contact Cotton Incorporated.

Finish Bath

1. Add the following components:
 - 80 to 100 g/L water- and oil-repellent fluorochemical (based on 5% to 6% fluorine content).
 - 50 g/L stearated melamine wax extender emulsion.
 - 15 g/L fluorochemical-compatible silicone softener.
 - 50 g/L dimethyloldihydroxyethyleneurea (DMDHEU) resin (optional).
 - 15 g/L magnesium chloride catalyst activated with citric acid (optional; use with resin).
 - 10 g/L polyfunctional blocked isocyanate (optional).
2. Adjust the bath pH to between 4 and 5, using 56% acetic acid (or citric acid).

Garment-Dip Procedure

1. Weigh and load the garments.
2. Add finish bath (above) at a liquor ratio of at least 5:1.
3. Completely submerge the garments and soak for 15 minutes.
4. Extract to approximately 75% wet pick-up.
5. Tumble dry to 8% to 10% moisture and press as required.

Metered Addition Procedure

1. Load the garments.
2. Tumble for 3 minutes.
3. Spray-apply the finish bath (above) over 15 minutes.
4. Tumble for an additional 15 minutes (to allow the finish to equilibrate).
5. Tumble dry to 8% to 10% moisture and press as required.

Curing Procedure

1. Cure at 310°F (155°C) for 10 to 12 minutes.
2. A cold tumble for 10 to 15 minutes may be used to help soften the hand.

TEST METHODS AND SPECIFICATIONS

The following standardized test methods can be used to evaluate the water and oil repellency and breathability of a STORM DENIM finished garment. For each test, the finished garments should meet the stated specifications after the indicated numbers of home launderings and tumble dryings (HLTDs).

Water Repellency: Spray Test (AATCC 22)

Water is sprayed onto the taut fabric surface. The resulting spray pattern is then visually rated against a set of standards.

Specifications: 95 ± 5 at 0 HLTDs; 65 ± 5 at 10 HLTDs; 55 ± 5 at 25 HLTDs.

Aqueous Liquid Repellency: Water/Alcohol Solution Resistance Test (AATCC 193)

A range of aqueous solutions with varying surface tensions are dropped gently onto the taut fabric surface to test the surface energy of the treated fabric. Higher numbers indicate better repellency.

Specification: 8 to 10 at 0 HLTDs.

Oil Repellency: Hydrocarbon Resistance Test (AATCC 118)

A series of standardized hydrocarbon solutions of varying surface tensions are dropped gently onto the taut fabric surface to test the surface energy of the treated fabric. Higher numbers indicate better repellency.

Specification: 5 to 6 at 0 HLTDs

Water Resistance: Rain Test (AATCC 35)

A fabric sample is backed by blotter paper and sprayed with water under a controlled amount of pressure for a specified time. The blotter paper is weighed before and after to determine the amount of water that penetrated the fabric.

Specification: Less than 1 g of water absorbed at a column height of 2 feet for 2 minutes at 0 HLTDs.

Note: Passing the rain test depends heavily on the fabric construction. If the garment is abraded such that the fabric has holes or its integrity is compromised, then this test need not be performed.

Water Vapor Transmission of Materials (ASTM E96, Procedure B)

The rate of water vapor diffusion through a fabric is measured by the upright cup method at 23°C. Results are given in grams per square meter per 24 hours. Higher numbers indicate greater breathability.

Specification: The treated garment should give results similar to those for a garment that has undergone similar processing but without the STORM DENIM finish.

Air Permeability of Textile Fabrics (ASTM D737)

The rate of air flow passing perpendicularly through a fabric is measured with the Frazier air permeability measuring instrument. Results are given in cubic feet per minute through one square foot of fabric. Higher numbers indicate greater breathability.

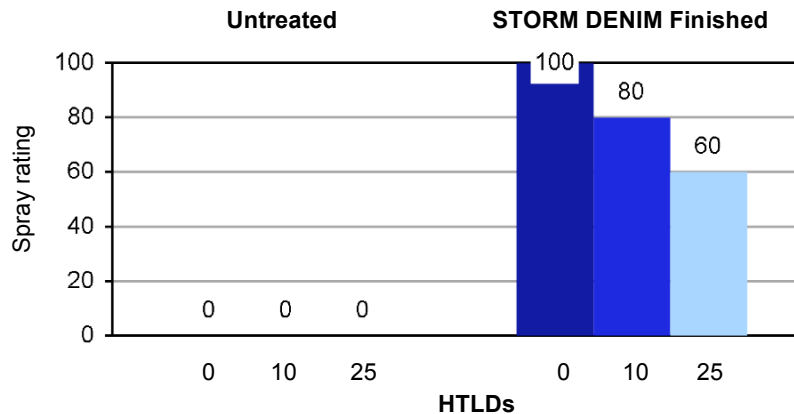
Specification: The treated garment should give results similar to those for a garment that has undergone similar processing but without the STORM DENIM finish.

TEST RESULTS

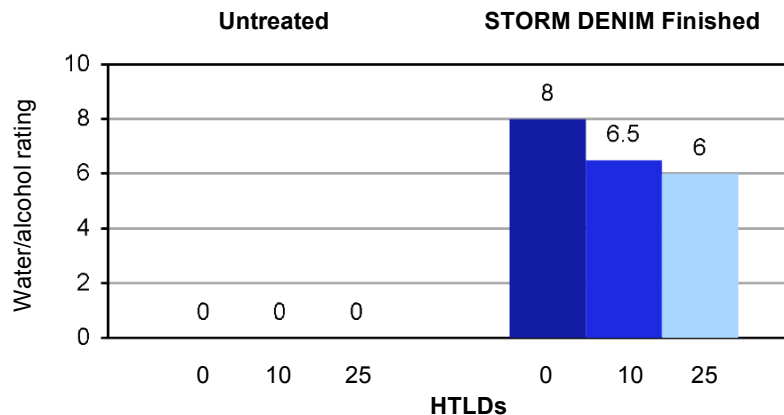
Following are results from Cotton Incorporated's testing of garments that had undergone laboratory-scale treatment by the methods described above. The results are from testing at 0 HTLDs unless otherwise indicated. All testing was performed on 14.25 oz/yd² 3/1 right-hand twill denim that had been sewn into pants legs. The finish was applied by the garment-dip procedure described above. The samples were finished without the optional finish-bath components listed above.

Note that the addition of a durable-press resin and cross-linking agent could boost water- and oil-repellency performance and durability to home laundering. Contact Cotton Incorporated for recommendations.

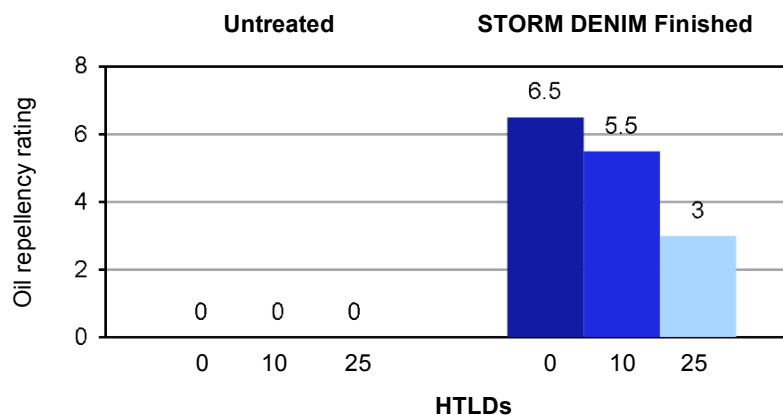
Water Repellency: Spray Test (AATCC 22)



Aqueous Liquid Repellency: Water/Alcohol Solution Resistance Test (AATCC 193)



Oil Repellency: Hydrocarbon Resistance Test (AATCC 118)



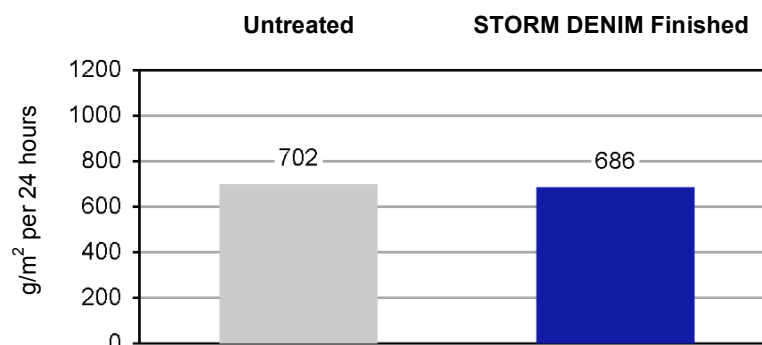
Water Resistance: Rain Test (AATCC 35)

The table below shows the results at 0 HTLDs. “Pass” indicates that less than 1 g of water penetrated the sample under the specified test conditions.

Test conditions	Untreated	STORM DENIM Finished
2 Feet for 2 minutes	Fail (> 1 g)	Pass (< 1 g)
3 Feet for 5 minutes	Fail (> 1 g)	Pass (< 1 g)

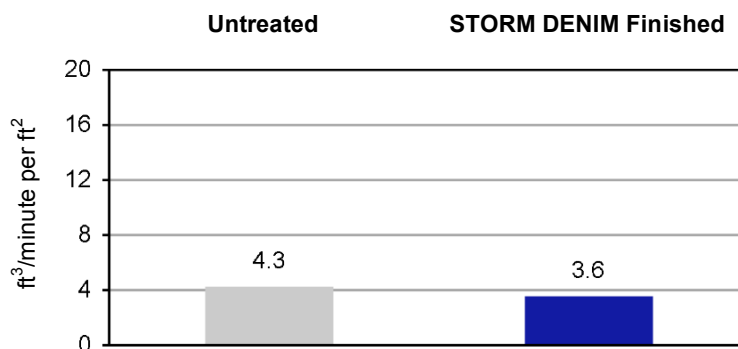
Water Vapor Transmission of Materials (ASTM E96, Procedure B)

The graph below shows that there was no perceptible difference in water vapor transmission between STORM DENIM finished denim and untreated denim at 0 HTLDs.



Air Permeability of Textile Fabrics (ASTM D737)

The graph below shows that there was no perceptible difference in air permeability between STORM DENIM finished denim and untreated denim at 0 HLTDs.



RECOMMENDED CONSUMER PRACTICES

For the best performance after repeated launderings, the following practices should be recommended to consumers:

- Home launder at 105°F (40°C) or less.
- Use the smallest amount of detergent possible.
- Use the highest possible liquor-to-goods ratio during laundering.
- After goods are dry, continue to dry for an additional 10 to 15 minutes.
- Never use detergent containing fabric softeners.
- Never use fabric softeners or dryer sheets.
- It is okay to use water softeners.
- If performance starts to decline, run the garment through a warm rinse without detergent, tumble dry hot, and iron without steam.

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RESEARCH AND TECHNICAL SERVICES

Cotton Incorporated is a research and promotion company representing cotton worldwide. Through research and technical services, the company has the capability to develop, evaluate, and then commercialize the latest technology to benefit cotton.

- Agricultural research leads to improved agronomic practices, pest control, and fiber variants with properties required by the most modern textile processes and consumer preferences. Ginning development provides efficient and effective machines for preservation of fiber characteristics. Cottonseed value is enhanced with biotechnology research to improve nutritional qualities and expand the animal-food market.
- Research in fiber quality leads to improved fiber testing methodology and seasonal fiber analyses to bring better value both to growers and to mill customers.
- Computerized fiber management techniques result from in-depth fiber processing research.
- Product Development and Implementation operates programs leading to the commercialization of new finishes and improved energy- and water-conserving dyeing and finishing systems. New cotton fabrics are engineered — wovens, circular knits, warp knits, and nonwovens — that meet today's standards for performance.
- Technology Implementation provides comprehensive and customized professional assistance to the cotton industry and its customers — textile mills and manufacturers.
- A fiber-to-yarn pilot spinning center allows full exploration of alternative methods of producing yarn for various products from cotton with specific fiber profiles.
- The company operates its own dyeing and finishing laboratory, knitting laboratory, and laboratory for physical testing of yarn, fabric, and fiber properties, including high volume instrument testing capable of measuring micronaire, staple length, strength, uniformity, color, and trash content.

For further information contact

Cotton Incorporated
World Headquarters
6399 Weston Parkway
Cary, NC 27513
Phone: 919-678-2220
Fax: 919-678-2230

Cotton Incorporated
Consumer Marketing Headquarters
488 Madison Avenue
New York, NY 10022-5702
Phone: 212-413-8300
Fax: 212-413-8377

Other Locations

• Mexico City • Osaka • Shanghai • Hong Kong •

Visit our Web site at www.cottoninc.com



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