TECHNICAL BULLETIN

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TRI 3012

WET PROCESSING OF COTTON/SPANDEX FABRIC

INTRODUCTION

Spandex is incorporated into cotton fabrics to impart a greater level of stretch and recovery than can be achieved by cotton alone. Prevalent in women's wear, but expanding into other product categories, cotton/spandex blends can be found in knit goods such as skirts, leggings, and tops, or in most all types of woven goods such as stretch jeans. Some features of spandex are listed below:[(1)]

- high elasticity and recovery
- low moisture absorption
- resistant to normal apparel exposure to sunlight
- resistant to most common chemicals

Spandex is not degraded under normal acidic or alkaline conditions, and it is not usually affected by small amounts of knitting oils and lubricants. However, it is known to lose strength when subjected to prolonged UV radiation exposure or chlorine.[(1)]

Cotton/spandex knit fabrics may contain spandex in every course or in alternating courses. The spandex may appear as plaited raw spandex, corespun within a cotton sheath, or covered by cotton fibers. Spandex yarn deniers between 40 and 70 are the most commonly used in circular knits. Stretch values may vary depending upon the fabric construction, the amount of spandex used, the denier of the spandex, and the heat-setting conditions. Typical stretch levels for cotton knit fabrics with spandex are in the 50-100 percent range.

In woven goods, spandex may be found in the filling yarns, in the warp yarns, or in both. Construction of the woven fabric is paramount in determining the achievable amount of stretch. Typically, the spandex used in woven goods will be found in a corespun yarn; however, the form in which the spandex is used depends upon the fabric construction, performance requirements, and experience of the designer. Lightweight woven goods, weighing up to 5.5 oz/yd^2 (186 g/m^2), typically incorporate spandex yarns ranging from 40 to 70 denier. Heavier goods, those weighing more than 7.5 oz/yd^2 (254 g/m^2), may contain yarn that is as heavy as 140 denier. The choice of denier depends on the aesthetic properties that are desired. Stretch levels are typically 15-50 percent for woven structures.

SPANDEX IN KNIT FABRICS

Relaxation

A fabric composed of cotton and spandex will always want to relax to a lower energy state. Regardless of end use, the fabric should be relaxed before dyeing to reduce residual stresses caused by tensioning of the elastic yarns during knitting. Heat-setting will also prevent cockling or crepeing of the yarns, distortion of the structure, and uneven dyeing and finishing.[(2)] Allowing the fabric to relax from inherent construction and processing stresses will result in improved dimensional stability.

After knitting and before processing in the dyehouse, the fully relaxed state for the fabric should be determined. By relaxing the fabric to its fully relaxed state, the maximum weight and minimum width can be determined. A good method for quickly determining the relaxed state is to "boil-off" a full width sample of two yards length. The bath used in the boil-off should contain a good textile detergent or could contain the scouring agents to be used in processing. After boil-off, the samples can be dried in a sample oven, and the fabric width can be measured. This width will be the absolute minimum width to which the fabric will shrink. This knowledge will prevent the finisher from trying to finish at a width that is less than the relaxed width. By acquiring experience in getting the relaxed width and with the individual pieces of equipment used to wet process the fabrics, the dyer/finisher can predict the best heat-set width for each style.

Knit fabrics containing spandex can be relaxed in the mill by a number of methods. Open-width fabrics can be relaxed by:

1. Passing the fabric over a steam box off-line of the tenter frame after slitting.
2. Steaming the fabric after slitting while it is held by the pins on a tenter frame.
3. Prescouring in a soft flow jet before slitting.
4. Padding through a 120-140°F (50-60°C) bath with a wetting agent after slitting.

Tubular knit fabrics can be relaxed by:

1. Sending the fabric through a tensionless steam calender.
2. Steaming in an autoclave in a batched roll.

When collapsed, tubular fabrics are slit along one edge, the remaining edge becomes the center line in the fabric after the slit tube is opened. This line, if not removed before heat-setting, will become a permanent feature in the fabric. A few means for avoiding or removing this edgeline are detailed below:

1. Take-up the tubular fabric into a truck directly under the take-down roll on the knitting machine.
2. Slit the fabric immediately off the knitting machine; pad the slit fabric through a trough containing hot water and a wetting agent; then open and heat-set the fabric on a tenter frame.
3. Slit the fabric directly on the knitting machine and roll-up in open-width form on the machine.

Heat-Setting

Once the fabric is adequately relaxed, it can be heat-set. Heat-setting can be done before or after the fabric is scoured, bleached, or dyed; however, some shades of color, including white, may yellow when subjected to high heat-setting temperatures. This is especially true if greige fabric is heat-set. If heat-setting is performed on greige goods, spinning oils, waxes, and knitting oils may cause discoloration or yellowing that cannot be removed in subsequent scouring and bleaching processes. Greige goods can be padded in hot water with a wetting agent before heat-

setting to achieve the relaxed width. However, over the time it takes to process the fabric, the padding trough can become very contaminated with the spinning and knitting lubricants as some are removed from the fabric. These contaminants can redeposit onto the fabric and result in uneven discoloration of the fabric during heat-setting. Therefore, products for spinning and knitting lubricants should be carefully chosen for potential discoloration in greige heat-setting. In most cases, the yellowing of greige fabric during heat-setting can be removed with normal cotton bleaching procedures.

There is little that can be done about the discoloration if heat-setting is performed following the dye process. Also, heat-setting after dyeing may leave fabrics with poor stretch uniformity, variations in width, stitch distortion, or pattern distortion.[3] When heat-setting is performed after proper fabric relaxation, it also helps to prevent crease, rope, and crack marks from developing in subsequent wet processing operations. However, if the fabric is relaxed in rope form, care should be taken not to generate creases that could permanently remain in the fabric.

Heat-setting temperatures range from 360-385°F (182-196°C). A fabric heat-setting temperature of 360°F (182°C) is used if the desired effect is to maintain fabric weight while retaining good stretch and growth properties. However, a fabric temperature of 385°F (196°C) is recommended when a sheer look with reduced stretch is desired. Temperatures above 385°F (196°C) will cause the fabric to lose "power" due to the denier reduction of the spandex.[2] In this discussion, the ability of a fabric to stretch and then recover from that stretch is referred to as power. For knit constructions that have a tendency to curl, such as jerseys and tricots, a low heat-setting history may demonstrate a higher curl potential.

Because a small amount of shrinkage remains in the spandex after heat-setting and because heat-setting does not prevent the cotton fiber from shrinking, the heat-setting width should be 5-15 percent wider than the desired width to account for any additional shrinkage that may occur in subsequent wet processing.[4] In the case of open-width knit goods, the fabric may need to be extended wider than 15 percent in order to remove the center line.

When open-width fabrics are heat-set on a pin tenter frame, care must be given to width control and heat distribution. The amount of overfeed needed and the frame width used will depend on the fabric weight, width, and stretch level that are desired. A fabric that is wet from a previous process (e.g. prescour or relaxation) should be rewet and padded at the entrance to the tenter to ensure uniform moisture content throughout the fabric. Often there is a delay in going from a wet process to drying. If the wet fabrics are stored in a truck or on an A-frame while awaiting drying, there may be partial or complete drying of the top layers and the edges of the stored fabric. If these goods are not rewet and brought to a uniform moisture content, then the drier areas will get hot faster and have a different heat history. This will result in uneven heat-setting and thus uneven dyeing, shrinkage, stretch, and recovery. Therefore, a uniform moisture content in the fabric is essential for uniform drying and heat-setting.

During the open-width heat-setting process, the fabric with spandex is held under tension, and this results in a denier reduction that corresponds to a reduction in power and reduction in width retraction.[5] However, too much tension in the width during heat-setting may result in curling and high shrinkage caused by stitch distortion.[7]

The most common method of heat-setting tubular knits is the use of cycles of high pressure steam with vacuum in an autoclave. It should be noted that because the knitted tube is rolled in a flattened configuration, the edges of the tubular goods might be permanently set during this process. It is recommended that entire dye lots be autoclaved together to avoid any dyeing anomalies that may result from non-uniform autoclave conditions.[6] However, the heat-setting stage can be omitted if the fabric is designed to optimize contraction and power. When fabrics are unrolled from the greige condition, they are usually too narrow, too heavy, and for most apparel applications, they have too much power. Therefore, heat-setting is warranted.[5] After any heat-setting process, the fabric should be cooled before going to any preparation, dyeing, or finishing process. This is especially true if it is going to be pad-batch dyed or printed directly after heat-setting, as residual heat in the fabric could affect the resulting shade.

Wet Processing

Knit fabrics should be subjected to a pre-scour soon after heat-setting to remove any impurities that may be contaminating the fabric. Processing lubricants from spinning or knitting, which contain unsaturated fatty acids, may discolor or degrade the spandex yarn. The method of width control in which the fabric is to be processed, whether tubular or open-width, will determine which machinery should be used in the dyehouse. It is usually recommended that open-width fabrics be processed on a pad-batch or beam system to keep the fabrics flat and reduce the amount of tension applied. It may be necessary to gum the edges of the fabric to eliminate curl when the fabric is processed open-width on pad-batch or beam equipment.

Both tubular and open-width fabrics can be processed in either jets or paddle machines. If the fabric is processed in a jet, then the use of a soft flow or overflow version with a tensionless lift and a plaiter to preserve fabric stretch and recovery properties should be investigated. Low profile jets are also recommended and paddle dyeing is advocated for lightweight goods.[6]

Cotton/spandex blends may be dyed according to the usual procedures for dyeing cotton. It is recommended that a lubricant be used when processing the fabrics in jets.[6] Centrifugal extraction is preferred over padding or vacuum to remove excess water after dyeing.[7]

Drying

Open-width fabric may be dried on a pin tenter frame with overfeed. It is not recommended to apply more than the minimum amount of heat required so the fabric does not become yellow during the drying stage.[4] The recommended temperature range for drying is 250-275°F (121-135°C). Open-width fabric, as well as tubular fabric, may also be dried on a relaxation dryer. A continuous tumbler is another option for drying a tubular fabric.[2] If the goods are heat-set after preparation and before dyeing on a continuous or pad system, they must be cooled to a uniform temperature to prevent shading during dyeing.

Finishing

Cotton/spandex fabrics can be mechanically or chemically finished. If mechanical finishing is employed, very little tension should be applied to the fabric, especially if the fabric is hot. Cotton and spandex blends will withstand most mechanical finishing processes that can be applied to cotton. On the chemical side, spandex can withstand mercerization and is compatible with most finishes applied to cotton and cotton blend fabrics.[4] An anti-curl finish may be padded onto the fabric to improve its stability through later cut and sew operations.

Inspection

Fabric inspection should be conducted during the drying stage while the fabric is still on the tenter frame. Re-rolling the fabric for off-line inspection may expose the fabric to linear tension and cause a reduction in fabric width.

SPANDEX IN WOVEN FABRICS

Woven constructions containing 100 percent cotton warps and blended fillings of cotton/spandex require different handling techniques in the dyehouse than cotton fabrics without spandex. Normal techniques that use continuous, pad-batch, jet, or jig equipment must be adjusted to accommodate the inherent relaxation property of the spandex. This relaxation is a bulking of the structure resulting in a loss in length of the yarn, and therefore a reduction in the width of the fabric. The more relaxed the fabric is processed, then the greater the bulking phenomena. The dyer/finisher must determine the level of bulking to give the best performance in terms of yield, shrinkage, stretch, and recovery to meet the customer's specifications. Also, controlled use of heat to set the spandex at any point during processing will have a great effect on bulking and appearance. The type of finish applied, either chemical or mechanical, will affect the performance of the product. Considerations during handling to impart performance will be discussed below.

Relaxation

Before mill processing, cotton and spandex woven fabrics need to be boiled-off to determine the fully relaxed state. The method discussed in the knitting section concerning a boil-off technique would be the same for wovens with a few changes. The woven fabric sample of full width and two yards length should be boiled-off with the same chemistry used that would be used in the mill desize. The sizing materials for the warp should be removed to allow for complete relaxation. The resulting relaxed width will be the reference width upon which heat-setting conditions should be based.

After the fabric has been woven, the goods are usually singed. If singed, the goods will be quenched before preparation. If not singed, the goods will usually go directly into a wet-out bath containing a desizing agent, whether the process is continuous or batch. In either case, the temperature of the bath should be at least 160°F (71°C) to allow for the fastest and most controlled width relaxation. Higher bath temperatures will result in greater width losses. In some

mill operations, the linear speed of the fabric is so fast that the fabric cannot achieve its relaxed width before it is squeezed at the nip of the quenching box. If the fabric does not shrink to its relaxed width, then the fabric will fold in the linear direction and be squeezed in the nip resulting in a permanent linear defect. Therefore, it is recommended that the linear speed of the range be slowed to allow for full width relaxation.

After the width relaxation takes place, the speed can be increased as required. Jigs, continuous preparation ranges, and pad-batch equipment should make use of their opening devices. Jet equipment will exhibit the greatest tendency for the fabrics to form creases but will result in the greatest shrinking of the width. Uniform length tensions are more important than the level of tension.

Heat-Setting

Following the relaxation stage, the "filling stretch" fabric has contracted to become less than the desired width. Heat-setting is most effectively used at this point to re-stretch and stabilize the fabric close to the desired width. If desired, heat-setting can also be conducted following preparation or dyeing. The fabric should be heat-set on a pin tenter with much care given to width control and heat distribution. The amount of overfeed and the framing width will depend on the desired fabric weight, width, and stretch level. During the heat-setting stage, the spandex is held under tension, and this results in a denier reduction that corresponds to a reduction in power and reduction in width retraction.[5]

In the case of "warp stretch" fabric, desizing should be done in a manner that will allow bulking to occur in the warp direction. If a "warp stretch" fabric is to be processed on equipment that will impart tension in the warp direction, such as a continuous range or a jig, the fabric should be allowed to relax prior to heat-setting. Heat-setting fabric in its relaxed state will enable the fabric to retain its maximum retractile power.[8]

Heat-setting temperatures for wovens range from 360-385°F (182-196°C) on the fabric and are chosen according to the desired performance properties of the fabric. Because a small amount of shrinkage remains in the spandex after setting and because heat-setting does not prevent the cotton fiber from shrinking, the set width for "filling stretch" fabrics should be 5-15 percent higher than the desired width to account for any additional shrinkage that may occur in wet processing.[4] The amount of stretch set into "warp stretch" fabric can be determined by the overfeed or pull on the tenter. The stretch of a fabric should be evaluated after it has been relaxed but before heat-setting. Also, after heat-setting, the goods must be cooled before subsequent dyeing or printing processes where dyes will be directly applied to the dry fabric. Differences in dye shade will result from the areas of different temperature. These shade differences can be prevented by cooling the fabric after heat-setting. To prevent curling or edge folding, the selvage should be constructed to accommodate the width shrinkage.

Wet Processing

As with desizing, the fabric should be kept flat through wet processing to avoid uneven tensions and creases. Jig, pad-batch, or continuous open-width equipment is recommended for processing woven fabrics containing spandex. Great care must be taken to control the width of "filling stretch" fabrics throughout processing. If heat-setting is conducted between preparation and dyeing, the fabric must be uniformly cooled if it is to be dyed either continuously or by the pad-batch system, as the heat can interfere with the resulting fabric shade.[9]

Finishing

Warp stretch fabrics should be dried and finished in a relaxed state on pin tenter frames with overfeed or loop dryers. Sanforizing™ may be needed as a final finishing step to reduce length shrinkage and to remove any puckers or wrinkles that develop on the selvages. As with 100 percent cotton fabrics, stretch fabrics can also be resin treated to impart an added stability to the fabric. Silicone elastomers combined with resin crosslinkers will yield the best control of finished width and/or growth resulting from stretch during wear. The tradeoff for improved recovery using crosslinking resins is lower fabric strength. In some cases, changes in construction can reduce the strength loss and still allow for the desired stretch for the end use.

Heat-setting and crosslinking may be done at the same time; however, temperatures above 360°F (182°C) may result in problems with shade change and strength loss. An anti-curl finish can also be applied to stabilize the fabric for later cut and sew operations. Fabrics containing spandex can withstand many of the same mechanical finishes as cotton fabrics. However, care should be taken not to apply tension to hot fabric to avoid denier reduction of the spandex fiber.[8,9]

Experimentation - Knits

Cotton/spandex jersey fabrics were processed by various sequences to determine what characteristics would be imparted. The process under which the fabrics were treated, as well as the results obtained, appears below:

Fabric Construction One: 95% Cotton/5% Spandex, 30/1 RS Cotton/40 Denier Spandex

Process Conditions:

A. Prepare and dye in a jet, extract, slit, **heat-set,** and finish.
B. Slit, **heat-set**, prepare and dye in a jet, extract, dry, and finish.
C. Slit, **heat-set**, pad-batch prepare and dye, dry, and finish.
D. **Heat-set in an autoclave**, prepare and jet dye, extract, dry tubularly, and finish.

Fabric	A	B	C	D
Shrinkage, %(LxW) 5 HLTDs	7.8 x 3.0	8.2 x 3.4	9.8 x 4.2	5.2 x 1.8
Count (CxW) per inch per 3 centimeters	64.0 x 37.0 75.0 x 43.0	54.0 x 41.0 63.0 x 48.0	49.0 x 38.0 57.0 x 44.0	60.0 x 42.0 70.0 x 49.0
Weight, oz/yd^2 g/m^2	9.1 308.0	6.7 227.0	5.9 200.0	8.2 277.0
Width, inches centimeters	64.0 162.0	64.8 164.0	65.1 165.0	32.5 (tube) 82.0 (tube)
Stretch, %(LxW)	>100.0 x >100.0	80.0 x >100.0	77.0 x >100.0	89.0 x >100.0
Growth, %(LxW)	1.0 x 2.0	0.0 x 1.0	1.0 x 3.0	1.0 x 2.0

Comments:

1. Fabric A was similar to Fabric B except that it was heavier. This was because Fabric A was able to bulk during wet processing, whereas Fabric B, which was already heat-set, could not bulk much further.
2. Fabric D, which was set in an autoclave, had a resulting weight between that of Fabric A and Fabric B.
3. Fabric C had a lower weight and higher shrinkage than did the others.
4. All fabrics had good performance with regards to shrinkage, stretch, and recovery.

Fabric Construction Two: 90% Cotton/10% Spandex, 30/1 RS Cotton / 70 Denier Spandex

Process Conditions:

A. Slit, **heat-set**, prepare and dye in a jet, extract, dry, and finish.
B. Prepare and dye in a jet, extract, slit, **heat-set,** and finish.

Fabric	A	B
Shrinkage, %(LxW), 5HLTD's	6.5 x 5.9	5.0 x 4.6
Count (CxW) per inch per 3 centimeters	60.0 x 41.0 70.0 x 48.0	62.0 x 41.0 73.0 x 48.0
Weight, oz/yd^2 g/m^2	7.8 264	8.5 288
Width, inches centimeter	60.2 152.0	60.8 152.0
Stretch, %(LxW)	64.5 x 64.5	77.0 x 61.0
Growth %(LxW)	2.0 x 3.0	1.5 x 3.5

Comments:

1. Fabric B was similar to Fabric A except that it was heavier. This was because Fabric B was able to bulk during wet processing, whereas Fabric A, which was already heat-set, could not.
2. Both fabrics had good performance.

PROCESSING TECHNIQUES FOR COTTON/SPANDEX KNITS

Open-Width Knit Fabrics

1. Slit. If a prescour is desired, then scour in a soft flow jet and then slit. *
2. Steam to relax the fabric if not prescoured.
3. Heat-set 360-385°F (182-196°C).**
4. Scour, bleach, and/or dye (pad-batch, beam, or jet).
5. Dry (relaxation dryer or tenter frame).
6. Finish to width on a tenter frame (resin or non-resin).

* Fabrics made on wide diameter cylinders (60 inches/152 cm) can be handled in tubular form on a pin tenter.

** Heat-set now or following preparation. When choosing the latter, be sure to prepare on a pad-batch or beam dye unit to keep the fabric flat.

Tubular Knits

1. Steam calendar (to set the width and yield).
2. Heat-set in an autoclave.
3. Scour, bleach, and/or dye (jet, beck, or paddle machine).
4. Extract.
5. Dry (relaxation dryer or continuous tumbler).
6. Finish (normal cotton formulations).

PROCESSING TECHNIQUES FOR COTTON/SPANDEX WOVENS

Jig Processing

1. Load into desizing bath at 160°F (71°C) or higher.
2. Desize at temperatures as hot as possible to ensure complete removal of size.
3. Scour and/or bleach.
4. Dye with a normal jig procedure or dry the fabric for pad-batch dyeing or continuous dyeing.
5. Dry at temperatures between 250-275°F (121-135°C) and/or heat-set at temperatures from 360-385°F (182-196°C).
6. Finish with a crosslinking resin and silicone softener formula on a pin tenter frame.

Finishing

1. Cotton Soft Plus Formula containing a reactant silicone with a resin crosslinker.

Chemical	% OWB
Nonionic Wetting Agent	0.3
Low Formaldehyde Glyoxal Resin	7.5
Magnesium Chloride Catalyst	2.0
Silicone Softener	3.0

Pad at 60% wet pickup and dry/cure at 340°F (171°C) on a pin tenter.

2. Cotton Soft 100 Formula for resin free application on a compactor.

Chemical	% OWB
Nonionic Surfactant	0.2
Silicone Softener	2.0
High Density Polyethylene Emulsion	3.0

Pad at 60% wet pickup, dry at 300°F (150°C) on a pin tenter frame, and mechanically shrink.

REFERENCES

(1) "Lycra® Spandex Fiber," DuPont Technical Presentation.

(2) "Dyeing and Finishing of Cotton/Spandex Circular Knits," Cotton Incorporated Technical Services Information, Raleigh, NC.

(3) "Cotton/Spandex Wet Processing Recommendations," Burlington Technical Service Bulletin, Greensboro, NC, May 1996.

(4) "Wet Processing of Fabrics Containing Lycra® Elastane, Basic Information," DuPont Technical Bulletin No. L-517, Wilmington, DE.

(5) Luongo, R. R., "Dyeing and Finishing of Circular Knits With Lycra® Spandex – II," DuPont Technical Bulletin No. 500, Wilmington, DE, September 1989.

(6) Sadowski, J. Z., Gross, R. J., Luongo, R. R., "Dyeing and Finishing of Circular Knits with Lycra® Spandex – I," DuPont Technical Bulletin No. 501, Wilmington, DE, Sept. 1989.

(7) "Dyeing and Finishing Lycra® Spandex Containing Circular Knits," DuPont Technical Bulletin No. 505, Wilmington, DE, April 1992.

(8) "Producing Stretch-Woven Fabrics From Core-Spun Yarns Containing Lycra® Spandex," DuPont Technical Bulletin No. L-94, Wilmington, DE, April 1980.

(9) “Dyeing and Finishing of Cotton/Spandex Wovens with Corespun Filling Yarns,” Cotton Incorporated Technical Services Information, Raleigh, NC.

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Cotton Incorporated is a research and promotion company representing cotton worldwide. Through research and technical services, our 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 then 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 a 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.

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