TECHNICAL BULLETIN

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ISP 1013

IMPROVING THE ABRASION RESISTANCE OF NON-DURABLE PRESS COTTON TEXTILES

This report is sponsored by the Importer Support Program and written to address the technical needs of product sourcers.

INTRODUCTION

For some markets, there is a need to improve the wearing characteristics of 100% cotton textiles. Engineering the best cotton fabric to meet those specifications requires a number of considerations.

From the substrate standpoint, economics, fashion, and performance play important roles. Some of the decisions include fiber selection, yarn (size, twist, singles, plied, type spinning, etc.), and fabric (weight, construction, ends and picks count, etc.).

A similar situation is true for finishing. The selection of the finishing processes will have a dramatic influence on the performance of the final garment. Among the choices that affect the final product are batch versus continuous, method of preparation, dyes and method of dyeing, finishing agents and how they are applied. Mechanical finishes (sanding, sueding, brushing, calendering, sanforizing, etc.) may also influence the product's performance.

In this text, attention will be given to the application of specific finishing chemicals to the fabric to improve the abrasion resistance of the final garment. Interestingly, the additives that have shown the most benefit in abrasion resistance also improve the softness, sewability, and drape of the fabric.

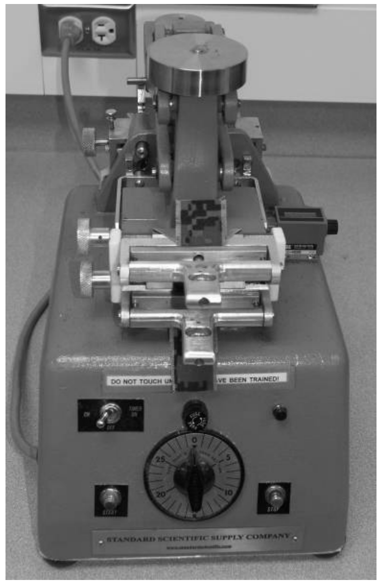
MEASURING THE DEGREE OF ABRASION RESISTANCE

The abrasion of a textile that occurs during wear and maintenance is due to a complex interaction of forces. Some of the factors affecting the extent of the abrasion include the type of activity by the wearer, parts of the garment most involved in the activity, the construction and fit of the garment, and consumer care practices.

To be acceptable, a test method should be simple, quick, meaningful, graduated for degree, and reproducible. Although wear testing by people would be most meaningful, the procedure would be expensive, time consuming, and impractical for routine use. Thus, other methods for measuring resistance to wear must be utilized.

There are several types of abrasion tests that have been developed for textile testing. Each type of test measures a different aspect of abrasion, so the test method that is used depends on the end use of the fabric. Since these tests can only simulate actual wear, it may be appropriate to perform two or more types of abrasion tests when developing new abrasion-resistant fabrics and/or finishes.

Perhaps one of the most common methods used for woven goods involves the use of the Stoll Flexometer. This test primarily measures fabric-to-metal abrasion and simulates the wear that occurs when a garment is rubbed against hard surfaces. A strip of fabric is abraded across a bar between two parallel metal plates; the top plate is fixed and the bottom plate moves back and forth in the length direction of the fabric strip. The test is automatically stopped when the strip of fabric breaks, and the number of cycles is recorded.



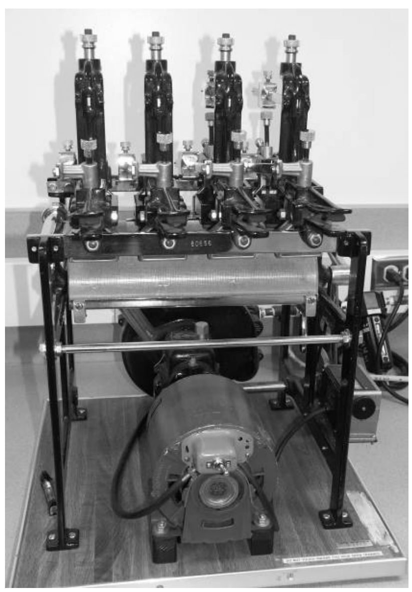
Stoll Flexometer

Another procedure sometimes used is the Accelerotor method. The apparatus consists of a metal cylinder lined inside with an abradant. A two-bladed propeller driven by an electric motor rotates inside the cylinder that can be closed with a door equipped with an inspection window. Square specimens, whose size depends on the weight per unit area of the cloth, are weighed and whirled around inside the metal cylinder where they are exposed to bending, rubbing, abrasion, impact, and compression forces. After whirling for a given number of revolutions per minute and for a given amount of time, the specimens are re-weighed. The loss in weight or the decrease in tensile strength is a measure of the reduction in abrasion resistance.

The Martindale abrasion test is a method that gives further insight into possible performance of a given fabric. A small, circular test specimen is rubbed against a standard abrasive fabric. The test specimen moves in an almost random pattern in order to simulate wear that occurs when fabrics rub against themselves or other fabrics such as chairs, seat belts, etc. The end point is reached when two or more yarns are broken or when there is a change in shade or appearance, which is sufficient to cause a customer to complain. This test can also be conducted for a pre-specified number of cycles, after which the specimen is visually rated. This test is particularly useful for those fabrics that are ring dyed.

Martindale Tester

Another type of abrasion test that is sometimes used for upholstery fabrics is the Oscillatory Cylinder Machine (a.k.a. Wyzenbeek Tester). This test rubs an abrasive surface - mounted on an oscillatory cylinder - against a strip of the fabric to be tested. The abradant may be a wire screen or a standard fabric such as cotton duck. The specimens are rated throughout the test until noticeable wear occurs, and then the number of cycles is recorded. The number of cycles indicates the end use specification (light, medium, or heavy duty) of the fabric.



Wyzenbeek Tester

Since much of the abrasion of fabrics occurs during laundering and tumble-drying, an indicative test is to wash a garment or a pant leg 10 to 50 times and inspect it for fading and abrasion. Although this procedure is time consuming, it is helpful to correlate the results with the test methods described above.

FINISHING COMPONENTS FOR ABRASION RESISTANCE

Polyethylene

By far, the most essential finishing agent found for improving the abrasion resistance of non-durable press cotton fabrics is polyethylene. Studies some years ago demonstrated that polyethylene properly applied is quite durable to machine washing. To achieve an applicable form, polyethylene is partially oxidized and then dispersed in water with the aid of non-ionic or cationic surfactants. The non-ionic dispersion may be applied to the fabric by pad, spray, foam, or metered addition (in the case of garment application). For exhaust applications such as after piece dyeing or after garment wet processing, the cationic dispersed polyethylene may be used. The polyethylene dispersions are also available in high, medium and a low density (softer hand than a high density) form. The solids content of these dispersions varies commercially, typically in the range of 20 to 40 percent.

The quantity of the polyethylene applied is critical to achieve adequate abrasion resistance. Whereas a quarter of one percent solids on the weight of the fabric may be adequate for improved sewability and hand, about one percent is required for optimum wear life.

For best durability, the applied polyethylene must experience a minimum cure temperature. Studies have shown that a temperature of 300ºF (150ºC) is adequate. Where the temperature is lower than this level, abrasion resistance suffers.

Auxiliary Agents Useful with the Polyethylene

An agent that has proved useful in further improving the durability and the performance of the polyethylene is a polyfunctional blocked isocyanate (PBI). This compound is available as a dispersion of about 25 to 40 percent solids. Usually a quarter percent solids on the weight of the fabric is adequate. For some shades, yellowing may be a concern.

To obtain the desired hand, other softeners may be used with the polyethylene. These may include silicones, non-ionic softeners, and cationic softeners. In some cases, the polyethylene may be applied, dried, and cured in the fabric form, and then the garment may be wet-processed and top softened with a suitable cationic softener.

Photos are shown below for a limited wear test, which was conducted comparing an abrasion-resistant treatment to a “control” with no treatment. In the first photo showing the front, the jeans on the right were treated with polyethylene, PBI, and silicone softener. Note that the treated pair has better color retention (due to less surface abrasion) than the control pair on the left.

Front

In the second photo showing the back of the jeans, the bottom pair was treated with the abrasion-resistant finish. Note that the treated pair has no holes; whereas the control jeans have holes in the center above the pockets.

Back

In some instances, the addition of an acrylic or a polyurethane polymer may be useful. These materials aid in binding color, imparting body to the hand, and reducing pilling and fuzzing.

Other functional finishes may also be used in conjunction with the polyethylene. Among these special finishes would be flame retardants, water and stain repellants, soil release agents, anti-microbial agents, etc. The finish must be formulated with respect to compatibility and performance.

Finally, addition of a surfactant is commonly used to ensure quick and adequate wetting of the fabric with the finish. If the finish contains a water or stain repellant, the surfactant should be a non-rewetting type.

SOME TYPICAL FORMULATIONS

A number of suitable finishes for improving the abrasion resistance of non-durable press cotton textiles are described below. Unless otherwise noted, the wet pickup is assumed to be about 60 percent based on the weight of the dry fabric.

Basic formulation:

	% on weight of bath
Polyethylene (non-ionic dispersion, medium density, 40% solids)	4.0
Surfactant for wetting	0.2

Basic formulation plus softener:

	% on weight of bath
Polyethylene (as in previous example)	4.0
Surfactant for wetting	0.2
Aminofunctional silicone (20% solids)	0.5 to 2.0

Basic formulation plus softener and PBI crosslinker:

	% on weight of bath
Polyethylene (as in previous example)	4.0
Surfactant for wetting	0.2
Aminofunctional silicone (20% solids)	0.5 to 2.0
PBI (as described in text above)	1.0

Basic formulation plus softener, PBI, and acrylic polymer:

	% on weight of bath
Polyethylene (as in previous example)	4.0
Surfactant for wetting	0.2
Aminofunctional silicone (20% solids)	0.5 to 2.0
PBI	1.0
Acrylic polymer (available in varying degrees of stiffness and resilience)	3.0

Basic formulation plus PBI and water/stain repellant:

	% on weight of bath
Polyethylene (as in previous example)	4.0
Non-rewetting surfactant	0.2
PBI	1.0
Fluorocarbon water and stain repellant	4.0
Aliphatic water repellant extender	5.0

For exhaust application:

	% on weight of fabric (or garments)
Cationic polyethylene (25% solids)	6.0

The pH adjusted to 4.5 with acetic acid
Temperature 140ºF (60ºC)
Agitate for 20 minutes
Drop bath and extract
For durability, the temperature of the fabric during drying should reach 300ºF (150ºC).

CONCLUSIONS

Polyethylene has been shown to be uniquely effective for imparting abrasion resistance to non-durable press cotton textiles. This chemical is fairly inexpensive and readily available in most finishing plants. Other auxiliaries may be added to improve their performance and softness as well as to aid in color retention and to reduce seam slippage and fuzzing. The polyethylene finish is compatible with most other functional finishes. In addition to padding, cationic polyethylene emulsions are available to permit exhaustion after wet processing.

Importer Support Program

The Cotton Board and Cotton Incorporated are funded by U.S. upland cotton growers and importers of cotton and cotton products (this includes raw cotton, piece goods, and finished apparel). A percentage of the importer funds are devoted for importer specific programs organized under the Importer Support Program. Examples of projects funded from this fund include training schools, educational programs, focus groups, economic meetings, and research initiatives.

Selected technical issues have been identified by importer members as relevant to their business. This report is a condensed, less technical report of those issues intended to provide the reader with basic, yet useful information on the topic.

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