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SHRINKAGE IN DRYCLEANING

INTRODUCTION

The shrinkage of garments during the drycleaning process has always been a problem. According to IFI's Garment Analysis statistics, since 1990 the percentage of problem garments involving shrinkage due to manufacturing has averaged 11.7 percent, ranging from five percent in 1994 to 18 percent in 1995. Drycleaners have been responsible for an additional 9.6 percent, ranging from six percent in 1994 to a high of 12 percent in 1993. Most of the shrinkage caused by the drycleaner was wool felting.

Shrinkage has two prime causes. If the garment is not properly stabilized during manufacturing, shrinkage can occur during processing.

If the fabric is mishandled during the drycleaning process, shrinkage may also occur. Unlike laundering, where water saturates the fabric, drycleaning uses a "dry" organic solvent, which does not adversely affect the shrinkage rate of a fabric. Water tends to cause the swelling of hydrophilic (water-loving) fibers, such as cotton, ramie, wool, and linen, while drycleaning solvent does not. However, drycleaning can cause dimensional change if the process involves excessive moisture, heat, or agitation.

Shrinkage of unstabilized fabrics during drycleaning is cumulative. Small amounts of shrinkage may occur with each cleaning due to the small amount of relative humidity needed for effective cleaning. The amount of shrinkage that occurs with each cleaning is usually so small that it goes unnoticed by the customer. After several cleanings, however, the shrinkage reaches a level that becomes unsatisfactory to the customer. Sometimes customers may conclude that all the shrinkage is the result of the most recent cleaning, when in fact, the shrinkage has been slow and gradual over several cleanings.

TYPES OF SHRINKAGE

There are three main types of shrinkage: relaxation, progressive, and felting.

Relaxation Shrinkage

Relaxation shrinkage is caused by two mechanisms: (1) the swelling of fibers in the yarns and (2) the release of strain introduced into the fabric during manufacturing.

Relaxation shrinkage is most commonly attributed to the release of tension introduced into the cloth during manufacturing. Fabrics are processed wet under tension, which stretches the cloth to a dimension larger than it normally would be, and dried in this stretched, enlarged condition. When the cloth is later moistened without tension (such as laundering or drycleaning), the strain is released, and the cloth returns to its normal, relaxed dimension.

The second contributor to relaxation shrinkage is the swelling of fibers as they absorb moisture. As fibers swell, they become thicker and shorter,

and the cloth changes dimensions due to the change in the yarns. If the cloth dries without tension, the relaxed, compacted yarns are not able to return to their original dimensions.

Progressive Shrinkage

Progressive shrinkage occurs after repeated cleaning cycles. All the potential shrinkage may not take place during the first cleaning. The delay may be due to the presence of finishing agents, which are gradually removed, resulting in additional relaxation shrinkage.

Felting Shrinkage

Felting shrinkage occurs in animal hair fibers, such as wool, angora, cashmere, camel, and others. Felting shrinkage occurs when the scaly surface of the hair fibers becomes entangled when exposed to heat, water, agitation, detergent, and/or pressure, making the fabric become thick and compact. Unfortunately, the original dimensions of the cloth are not recoverable. The fabric may also become harsh and somewhat stiff.

Every fabric has a limit to the amount it can shrink. When this limit is reached, the fabric or garment dimensions stabilize.

FABRIC FEATURES THAT AFFECT SHRINKAGE

A variety of fabric and fiber properties affect dimensional change. These include fiber content, yarn size and twist, type of weave, thread count, and the finishing process during manufacturing.

Shrinkage of any fabric depends on the physical and chemical structure of the fiber. Following is a list of the different types of fibers:

- Natural fibers
  (1) Cellulose (cotton, linen, ramie)
  (2) Protein (silk, wool)
  (3) Rubber
- Manmade fibers
  (1) Cellulose derivatives (rayon, acetate, and triacetate)
  (2) Synthetic (nylon, polyester, acrylic, olefin)
  (3) Glass

Each of these fibers has different physical and chemical structures that affect moisture absorption. This, in turn, affects the shrinkage of a fabric. For instance, the chemical structure of cellulose fibers enable them to absorb moisture quickly. Therefore, cotton and other cellulose fibers are more likely to swell in water than a fiber with a different chemical structure, such as polyester. On the other hand, it is the physical structure of the scaly wool fibers that entangle, resulting in felting shrinkage.

Some fibers swell in drycleaning solvent. When swelling occurs, the yarns actually draw up, resulting in shrinkage. Acrylic, a fiber that is known for its ability to stretch, can also demonstrate this swelling and subsequent shrinkage during drycleaning

The fineness, length, and twist of the fibers in the yarn also have an effect on the potential shrinkage of a fabric. When the yarn twist is low, dimensional change may be greater. Soft wools are made of yarns with relatively low twist, while hard wools have yarns with high twist. Because of this, soft wools experience more shrinkage than hard wools. When the yarn twist is higher, dimensional change is usually less; however, too much twist can dramatically decrease the strength of the yarn.

Thread count is the number of warp or wales (or the row of vertical loops in knits) and filling yarns or courses (or the row of horizontal loops in knits) per square inch in a fabric. In general, the greater the thread count, the smaller the shrinkage and vice versa; the larger the spaces between the yarns, the greater the movement of the yarns, resulting in greater shrinkage.

If a knit fabric has more wales per inch, most likely it will be more stable in the width direction. A knit fabric that has more courses than wales per inch most likely will be more stable lengthwise. Knit fabrics with more wales and courses per inch usually possess better stability to both stretching and shrinkage.

The yarn size, thread count, twist count, and the type of weave used are all interrelated. Different weaves are used according to the end use of the fabric.

Weaves that contain yarns with few yarn intersections can shrink more readily. In a plain weave, each warp yarn intersects with each filling yarn. In contrast, filling yarns in a satin weave float over several warp yarns before intersecting with a warp yarn. With all other factors being constant (fiber, content, yarn size and count), satin is likely to be less dimensionally stable than a plain weave. Unbalanced rib weaves (such as corduroy) would also be less stable based on the same yarn intersection principle.

Chemical or mechanical finishes are applied to every fabric after weaving or knitting. Mechanical finishing may include pressing, heat-setting, and tentering. Knit fabrics made of polyester, acrylic, nylon, and other heat-sensitive fibers retain their shape and size in wear and cleaning if they are properly heat-set by the manufacturer. Chemical finishes include chlorination, the application of resins, mercerization, and others.

Some finishes may be removed after the initial drycleaning or laundering process; therefore, greater shrinkage may occur after the second or successive cleaning cycles. Finishes are designed to improve the quality of a fabric. Shrinkage may occur during this finishing process. After mill finishing, the fabric is stretched to regain the length and width.

HOW DRYCLEANING AFFECTS SHRINKAGE

Four factors in drycleaning affect shrinkage:

- The moisture content (percentage of relative humidity) of the solvent and the moisture content of the load;
- The mechanical effect of agitation;
- The drying temperature;
- Steaming during finishing.

In general, a combination of adverse conditions is necessary for drycleaning to be the cause of objectionable shrinkage. For example, mechanical action alone is not likely to result in excessive shrinkage unless an excessive amount of moisture is present or extremely high drying temperatures are used.

Moisture Content

Moisture content in the solvent should be carefully monitored, especially during the humid, summer months. Water added to the solvent, as well as the fabrics that pick up moisture from the

atmosphere, stain removal, or spray, can increase the total moisture content in the wheel, contributing to additional shrinkage.

Garments collected in a drycleaning plant can pick up a high level of moisture overnight, prior to drycleaning the next day. Hydrophilic fibers—cellulose and protein—tend to attract moisture from the air and thus have high moisture regain. Wool has the highest moisture regain of any fiber. Garments made from hydrophilic fibers should be processed promptly, especially when under humid conditions, to eliminate the effect of moisture regain.

One indicator of higher than normal moisture content in the solvent, either from moisture regain or water addition, is the lining of suit jackets. If you notice the linings are more wrinkled than normal, the moisture content of the solvent is rising. To lower the moisture content of the solvent, run a load or two of dry cotton towels or blankets. The cotton will pick up the excess moisture from the solvent, and during drying, the moisture will condense with the solvent and separate in the water separator.

The Effect of Agitation

According to previous IFI studies, mechanical action on fabrics increases with solvent level elevations (gallons per pound) or with decreases of loading ratio (pounds per cubic feet). Thus, high solvent levels and/or underloading increase mechanical action.

Studies also show that lightweight fabrics, such as silks and rayons, generate greater mechanical action due to a greater frequency of folding, twisting, and flexing of the fabric.

ASTM STANDARDS FOR SHRINKAGE

TYPE OF ITEM	CARE PROCEDURE	% SHRINKAGE ALLOWED
Men's and Boys' Woven Dress Shirt Fabrics	Pressing Pressing and Drycleaning Drycleaning	1% Maximum in Each Direction 2% Maximum in Each Direction 2% Maximum in Each Direction
Men's and Boys' Woven Dress Top Coat and Dress Overcoat Fabrics	Pressing Drycleaning	2% Maximum in Each Direction 2% Maximum in Each Direction
Woven, Lace and Knit Household, Curtain, and Drapery Fabric	After 5 Launderings After 3 Drycleanings	3% Maximum in Each Direction 3% Maximum in Each Direction
Women's and Girls' Drycleanable, Woven Dress Coat Fabrics	Pressing Drycleaning	2% Maximum in Each Direction 2% Maximum in Each Direction
Men's and Boys' Dress Suit Fabrics and Woven Sportswear Jacket, Slacks, and Trouser Fabrics	Pressing After 5 Launderings After 3 Drycleanings	2% Maximum in Each Direction 3% Maximum in Each Direction 2% Maximum in Each Direction
Men's and Women's Knitted Career Apparel Fabrics: Dress and Vocational	Pressing After 5 Launderings After 3 Drycleanings	2% Maximum in Each Direction 3% Maximum in Each Direction 3% Maximum in Each Direction
Women's and Girls' Woven Dress and Blouse Fabrics	Pressing After 5 Launderings After 3 Drycleanings	1% Maximum in Each Direction 3% Maximum in Each Direction 2% Maximum in Each Direction
Woven Napery and Tablecloth Fabrics (Household and Institutional)	After 5 Launderings	5% Maximum in Each Direction
Women's and Girls' Knitted Sportswear Fabrics	Pressing After 5 Launderings After 3 Drycleanings	2% Maximum in Each Direction 3% Maximum in Each Direction 3% Maximum in Each Direction
Men's and Women's Dress and Vocational Career Apparel Fabrics	Pressing After 5 Launderings After 3 Drycleanings	2% Maximum in Each Direction 2.5% Maximum in Each Direction 2.5% Maximum in Each Direction

Wool fabrics with a naturally high absorbency increase in weight. Consequently, the force of drop in the wheel during cleaning is greater on wool than on silk, increasing the amount of mechanical action the wool is exposed to.

Shrinkage can generally be reduced by reducing mechanical action.

Drying Temperatures

The heat in the drying tumbler contributes to shrinkage, especially in garments with heat-sensitive fibers. For a regular cycle, the optimum drying temperature measured from the exhaust air stream is 140°F. However, for fabrics such as soft wools or heat-sensitive synthetics, the temperature of drying should be lower (90°F to 120°F).

Since the drying cycle is regulated by a drying sensor in many machines, the length of the drying cycle cannot be easily changed or manipulated. A load containing bulky articles or garments of multiple layers will require a longer drying time. This is why proper classification is important. One should not combine slower-drying, bulky garments with fast-drying garments, as the overdried item may experience more dimensional change.

SUGGESTED PROCESSING FORMULAS

In determining how to process a garment, the drycleaner should consider the garment type (regular or fragile) and the fiber content. Process regular garments by following the suggested guidelines. Fragile garments are generally constructed of sheer fabrics, soft wools, or heat-sensitive materials or are decorated with beads, sequins, leather appliques, metallic yarns, or other similar trim. The construction and detailing of the garment may also dictate that the garment be processed in a fragile classification. When cleaning fragile garments, shorten the cleaning cycle and drying time. For some fragile items, lowering the relative humidity level and increasing the solvent level may also be necessary. High solvent levels prevent fabric friction and abrasion.

The fiber content is also important in determining the care procedure. Garments containing a blend of fibers should be treated according to the procedure used for the most fragile fiber. For example, process a polyester/wool fabric as wool, and process a cotton/rayon fabric as rayon.

Although a drycleaner cannot prevent shrinkage if the fabric is not properly stabilized, precautions in drycleaning can minimize shrinkage. The chart on the preceding page by the American Society for Testing and Materials (ASTM) indicates standard guidelines for shrinkage.

SUMMARY

According to studies on shrinkage in drycleaning, the following factors affect shrinkage during the drycleaning process:

- Relaxation shrinkage potential of the fabric;
- Fiber content and structure of the fabric;
- Elevated moisture content above 75 percent;
- High drying temperatures;
- High mechanical action.

As drycleaners, we may not be able to eliminate shrinkage entirely, but we can try to minimize shrinkage through proper processing. When the fiber or fabric construction lead you to suspect that shrinkage may be a potential problem, the drycleaning process can be modified in an effort to obtain acceptable performance.

REFERENCES

C.S.I.R.O., "The Conflicting Requirements of Wool Settings for the Finisher and Tailor" (1987).

W.K. Rhodes, Dyers and Cleaners Research Organization, Ltd. "The Shrinkage of Textiles in Drycleaning" (1970).

A.C. Lloyd, "Fabric Shrinkage in Drycleaning" (1982).

Dr. Manfred Wentz, Ivan J. Andrasik, William Fisher, "Shrinkage in Drycleaning" (1966).

Von Bergen-Mauersberger, American Wool Handbook, Second Edition, (1947).

Albert R. Martin, William Fisher, Ivan Andrasik, "What A Good Drying Tumbler Is Like" (1971). ❐

Written by Cindi Busler, IFI Technical Information Specialist.