A STUDY OF THE PERFORMANCE OF THREE FUNCTIONAL FINISHES IN LAUNDERING A SELECTED GROUP OF APPAREL FABRICS

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INTRODUCTION

The science of "finishing" fabrics has been known for centuries. Probably, the first process ever used by man was that of sun bleaching. The brighter, cleaner, appearance of cotton and linen fabric after exposure to the sun's rays, enhanced its value and so became a common practice in the treatment of cloth. Later, starches, dextrines, natural gums, clays, fuller's earth, and other products were gradually introduced to improve the hand and attractiveness of the fabrics. (27) It was not until 1844, when John Mercer made his momentous discovery of the effect of caustic soda on cotton, that chemical agents were used for the purpose of finishing. (35) Since the development of the mercerization process by Lowe in 1890, (18) the textile industry has experienced great progress in the field of fabric finishing.

The advent of the machine age brought about increased speed and ease of production. This, combined with increased consumer demand lead to the development of finishes of a more permanent type and functional nature. A crisp quality was one of the first of these new permanent type functional finishes to be imparted to a fabric and many types of this finish have been developed and are in use today. (41)

In 1928, after 14 years of intensive research, Kenneth Lee of Tootal Broadhurst and Lee Co., in England, announced the development of the first successful process for rendering cotton, linen and rayon fabrics resistant to creasing and crushing. (2) This, indeed, marked a milestone in the textile industry, for this discovery established the successful use of resins in the finishing trade, and opened a whole new field for research.

However, the problem of shrinkage remained as yet, unsolved. The textile manufacturers were being constantly bombarded with complaints of shrinkage, from the consumer.

In 1930, the first successful method of shrinkage control was developed by Sanford L. Cluett, vice president of Cluett Peabody and Company. This process was so effective that within five years of its adoption, the term "Sanforized shrunk", appearing on a fabric, was accepted as a highly satisfactory indication of shrinkage control to the textile trade. (5)

The war years greatly accelerated research and progress of permanent finishes, especially for military fabrics. Civilian production was reduced, scarcities resulted and quality suffered, mainly due to imposed restrictions on essential materials and available labor. Since the end of the war, the vast knowledge and research data accumulated in this period, along with increasingly competitive markets and consumer demand have resulted in the introduction of many new functional finishes in the consumer market. Publicity given to these finishes as well as their performance in service, will influence consumer acceptance and increase demand for improved finishes. However, if the finish should reduce the strength of the fabric, if it should seriously affect the appearance or handle or if the finish is not permanent under the usual conditions of use in washing, and ironing, then the consumer will be unsatisfied and the textile market will suffer.

J. G. Evans (10) points out that in general, the public are keen and discriminating buyers. Although usually attracted initially by the colorfulness of a fabric, and secondly by the feel or handle, the consumer is becoming increasingly conscious of those qualities which are intangible and unseen at the time of purchase. Such questions as "how does it wash?", "does it shrink?", "does it crease?", "does it remain crisp?", are being asked, increasingly by the consumer, and constitutes a definite preference for fabrics of quality, distinction and durability. (11)

In a study based on interviewing 1,782 women which was made by the U. S. Department of Agriculture (44) in a "Survey of Women's Preferences Among Selected Textile Products", it was found that one of the main objections to the use of cotton and rayon material used in ready-made clothing was the fact that it wrinkled very badly.

A similar study made by the U. S. Department of Agriculture (20) concerning men's preferences among selected clothing items, shows the relative preference among male consumers for the various competing fibers ---- cotton, wool, rayon, nylon, and their mixtures, in certain selected wearing apparel as well as the advantages and disadvantages of each of the competing fibers in these garments. These preferences show the desirable and undesirable features which the men believe these fibers possess, when used in each of the selected items.

About two thirds of the men interviewed preferred cotton for business shirts, underwear and pyjamas. The main reason for this preference was that cotton could be washed safely, more easily and more satisfactorily than the competing fibers. Men who preferred rayon for summer sport shirts, pyjamas, and extra trousers, mentioned resistance to wrinkling as one of the reasons for their choice. Owners of extra trousers and summer suits, who preferred rayon rather than cotton said they felt cotton garments of this type wrinkle easily and fail to hold a crease. Owners of both business and sport shirts, extra trousers for both year round and summer use, and summer suits, who disliked rayon because of appearance, most often mentioned wrinkling or rumpling and not holding a press as reasons for nonpreference.

One of the main reasons given by those who said they preferred a fiber other than cotton was the fact that it does not stay fresh looking. This is especially true of extra trousers and summer suits, business dress shirts and sport shirts. This study likewise points out that men as well as women are equally aware of the disadvantages of rayon and cotton fabrics as far as crease resistance is concerned.

From this investigation it is seen that there is a very great need for a satisfactory solution to this problem of crease resistance. Obviously there is a very large potential demand for effective and durable crease resistant finishes. The development of such a finish would not only result in greater satisfaction on the part of the consumer but would have far reaching implications on the future market for the fabric finisher.

Buck and Mc Cord (18) state that the market for crease resistant cotton fabrics is primarily in apparel and household uses where appearance is a major consideration. They list the following articles as the most important ones, in which crease resistance is desirable:

Men's wear----dress and sport shirts, dress and sport trousers, work pants, pyjamas and nightshirts.

Women's and junior apparel----dresses, blouses, waists, shirts, aprons, uniforms, pyjamas, nightgowns, bedjackets, slips and petticoats, childrens dresses and play clothes.

Household goods----bedspreads, draperies, pillow cases, sheets, tablecloths and napkins.

About 2,500,000,000 square yards of cotton fabrics are used each year in the production of cotton fabrics for apparel and household uses. Considerably less than 1% of cotton fabric production was finished for crease resistance last year.(3) This shows the opportunity the textile converters and finishers have for increased production of crease resistant fabrics and also it represents a measure of the satisfaction the consumer will experience if an effective and durable crease resistant finish is developed.

Satisfactory crease resistant finishes of cotton fabrics provide the opportunity to expand consumption of cotton in uses where crease resistance is a primary consideration. Crease resistant cottons might make inroads in wool's market in summer suitings, and might even take over some of the market for winter suitings. Many of the cotton markets could be expanded in uses where their principal competitor is rayon. (3)

For apparel and household uses in which crease resistance is a desirable fabric characteristic, consumption totals 4,055,000,000 square yards of fabric annually. The potential market for crease resistant cotton fabrics is the 2,434,000,000 square yards now held by competing fibers, provided that:

(1) The crease resistance of cotton fabrics is as nearly adequate as that of competing fabrics for each particular use.

(2) Cotton properties necessary or desirable in each particular use are not sacrificed by the addition of a crease resistant finish.

(3) There is no appreciable increase in the cost of the cotton fabric as a result of the crease resistant finish.

(4) Sufficient sales promotion is employed to obtain consumer acceptance.

It appears then, that the development of an effective and durable crease resistant finish would be extremely important not only in terms of satisfaction to the consumer but in economic terms to the chemical manufacturer and fabric converter. However, at present, there is a very low percentage of the cotton treated for crease resistance and the retail price of such treated fabrics is high compared with an untreated fabric. For example, the price of untreated Indian Head, on the retail market, is $.79 per square yard compared to $1.19 per square yard for the crease resistant treated Indian Head which was used in this study. This is a fairly high price differential. It is probable, however, that with an increased demand, there will be a greater incentive for the manufacturer to establish large scale production methods which will result in lowered production costs.

There is likewise a great demand on the part of the consumer for fabrics that will retain their original stiffness after repeated launderings. Permanent crisp finishes produce a wide variety of effects and therefore can be used for many purposes. When applied to cotton percales they give a full, starched hand, which, if permanent greatly aid in the wear and care of the fabric. Many novelty dress fabrics possessing high fashion value can also be obtained from this finish. There are already many finishes of this type on the current market but their durability to laundering is not well enough established to provide the consumer with any real assurance that the finish will be permanent.

The problem of dimensional stability is an age old one. The fact that a garment will stretch or shrink in laundering has serious implications for the consumer. Not only is the consumer faced with the discomfort of ill fitting garments, but is faced with a considerable loss of money as well. It is of the utmost importance that better methods for control of dimensional change in any fabric requiring laundering, be established, not only to save consumer dollars but to save the consumer the inconvenience of uncomfortable and unsightly wearing apparel.

It is evident from this short discussion of crease resistant, permanent crisp, and dimensional stability finishes, that there is not only a definite need for improvement in these finishes, but also a need for evaluation of existing finishes in terms of their initial characteristics and their performance in continuous launderings approximating normal wear and care expected of them.

This study has been set up primarily for exploratory purposes to investigate methods of measuring the effectiveness and durability of these three functional finishes on a selected group of apparel fabrics. The fact that so many functional finishes have been developed for establishing crease resistance, permanent crispness and dimensional stability on fabrics, has resulted in numerous trade names appearing on the market. This has lead to confusion on the part of the consumer as to their meaning and value. Therefore, one of the underlying purposes of this study is to acquaint the reader with some of the better known crease resistant, permanent crisp and dimensional stability finishes, and to clarify the advantages and limitations inherent in them.

Another general purpose in this study is to make available to the reader trade and manufacturer's names identified with different finishes, with the hope that such knowledge will assist in buying "finished" fabrics more intelligently and discriminatingly.

A critical analysis of laboratory procedures used in this study and an evaluation of experimental methods used, is still another objective. Recommendations for improvements in testing procedures as well as need for additional studies which might be of value to the consumer as well as the converter, constitutes the final objective.

One specific purpose in this study is to compare the effectiveness of several crease resistant finishes on types of fabrics which are structurally unlike. It is hoped that from an analysis of this selective group, which vary in type and finish, that their performance during laundering can be related to cost and consumer-buyer satisfaction. Specifically, this study is designed:

(1) To determine the effectiveness of the finish applied on;

(a) a group of fabrics consisting of cotton, linen and a cotton-rayon blend, which have been treated for crease resistance.

(b) a group of five selected cotton apparel fabrics which have been treated for permanent crispness.

(c) four types of dimensional stability finishes on cotton and a rayon-cotton blended fabric.

(2) To compare the relative durability of these finishes to continuous laundering at two temperatures, in an endeavor to determine the effect laundering temperature may have on the permanency of the finish.

(3) To determine in so far as possible, the effect of the finishing process on the tensile strength of the fabric.

(4) To discover if the claims made by the manufacturer are substantiated.

It is hoped that from this study sufficient information will be obtained to assist the consumer in buying more intelligently, and to stimulate the textile manufacturer, in the production of finished fabrics, which will be most satisfactory for a specific purpose.

REVIEW OF LITERATURE

Included in the review of literature is a short description of the processes involved in the formation of the crease resistant finish, the permanent crisp finish and the dimensional stability finish, along with the limitations which each finish experiences when applied to fabric. Such knowledge is essential for understanding the nature and function of these finishes on textile fabrics, and for interpretation and analysis of the laboratory tests performed in this study.

Crease Resistant Finishes

One of the most comprehensive and significant studies of crease resistant finishes was reported by George S. Buck Jr. and Frank H. Mc Cord in their article "Crease Resistance and Cotton".(3) For this reason the author refers frequently to this excellent source in the following discussion of crease resistance and in interpretating the results of this study.

Buck and Mc Cord (3) define crease resistance as, "that property of a fabric which causes it to recover from folding deformations that normally occur during its use." The recovery may be almost instantaneous, in which there will be an apparent resistance to the formation of a crease, or recovery may be slower with the crease mark disappearing gradually. The speed and completeness of a fabric's recovery from creases is the measure of its crease resistance. The permanence of creases depends on the force or pressure of creasing and on the time that the creasing force is applied.

Many factors affect the crease resistance of a fabric; First, the fiber content of the fabric has perhaps, the greatest influence on the fabric's crease resistance, the fibers with the largest cross section having the greatest bending, and torsional rigidity with which to resist deformation.

Secondly, the construction of the yarn plays a very important part in the resiliency of the fabric, The construction of the yarn, should be such that fiber strains are at a minimum. Twist that is too high will place the fibers in a position of strain, causing them to reach their elastic limit quickly upon additional stress. Where twist is too low, the resultant low fiber cohesion increases the possibility of actual displacement of the fibers in the yarn at or near the point of folding, so that permanent deformation results from the failure of these fibers to return to their normal position in the yarn.

The coarseness of the yarn also affects a fabric's ability to resist creasing. Coarse yarns cannot be creased as sharply as fine yarns and therefore the strain on the fibers will be less. Moreover, there will be more fibers in a given cross section of a coarse yarn than of a fine yarn, and therefore a better distribution of stress. Also a lower twist is generally used in the heavier constructions which will favor less creasing.

Thirdly, the construction of the fabric is important. Factors in constructing fabrics for maximum crease resistance are much the same as those for yarns. Wherever possible the fibers should be as relaxed and free from strain as possible. Plain weaves with a high count, place the fiber under a maximum strain and limit the flexibility of the fabric. It is recognized that fabric flexibility increases as weave pattern becomes more complicated. For this reason sateens, broken twills, and other similar weaves wrinkle and crease less than plain woven ones. Similarly thick fabrics will be more crease resisting than thin fabrics. Also it is to be pointed out that because of light reflection more lustrous textiles will show creases to a much greater extent than those which have a matte surface. (3)

Fourthly, the humidity of the atmosphere shows a marked effect on creasing powers of the fabric. In an atmosphere of relatively high humidity, fabrics are more easily creased, and recover less rapidly.

These factors had long been recognized by the fabric designer when constructing fabrics requiring high crease resistance. This knowledge, however, was not sufficient to produce cotton voiles, ginghams, chambrays and percales as well as linens and spun rayons possessing good crease resisting properties. Nothing was done to solve this problem until the fundamental technique for developing a crease resisting finish was established in 1928 by the Tootal Broadhurst Lee Co. These same techniques are being used today.

The principle of the crease resisting process is to form a synthetic resin inside the fibers of the fabric (6) or on the surface of the fiber (13). Resins used are almost exclusively of the urea formaldehyde type.(29) A newer resin, melamine formaldehyde, is being used more extensively now, because in sharp contrast to urea formaldehyde it is miscible with cold water in all proportions and has excellent stability to storage. Only one half as much melamine is required to produce the same effect as the urea formaldehyde. Urea formaldehyde absorbs chlorine from laundry bleach liquors in such a way as to cause tendering during hot ironing, unless the fabric is given a thorough anti-chloring. Melamine resins also absorb chlorine but in such a way that there is no subsequent loss in the tensile strength of the fabric. (26) Urea formaldehyde resins however, have the advantage of being low in price. (3)

These synthetic resins are dissolved in water using acid catalysts. Under carefully controlled conditions, the fabric is passed through the solution and then between the rollers of a mangle which impregnates the fabric with the resin. In order to obtain penetration into the core of the fiber, it is necessary that the size of the molecule shall be extremely small, and for that reason the resins are applied in as close to the monomeric state as it is possible to produce them. After drying, the treated cloth is cured at elevated temperatures. The small molecules join together during polymerization to form large ones which are too large to pass out of the fibers. These polymerized molecules impart the properties of permanent crease resistance and stability to the fabric. Finally the fabric is washed thoroughly in order to remove any uncombined chemicals, which may subsequently make the cloth tender and/or cause an undesirable odor. It is then dried and ready for use. (6)

When the fibers are impregnated with a low polymer resin, the concentration applied is extremely important. Each fiber seems to have a saturation point or limiting concentration which it will hold. When applying higher concentrations the excess seems to spill over and this gives brittle surface effects, poor abrasion and fabric stiffness. This saturation point seems to be dependent on a great many factors, such as the twist of the fiber, the tension on the yarn during weaving and depth of shade to which it has been dyed.(30) The degree of curing the resin is of utmost importance for if the resin is under cured, the large molecules will not be sufficiently formed and they will wash out during laundering. Hence, a new garment possessing excellent crease resisting properties when purchased, may lose this valuable property on being laundered. Unless the uncondensed resin, catalyst, excess formaldehyde and other materials are removed from the fabric by adequate washing, there will be a tendency for the finished goods to develop odor and sometimes to cause dermatitis. (3) Powers (30) points out that "each type of fiber and each fabric offers a separate problem and so general conclusions cannot be drawn. regarding the effect of any one type of resin on all types of fabrics or fibers." Claims made by manufacturers of crease resistant finishes are

1. Increased resistance to creasing of treated cottons, linens, rayons and rayon blended fabrics.

2. T. B. Lee reports an improvement in the tensile strength of treated viscose rayon, a little in the dry state and by 50-100% or more in the wet state. (6)

3. The increase in tensile strength of the treated fabric is accompanied by a decrease in extensibility, an improvement in the recovery from stretching and a decrease in the slippage of yarns one over the other. (6)

4. The crease resisting process is capable of yielding a wide variety of draping qualities, from firm linen-like goods to soft lofty fabrics and from smooth silk-like materials to sheer crisp fabrics.

5. The process has an advantageous effect on dyes, making them considerably faster to washing and light. (6)

Undoubtedly the volume of goods finished with the formaldehyde type of resin will increase substantially as the public becomes more familiar with the advantages of crease resistant finishes. Never the less, even the strongest promoters of the finishes now being produced commercially will concede the need for further improvements, as well as the opportunity for development of new types of crease resistant treatments. Finishes should be more durable and should withstand laundering for the life of the fabric. It would be desirable to have a finish that would not retain chlorine on bleaching, and that would not decrease fabric strength or abrasion resistance. The goal of research on the resilience and crease resisting properties of cotton and other fibers should be to produce fabrics that are the equal of silk and wool in these properties, with as little sacrifice as possible of the many other desirable qualities offered by the fiber.(3)

There are many chemical companies producing crease resistant finishes of the type described above. Many trade names have appeared on the market which have confused the consumer as to their meaning and value. The chart appearing in the appendix on pages 114-115 gives the trade names of the finish, the manufacturer, the fiber to which the finish is applied and the properties of the finish. (39)

Evaluation of the Crease Resistant Finish

Dr. D. H. Powers, Director of Textile Chemistry, Monsanto Chemical Co.(25) reports that in the use of the Monsanto Wrinkle Recovery Tester that a 100 degree recovery angle would be regarded as commercially acceptable. He reported that several Dan River cotton fabrics, which had treated with Resloom achieved a recovery angle greater than 110° or a 70% increase over the wrinkle recovery in the original untreated cotton.

Ephraim Freedman (14) reported the values of crease angles for different untreated fabrics as follows: Viscose rayon 60-65°; Acetate rayon 95-105°; Silk 120°; Wool 120°; Cotton and Linen 75-90°.

In an illustration appearing in the American Dyestuff Reporter (24) a beach coat, one half treated with Superset Resin and one half untreated, showed the extent to which wrinkling could be reduced by the use of a synthetic resin. The creases on the untreated part of the garment were numerous and well defined, while creases on the treated portion of the fabric were inconspicuous. On hanging over night practically all of the wrinkles came out of the treated part of the beach coat. This,however, was not true of the untreated portion.

In a study made by Phillip C. Scherer and N. Sugarmen (33) it was shown that the practical crush resistance for all the rayons is low but those spun with the highest tension have definitely better crease resistance.

Margaret S. Furry (15) made a study of the durability of the crease resistant finish to severe and mild laundering on a selected group of cotton, linen and rayon dress fabrics. By testing the fabrics with a flexometer developed by the

National Bureau of Standards, the effectiveness of the crease resistant finish with severe and mild laundering was ascertained. Five launderings were carried out on each fabric. Of the fabrics tested, the rayons had the most flexural resilience and the linens about as much, but the cottons were somewhat less resilient. Usually there was greater resilience in the filling than in the warp. On laundering, all of the fabrics lost resilience, considerably more on severe laundering than on mild. On severe laundering, one rayon fabric lost as much as 30% of its resilience in the warp and 17% in the filling, as compared to a loss of only 4% and 2% with mild laundering. On the whole the loss in resilience on laundering was greatest for the linen fabrics --the greatest loss occuring during severe laundering; 35% to 41% in the warp and from 25 to 40% in the filling. On mild laundering they lost only about half as much resilience. For the cottons, the loss in flexural resilience on severe and mild laundering was almost the same. In the warp direction they lost about 25-30% and in the filling 12-14%. Besides resistance to creasing, the specially treated fabrics of this study were found to have other desirable properties. Shrinkage for the cotton and linen fabrics was under 2%. However the rayon fabrics shrank more, although previously preshrunk. All these crease resistant fabrics had greater strength in the warp than in the filling direction. In laundering, the linens seemed to increase in strength, but the cottons and rayons lost strength. This special finish also tends to make fabrics very resistant to yarn slippage at the seams, cotton and rayon fabrics exhibiting more resistance than the linens.

In a study made by I. J. Gruntfest and D. D Gagliardi (17) substantial improvement was obtained in the wrinkle resistance of cotton and rayon fabrics when treated with formaldehyde. In the case of untreated viscose rayon the percent recovery from wrinkling was 52%, while that for shrinkage was 13.9%. The same fabric treated with 10% formaldehyde using 1% ammonium chloride as catalyst and cured for ten minutes at 150°C., produced a fabric which had 91% wrinkle recovery and showed only 1.1% shrinkage. However, tensile strength decreased from 52 pounds per inch to 27 pounds per inch. Untreated cotton sheeting had 51% recovery from wrinkling while shrinkage was 2.8% and tensile strength was 54 pounds per inch. When given the same treatment as the spun rayon, 87% wrinkle recovery and 0.3% shrinkage resulted, but tensile strength dropped to 12 pounds per inch. Similar tests were carried out using 2% and 5% formaldehyde but results obtained were not so marked as with the 10% solution. The conclusions drawn from this study were, that with each improvement in shrink or wrinkle resistance, there is an accompanying reduction in the tensile strength, the elongation and the tear strength of the treated fabric. (17)

Schnyder and Honegger (34) found that on laundering, cotton and linen fabrics, resistance to repeated bending in these fabrics was improved by laundering.

Permanent Crisp Finishes

Many textile fabrics, particularly cottons have a more pleasing texture if they have been treated to give them crispness or fuller body. Not only do these "finished" textiles protect, improve and beautify the fabric, but they offer the consumer an easier, better, more practical way of caring for her fabrics. (21)

The crispness of a fabric is best defined in terms of drapability. Morton (23) defines this term very well when he says; "a fabric is said to have good draping properties if it conforms readily to the shape and contours of the body which it covers."

The essential draping quality is measured by the ease with which a fabric bends under its own weight. There are many factors in the construction of a fabric which affect its draping qualities. First, the resistance of a fiber to bending depends on its thickness. Hence, the intrinsic stiffness of the fiber substance can be largely compensated for by the use of fine yarns or filaments, or conversely, a stiff fabric may be easily attained through the use of thick yarns.

Secondly, when a fabric is bent, the outer curved surface is put in tension, while the inner curved surface is put in compression, and, it is the fabric's resistance to these forces that accounts for its rigidity. For any given degree of curvature the magnitude of these forces depends on the distance between the two surfaces, so therefore, the thicker the yarn, the stiffer it is.

Thirdly, flattening of the yarn plane of the cloth will greatly reduce its resistance to bending. Soft twisted yarns can be flattened more readily than hard twisted yarns. Therefore if a stiff crisp fabric is desired, yarn twist should be high. (23)

There is no advantage in the use of highly twisted yarns unless the cloth structure is such as to prevent the yarns from spreading side-ways, otherwise the yarns will flatten out and a soft clinging fabric results. The cramming of threads together in such a way as to prevent or limit flattening, depends not only on the yarn count, but also on the structure of the weave itself. A plain weave provides the maximum frequency of intersections and imposes a greater restriction on thread flattening than any other.

The fabric finisher must keep these important facts in mind when designing fabrics that are to be stiff and crisp. Fabric construction alone, however, is not enough to give sufficient crispness to muslins, percales, prints, and to such sheer fabrics as dotted swiss, organdy, net and other fabrics where crispness and fuller body is a desirable property.

In the development of fabric finishing, it was soon found that fabric construction along with the addition of starch, dextrins, gums, etc., to the fabric, provided the desirable hand. Many of these substances though, proved to be unsatisfactory in laundering. Recent discoveries have presented the textile finisher with a wide range of chemicals from which he may choose a finish that will produce practically any desired hand. These new finishes supposedly, have the distinct advantage of being durable to laundering. For a clearer understanding of the nature of these materials, the following discussion points out the types of permanent crisp finishes that are being used today.

1. Cellulose finishes

A permanent cellulose finish is one whose characteristics are due to either producing a change in the cellulose of the textile itself, or the addition of cellulose or modified cellulosic material to the textile fabric. (19)

This definition indicates two groups of finishes:

A. Processes that modify or change the character of the cellulose of the textile fiber itself such as;

(a) Mercerization----besides the widely used and accepted mercerized process, such modifications of Mercer's caustic treatment have been used to produce permanent novelty effects such as crepes, plissés, and seersuckers.

(b) Heberlein process----this process was developed by the Heberlein Organization of Switzerland.

It consists of passing a light weight cotton fabric rapidly through cold sulphuric acid of the proper strength, followed by washing and neutralizing. The surface of the fiber is partially dissolved. This dissolved cellulose is re-precipitated on the fiber but not in sufficiently large amounts as to fill in the interstices of the cloth. The result is a transparent, sheer, crisp organdy fabric, which retains its appearance on repeated launderings. Several alternate treatments have been used and many novelty effects have been obtained using a slight modification of this process. (19)

(c) Cuprammonium process or Wilesden process has been used for treating cotton duck for crispness and luster but has proven unsatisfactory because of the high cost of the copper in the solution. (8)

B. Processes that modify the textile fiber by the addition of cellulosic solutions.

(a) Viscose or cellulose xanthate----this was one of the earliest of these solutions used but is not used widely now because of the special precautions required in preparing and using the solution, together with the considerable costly equipment that is required.

(b) Caustic solutions of cellulose ethers and caustic solutions of cellulose can be used to produce a wide range of finishes from full soft finishes to crisp organdy type finishes. These alkali solutions are usually applied to fabrics by padding and the cellulose is coagulated by passing through a bath of either sulphuric acid, acetic acid or boiling water, or simply by drying. (29)

(c) Catalytical activated caustic solutions of cellulose, commonly referred to as c.a.c. cellulose solutions. These are by far the most important of this group. C.a.c. cellulose solutions can produce practically any permanent finish effect desired except crease proofing. This finish has no known latent effects and is not chlorine absorbative. (19) On application to the fabric, not only does the coagulated cellulose hold firmly to the fabric treated with the cellulose solutions but in addition the cellulose will bind many other insoluble substances to the fabrics. Such materials as clays, talc, fillers, delusterants and pigments, accordingly may be added to the c.a.c. solutions and upon coagulation of the cellulose on the fabrics they are bound strongly enough to resist washing. (8) No curing or special equipment is required and for that reason it is extremely economical to use. Its use tends to lower overall finishing costs, and an increased yardage on treatment of the fabric more than offsets its slight cost. It is used on organdies and rayon fabrics. Full soft finishes are obtained on men's shirts, crisp finishes on dress fabrics and starched effects on poplins, when c.a.c solutions are applied to textile fabrics. (19)

2. Resin finishes

Such resins as urea and melamine formaldehyde are used to produce crisp finishes also, especially on spun rayon. These resins are applied from water solution by padding, drying and curing at a high temperature. This high temperature polymerizes the resin and supposedly, renders the finish wash fast. The finish is not practical for cottons as in the laundering process, the urea formaldehyde resin picks up chlorine which during pressing, is converted to acid which results in the weakening of the cotton goods. However the newer melamine formaldehyde resins do not have this disadvantage. (29)

3. Thermoplastic synthetic resins

The use in textile finishing of thermoplastic synthetic resin is of comparatively recent origin. They are invariably applied from aqueous emulsions or dispersions of the polymerized resin. Due to the fact that they are already fully polymerized they are applied merely by padding on to the cloth and drying. Such resins are acrylics, vinyl and styrene resins, and derivatives of acrylic and vinyl resins. They produce a wide range of finishes varying from soft and elastic, to hard and crisp finishes. (29)

Claims made by the manufacturers of these finishes:

(1) No starches used in the finishing process, therefore none to wash out, or replace.

(2) Starchless finished cottons do not lint up, do not get sleazy and fuzzy looking after being washed, laundered or exposed to moisture.

(3) They do not soil easily.

(4) They wear better because of the few washings required.

(5) Printed pattern definitions are clean cut and colors vivid and fresh because the printing has penetrated a fabric that is clean and free of fillers.

(6) Fabrics retain their crispness on repeated launderings.

(7) Cost of application of these finishes is low e. g. Kandar, a thermo plastic resin finish produced by the U. S. Rubber Company averages one half cent per yard of fabric treated. (42)

A comprehensive chart appearing in the appendix lists the common permanent starch or permanent crisp finishes appearing on the market today. The reader will obtain considerable information about these finishes from this source.

Evaluation of the Permanent Crisp Finish

The greatest difficulty at the present time is the lack of a suitable measuring device which will measure the drapability of the fabric. This, in part, explains the absence of studies concerning the effect of laundering on these permanent crisp finishes.

Lelia J. Winn and Edward R. Schwarz,(43) in a comparison of four different methods of testing the draping qualities of different fabrics, found that three out of four of the devices tested recorded laundered organdy to have a greater degree of crispness than unlaundered organdy. No indication was made as to how many launderings were performed on the fabric. Aside from this study, no other published reports have been found to show the effects of laundering on the drapability of fabrics.

Finishes Controlling Dimensional Stability

In the finishing and merchandising of textile fabrics there is no more important or more universal problem than shrinkage. Any change in the dimensions of an article during its life renders it less satisfactory for its purpose. It may acquire an unsightly appearance, or at worst it may become completely unserviceable.

Causes of Fabric Shrinkage.

During the process of manufacturing the textile fiber is put under tension. The extent to which it stretches depends on the nature of the particular fiber substance, the magnitude of the tension and the duration of its application. On removal of the stress there is not immediate and complete recovery. Recovery takes place only with the passage of time; fairly quickly at first, but more and more slowly as time goes on. This is called creep recovery or residual shrinkage. Thus when a fabric is taken from the loom, where it has been in a stretched condition for a long period of time, it exhibits a slow contraction in length which may continue over many days, and if it is to be made up immediately into an article for use, such contraction must be allowed for. But whatever length of time is allowed for recovery under normal conditions, it is probably safe to assume that recovery is never complete. The fabric is left with a residual deformation. If the tensions have been small and applied only for short periods of time the residual deformation may be so small as to be immeasurable. But if they have been substantial i.e. applied for long periods of time, or applied to a fabric in the wet state followed by hot calendering, then the so called residual deformation or permanent set may assume permanent proportions. (23) This stretch of the fabric during weaving and finishing would be of little significance were it not for the fact that the stretch tends to come out and the fabric consequently shrinks when it is wet or swollen with water vapor. (31)

Collins (4) ascribes shrinkage to two causes, swelling and release of strains. The release of strains that have been imposed occurs when the material is wet; the swelling that also occurs when water is absorbed produces an internal rearrangement that can result in external shortening.

Another aspect of dimensional change is elongation in service. In the course of its useful life, a fabric is subjected to deformations of various intensities, at intervals of varying frequency and for periods of various durations. Here again, the same phenomenon of delayed elasticity is encountered; e.g. bending of the fabric as over the knee and elbow, the actual weight of the fabric itself. (23)

The shrinkage of a cotton fabric can be analyzed into several portions. The largest amount of the shrinkage is that represented by increase of crimp, yarn shrinkage takes a second place being generally much less than the increase of crimp, while fiber shrinkage is usually negligible. (4) Collins (4) reported from his study of "The Fundamental Principles that Govern the Shrinkage of Cotton Goods by Washing" that; the shrinkage after the first two or three washes is the maximum that is likely to occur in practice. The ratio of the final shrinkage to the first shrinkage depends upon the intensity of the washing treatment.

Collins (4) points out that from the point of view of the underlying principles, the limited shrinkage of cotton materials is to be expected since the swelling of the fiber is limited.

Gaston and Fletcher (16) found that shrinkage in cotton, linen and rayon yard goods, is considerably greater lengthwise than crosswise, and that fabrics of plain weave shrink more than those of other weaves because the yarns are bent more.

Jack Epelberg (9) reports that rayon has a much greater first wash shrinkage than cotton and exhibits progressive shrinkage on continued washing. This was also substantiated by Pfeffer.(28)

Viscose fabrics have a large amount of potential shrinkage because of the excessive swelling of the fabrics when wet, also because of the stretch imparted to the warp yarns during weaving and finishing.

In viewing the problem of dimensional stability; it would seem that the fabric designer should endeavor to use a raw material, a yarn structure, and a cloth structure such that the finished product will exhibit a minimum amount of shrinkage and be most satisfactory in use.

Many finishes have been devised to eliminate if possible, or otherwise control dimensional stability. Powers (31) claims that the object of any shrinkage control should be to produce a fabric with less than 1% warp or filling shrinkage.

Methods of Stabilization

1. Mechanical

(a) Sanforizing process - This process was developed by the Cluett Peabody Company and attacks the shrinkage problem from the tension relaxation behavior of the yarns. The cloth enters the Sanforizing machine and runs through the tenter in rippled form, being dampened with pure water spray and steam. The cloth is gradually widened by moving chains and is shrunk to the predetermined length. After drying to set the length, the cloth is again dampened and passed into the modified Palmer, which by means of moisture, degree of tension, and then heat, gives the final shrinkage in both length and width as determined by a preliminary test. Sanforizing is applicable to cotton and linen and it has been applied to blends of cotton and rayon. The word "Sanforize" may appear on fabrics treated in this way and indicates that 90% of the yardage does not shrink more than three fourths of 1%, and 10% of the yardage does not shrink more than 1% both warp and filling. (40) Before Sanforizing, a preliminary test is made on the fabric to determine the amount of warp and filling shrinkage, and this information serves as the basis of control.

(b) Rigmel Process - This is another method employing mechanical means for shrinking fabrics. It was developed and is now being used by the Bradford Dyeing Association and guarantees average residual shrinkage within 1%. (7)

(c) Evershrunk process - This mechanical method is employed by Everfast Incorporated and guarantees average residual shrinkage within 2%.

Mechanical methods are successful in reducing the shrinkage but they do not stabilize the fabric. (9) In the case of fabrics having a high potential shrinkage such as viscose rayons, stretchiness is introduced into the warp of the fabric. This is due to excessive crimp which develops in the warp yarns when the warp is permitted to shrink an excessive amount, as occurs when mechanical methods of shrinkage control are used. In this case, a very elastic and stretchy fabric results which is very difficult to cut and sew. (9)

2. Chemical Methods

Chemical methods for modifying fabrics have long been known, but their use has been limited because they may easily damage the fiber. (31) However, recently several new finishes of this type have been found highly satisfactory especially in the field of rayon stabilization.

(a) Heberlein process lowers shrinkage by cementing together the warp and filling threads by parchmentizing with sulphuric acid. The reprecipitated cellulose shows much less fabric distortion which results in less shrinkage. (31) This process, however, is very limited in use.

(b) B R-1 Rayon Stabilization Process - This is known as the Sanforset process and has been developed just recently by the Cluett Peabody Co. A chemical compound, glyoxal, is applied to the fabric in the presence of an acid catalyst. (37) A washable rayon garment with the trade mark Sanforset is an indication to the consumer that the fabric will not shrink or stretch more than 2% by the governments standard cotton wash test. (32) An advantage of this process is that the loss of tensile strength in successive launderings is not as great as on untreated fabrics. This process is not considered applicable to fabrics containing cotton because of the tendency of the acid catalyst to tender the cotton fabric. (37)

(c) Definized process - Developed by the Alrose Chemical Co., this process consists of the application of caustic soda of high concentration to the rayon grey goods followed immediately by neutralization of the caustic soda. (37)

3. Resin Methods

Synthetic resins have been used only in the last ten years in the control of shrinkage. Rayon fabrics constitute the greatest yardage to be treated by this method. Resins may either penetrate the fibers or exert a surface effect and in many cases both effects occur. Resins not only reduce the tendency of fabrics to swell and consequently decrease shrinkage when wet but they also stabilize the fabric in the stretched condition so that it will hold all, or part of this stretched condition when repeatedly washed or dry cleaned. It is also possible to mechanically shrink it to any desired degree and then resin stabilize it so that it will not stretch or contract in subsequent washings.

Resin treatment of cotton

Urea formaldehyde not only gives crease resistance but shrinkage control as well. The disadvantage of this resin is that it retains the chlorine from bleach liquors. Melamine formaldehyde is gradually replacing the former, as chlorine is not retained by this resin.

Resin treatment of rayon

Urea formaldehyde and melamine resins are both used now extensively for rayon stabilization. (31)

In a study made by Fletcher, Hay and Surratt on the effect of resin finishes on the color fastness and physical properties of rayon gabardines (12) they found that the resin finished specimens shrank less than the nonresin specimens by a highly significant amount. At the same time it was found that laundering decreased the breaking strength of the nonresin finished specimens but not of the resin finished fabric.

Schnyder and Honegger (34) found that loss in strength of cotton and linen fabrics increased almost exactly in proportion to the number of launderings.

Leonard Shapiro (36) reporting the durability of the definized process found that using a filament rayon warp and cotton filling, with a yarn count of 248 x 76, after five launderings at 212°F. there was no shrinkage in the warp and 0.6 % in the filling, compared to 13.8% shrinkage in the warp and 1.7% shrinkage in the filling on the untreated fabric. No loss in tensile strength was observed in application of this process.

Appearing in the appendix is a chart which lists the various trade names and manufacturers of dimensionally stabilized fabrics which are in common use today. This chart endeavors to place before the reader a very concise picture of the extent to which this finish is used.

METHODS AND PROCEDURES

For this study, thirteen fabrics were purchased, twelve on the retail market and one from a wholesale house handling test fabrics. The test fabric purchased was an 80 x 80 bleached cotton grey cloth, which was used in this study as a control, and as a basis of comparison with the 80 x 80 "finished" percale. The other purchased fabrics were treated with one or more of the three functional finishes being considered. Appearing on the following page is a summary of the fabrics being studied and pertinent purchase data concerning each. Samples of these fabrics appear in the index on pages 134-138.

Preparation of Fabrics for Testing

Each fabric, before testing, was carefully pressed with a steam iron to remove any wrinkles.

Testing was performed after the 5th, 10th, 15th and 25th laundering interval. For each of these testing intervals two specimens approximately 12 x 13 inches were cut. In all, sixteen specimens resulted. The remaining fabric was used for analysis of the original fabric.

Each specimen was labelled with indelible ink, showing the direction of the warp and filling, the number of launderings to be performed, and the temperature at which the

SUMMARY OF FABRICS USED IN THIS STUDY

Fabric	Trade Name	Manufacturer of Finish	Fiber	Price	Cost Per Sq. Yd.	Width in Inches	Weave	Finish
Dotted Swiss	Dumari	Dumari Co.	Cotton	$1.29	$1.33	35	Plain	Permanent, Starchless Finish, Sanforized
Matelassé Organdy*	Belco	Bellman Brook Bleachery Co.	Cotton	$1.49	$1.53	35	Plain	Permanent, Matelasse Organdy Finish
Organdy	Belco	Bellman Brook Bleachery Co.	Cotton	$1.19	$ .95	45	Plain	Permanent Crisp Finish
Plissé**	Rioambra	Bellman Brook Bleachery Co.	Cotton	$1.29	$1.29	36	Plain	Bellamized Starchless Finish
Printed Percale	Mfr. for J.C.Penny Co.	Not available	Cotton	$1.19	$1.19	36	Plain	Starchless, Permanent Finish
Tafetella	Not available	Not available	Cotton	$1.98	$1.98	36	Plain	Crush Resistant Rigmel Shrunk
Indian Head	Everfast	Everfast Fabrics, Inc.	Cotton	$1.19	$1.19	36	Plain	Crush Resistant Ever Shrunk
Voile	Dumari	Tootal Broad-hurst & Lee Co.	Cotton	$1.39	$1.36	38	Plain	Tebelized for Crease Resistance, Sanforized
Salyna Cloth	Salyna Cloth	St. George Textile Co.	Cotton & Viscose	$1.89	$1.74	39	Plain	Crease Resistant, Shrink Resistant
Reeve Weave Cotton Suiting	Everfast	Everfast Fabrics Inc.	Cotton	$1.69	$1.69	36	Reeve	Crease Resistant
Czecho-Slovakian Linen***	Not available	Not available	Flax	$1.00	$1.00	36	Plain	Crease Resistant
Linen	Not available	Not available	Flax	$2.98	$2.98	36	Plain	Tebelized for Crease Resistance
Bleached Cotton Print Cloth Grey Cloth 80x80		Test Fabrics Inc.	Cotton	$ .30	$ .30	36	Plain	No Finishing

* Matelasse Organdy----the matelasse effect on this fabric was achieved by the application of a chemical finish, rather than by the construction of the weave.

** Plisse, as was used in this study is a cotton cloth treated in stripe and/or spot formation with a caustic soda solution which shrinks part of the fabric and gives it a crinkled surface. (7)

*** Czecho-Slovakian Linen----linen imported from Czecho-Slovakia woven from Russian flax and treated with a crease resistant finish. There was no information available as to the type of crease resistant finish applied to the fabric specimen was to be laundered. A code system was used to designate the two temperatures. A represented specimens that were to be laundered at 105°F., and B, specimens to be laundered at 150°F. Subscripts were used to designate the number of launderings to be performed on each specimen.

A line of machine stitching was placed one eighth inch from the edge of the fabric on the Salyna Cloth, Czecho-Slovakian Linen, Tebelized Linen Suiting and Reeve Weave Cotton Suiting, to prevent the specimens from ravelling during the laundering process.

Specimens to be measured for dimensional stability were prepared on the specimens to be laundered twenty-five times. Eight inch squares, marked exactly on the thread of the fabric with indelible ink, were placed in the center of the fabric. Each square was again marked off exactly in half to provide three points for measurement for the warp and three points for measurement of the filling.

TEST METHODS

The original fabrics were carefully analyzed in the laboratory for various physical characteristics. This data was used as a basis for comparison with the same fabrics after the fifth, tenth, fifteenth, and twenty-fifth laundering, at a temperature of 105°F.; and a second group at a temperature of 150°F.

All specimens were conditioned for at least four hours under standard conditions of 65% ±2 relative humidity and

$70^{o}F. \pm 2$, before being tested.

The following laboratory tests were performed on the original fabrics: yarn count, weight per square yard, tensile strength and elongation, crease resistance and drapability.

YARN COUNT

Yarn count was determined following standards set up by A.S.T.M. (1) A micrometer was used for determining the number of yarns per inch in the warp and in the filling of the fabric. Five counts for the warp and five for the filling were taken at random, proceeding from the upper left hand corner of the sample to the lower right hand corner. These counts were taken in such a way that no two spaces counted, included the same yarns. The average number of warp yarns and filling yarns per inch were computed using the arithmetic mean as a measurement of central tendency.

Yarn counts were taken on the original fabric and after the fifth, tenth and twenty-fifth laundering.

WEIGHT PER SQUARE YARD

For weight per square yard determinations, two inch squares were weighed on a chainomatic balance. (1) An average for five specimens was reported as the weight per square yard of the fabric using the following formula:

$$\text{Weight per square yard} = \frac{36 \times 36 \times \text{weight of sample}}{2 \times 2 \times 28.36} = \text{ounces per square yard}$$

Weight per square yard was determined in the original fabric, and again after the fifth and twenty-fifth launderings.

TENSILE STRENGTH AND ELONGATION

Specimens for this test were prepared using the ravelled strip method as outlined in the standards set up by A.S.T.M., (1) except in the case of the Tafetella, in which the cut strip method was used. A Scott Tensile Testing Machine was used to determine breaking strength and elongation. Directions were followed as outlined in A.S.T.M. (1) Five determinations were taken for both warp and filling and the average for each was calculated. Tests were carried out on the original fabric and after the tenth and twenty-fifth laundering.

CREASE RESISTANCE

The crease resistance or ability of the fabric specimen to recover after creasing, was measured using the Monsanto Wrinkle Recovery Tester. (22)

Test specimens were cut 1.5 centimeters by 4 centimeters long. Five specimens were prepared for measuring the warp and five for the filling. Great care was taken to prevent wrinkling of the specimens during cutting and conditioning.

Each test specimen was placed between the metal leaves of the specimen holder with one end flush with the longer metal strip. The exposed end of the specimen was then turned back so that its cut edge fell on a line marked on the shorter thin metal edge.

The specimen holder was then placed in a plastic press and placed on the table with the small platform of the press upward. Seven specimen holders were loaded at the same time, and pressed for a period of five minutes under a weight of one and a half pounds. At the end of the creasing period, the specimen holders were removed and the fabric specimen was allowed to recover for five minutes. The specimen holder was then mounted in the Monsanto Wrinkle Recovery Tester, and the angle of recovery was measured by aligning the protruding part of the material with the vertical guide line on the back panel of the instrument. This measures the angle of recovery in degrees.

In this study, the crease resistance of a fabric was expressed, (a) according to the size of the angle of recovery, the larger the angle the greater the crease resistance of the fabric; (b) according to the chord value of the fabric which was obtained from the size of the angle of recovery using conversion tables in the Monsanto Wrinkle Recovery Tester Bulletin.(22) In this case also, the higher the chord value, the greater the crease resistance.

DRAPABILITY

The crispness or drapability of the fabrics was measured by using a drapemeter.

The apparatus for the drapemeter was set up following instructions developed by John H. Skinkle and Arther J. Moreau (38) at the Lowell Textile Institute. The drapemeter, constructed for this study, consisted of two ring stands which supported a horizontal rod. On this rod was placed a series of $2\frac{1}{2}$ inch wide paper clamps. Another ring stand with clamp was used to hold a millimeter rule. This rule was fixed in a position such, that, it was just 100 mm. below the jaws of the paper clamps. This was the measuring device.

The specimens were cut 100 x 250 mm., with the short dimension parallel to the set of yarns being evaluated. Three specimens were prepared for the warp and three for the filling.

The sample was mounted for measuring by folding back one end of the fabric in such a way, that, the face of the fabric was on the convex side. The clamp was then attached one quarter inch below the end of the fabric. The fabric and clamp were suspended from the rod and allowed to hang for two minutes. At the end of this time, the scale was moved up to the concave side of the material with one end of the scale just touching one end of the fabric. The chord length was then read in millimeters directly from the rule. Since the sample was 100 mm. wide, the reading was also a percentage of the width. Three determinations were made on the warp and three on the filling. Measurements were carried out on the original fabric and after the fifth, tenth, fifteenth and twenty-fifth launderings.

The arithmetical average for each set of yarns was then determined. The stiffness of the fabric as a whole was computed as the geometric mean of the warp and filling (square root of warp times filling).

LAUNDERING PROCEDURE

One half of the fabrics being studied were laundered in an Atlas Launder-Ometer at a temperature of 105°F. At the end of the fifth laundering, two specimens from each fabric were removed for testing. Two more specimans were subsequently removed at the end of the tenth and fifteenth launderings and the remaining two at the end of the twenty-fifth laundering. The other half of the fabric specimens were laundered in a similar way only using a temperature of 150°F.

The following procedure was used in operating the Launder-Ometer:

(1) Twenty, one pint jars were placed on the loading tray of the machine to preheat at the prescribed, thermostatically controlled temperature of 105° F. or 150° F.

(2) Into each jar was placed the specimen to be laundered, 200 ml. of water, 10 steel balls one fourth inch in diameter, and two teaspoons of a 5 per cent soap solution.

This soap solution was prepared by weighing fifty grams of a pure, high titer soap, and dissolving it into

950 ml. of hot water. This solution was kept as a stock solution. The water was maintained at approximately 5 p.p.m. degrees of hardness by using Calgon as a water softener.

(3) After the jars were loaded, they were tightly clamped and placed in the racks of the Launder-Ometer. The rotating action of the machine was maintained for six minutes. The samples were then removed, squeezed gently, and returned to the jars. Two hundred ml. of fresh water was added along with the metal balls, and the specimens were then rinsed for four minutes. The specimens were rinsed a second time using the same procedure only eliminating the addition of metal balls and reducing the rinsing time to two minutes. At the end of the second rinse, the specimens were removed, squeezed gently and dried for approximately ten minutes in a General Electric Dryer.

(4) The specimens were pressed in an Iron-Rite mangle in such a way that the fabric rotated in a warpwise direction. This procedure constituted one complete laundering.

The following tests at the designated laundering intervals were performed on each fabric:

Tests	Laundering Interval				
	1	5	10	15	25
Yarn count		X	X		X
Weight per sq. yd.		X			X
Tensile strength and elongation			X		X
Crease resistance		X	X	X	X
Drapability		X	X	X	X
Dimensional stability	X	X	X	X	X

Dimensional change was determined on each fabric by measuring the specially marked specimen to the nearest one sixteenth of an inch by using a steel tape. Dimensional change was calculated as a percentage of the original measurement.

INTERPRETATION OF RESULTS

An analysis of the performance of each fabric in respect to the various laboratory tests which were made, will be considered in this section. Each fabric will be individually analyzed as to original values and performance, through an interpretation of data for that particular fabric. Comparison of the different fabrics in respect to inherent and changing values due to the laundering procedures will constitute a separate discussion. An attempt will be made to explain if possible the reasons for the variations in different original fabrics as well as the variations in their performance values. The investigation will consist of a group of fabrics treated for first, crease resistance, secondly permanent crispness, and thirdly dimensional stability. Seven fabrics, namely, Tafetella, Indian Head, voile, Salyna Cloth, Reeve Weave Cotton Suiting, Czecho-Slovakian linen, and a tebelized linen suiting, were selected because they each had been treated with a crease resistant finish. They constitute the first group to be individually discussed.

I CREASE RESISTANT TREATED FABRICS

The measure of crease resistance of each fabric was determined by reading the angle of recovery of the specimen from the Monsanto Wrinkle Recovery Tester. (22) A large angle of recovery is an indication that the specimen possesses good crease resistant powers, while a small angle shows poor crease resistance. Powers (25) reports that with the use of this instrument of test, a 100 degree recovery angle is regarded as commercially acceptable. However, the angle of recovery for wool and silk as measured by Freedman (14) was 120°. As the high crease resisting powers of silk and wool are universally recognized, it has most likely been the aim of the fabric finisher then, to approximate them through the improvement of naturally lower values, characteristic of cotton, linen and rayon. By the application of special finishes better crease resistance is possible. In interpreting the angle of recovery as a measure of crease resistance, the investigator considers an angle of recovery of 120° or over to be an indication that the fabric possesses good crease resisting qualities.

A chart recording the crease resistant values of the fabrics used in this study is found on page 120 in the appendix. The chord value is given as well as the size of the angle of recovery. However, it is the opinion of the author, that a more accurate account of the performance of the crease resistant finish will be possible using the angle of recovery as a basis of interpretation of this test.

Tafetella

The crease resistant values obtained for this specimen on testing the original fabric, showed an angle of recovery of 126° and 127° respectively for the warp and filling.

On laundering the fabric five times at a temperature of 105° F., it was found that the value of the angle of recovery had dropped to 117° and 118° in the warp and filling, thus showing a loss in crease resistance of 7.1% in both warp and filling. The warp underwent further changes showing 0.79%, 7.9% and 5.6% variations at the tenth, fifteenth and twenty-fifth laundering respectively. The filling showed a fairly steady trend with 3.1%, 2.4%, 4.7% loss occurring at the tenth, fifteenth and twenty-fifth laundering.

When laundered at a temperature of 150° F., a 16.7% decrease in warp crease resistance took place in the first five launderings and only a 2.4% decrease by the end of the twenty-fifth laundering.

The filling, likewise, showed the same general trend with a marked decrease of 10.2% occurring at the end of the first five launderings. This value remained constant at the tenth laundering but changed sharply to only a 2.4% loss from the original at the fifteenth laundering and then recovered completely to exhibit a 1.5% increase over the original value at the end of the twenty-fifth laundering.

This behavior may be partially explained on the basis of the findings made by Schnyder and Honeggar (34) who found that there was improved resistance to bending on laundering cotton and linen fabrics.

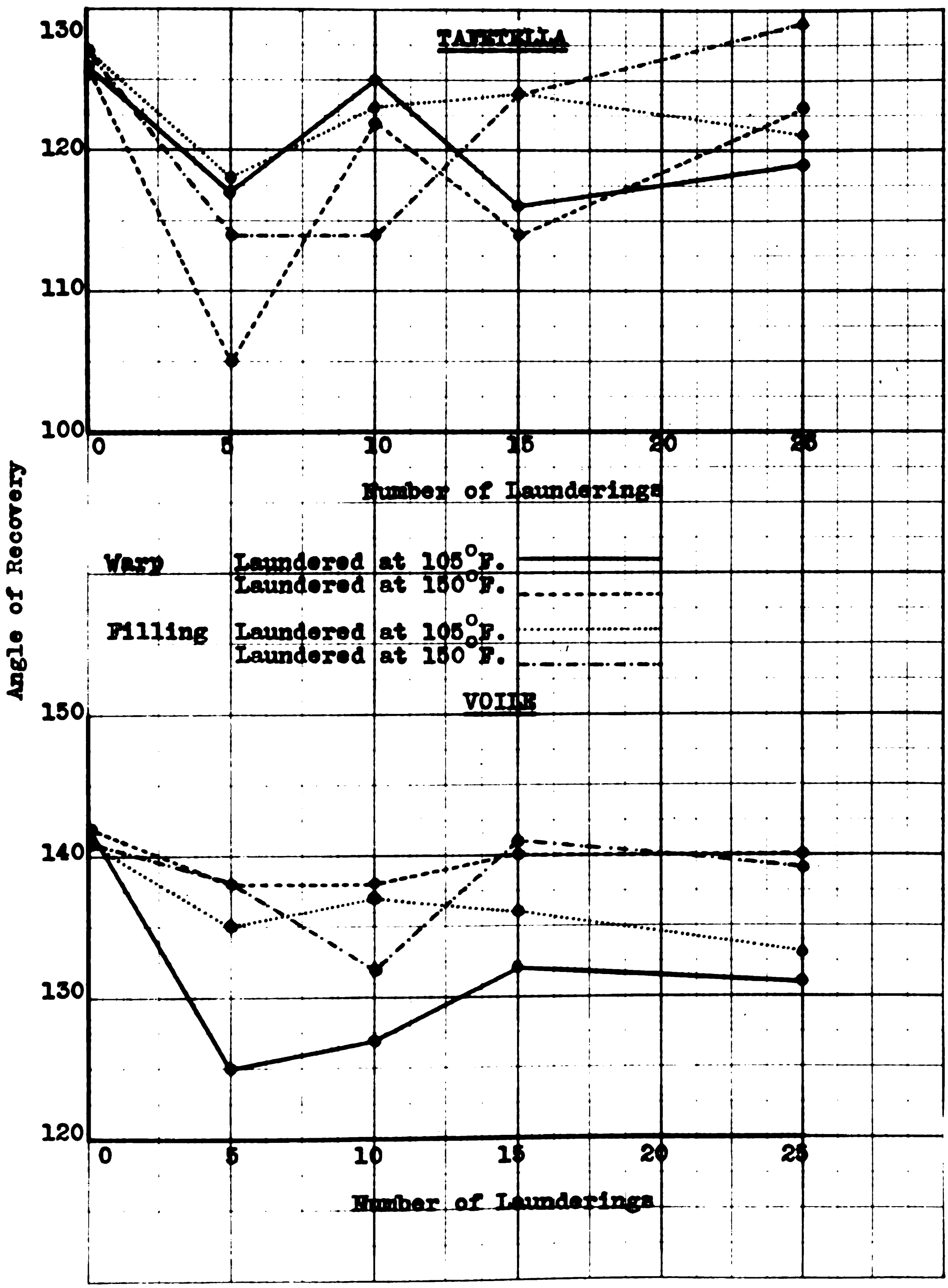
The effect that laundering, at two different temperatures, has on the crease resistance of the Tafetella is graphically represented on the following page.

The fact that there seems to be no definite pattern or direction which the crease resistance of this fabric takes after being laundered, might be accounted for in several different ways. First, during the processing of the fabric, penetration of the resin, which imparts the crease resistant properties may have been uneven due to the high twist and fineness of the yarn, resulting in a fabric with unpredictable crease resisting powers. Secondly, polymerization of the resin may not have been complete. If such was the case, the portion of the resin which was undercured would be easily removed on washing, thus leaving part of the fabric with low crease resistant values and part with high crease resistant values. Thirdly, a sufficiently large number of specimens were not taken to provide adequate sampling.

The change in weight and yarn count by either laundering method was negligible.

PLATE I

EFFECT OF LAUNDERING ON CREASE RESISTANCE



DRAPABILITY

By the fifth laundering there was a slight increase in the stiffness of the Tafetella, as observed in the rise of the drapability value of the fabric. From that point there was a slight decrease through the twenty-fifth laundering. No appreciable difference in the draping properties of the fabric occurred between laundering at the two different temperatures.

TENSILE STRENGTH

There was a marked loss of warp tensile strength in the first ten launderings, 14 % and 14.5 % at the low and high temperature. This increased to 19.4% and 21.2% respectively by the twenty-fifth laundering. In contrast, there was an increase of 6.4% in the filling by the tenth laundering at the lower temperature, remaining constant through the twenty-fifth. However, at the higher temperature, an 18.1% and 8.5% loss was recorded at the tenth and twenty-fifth laundering respectively.

Such loss in tensile strength can be explained on the basis of the treatment of the fabric with the resin finish. In processing the fabric, acid catalysts are used, which if not effectively removed will cause a subsequent loss in tensile strength. (3)

This loss in tensile strength of the Tafetella substantiates the findings made by Margaret S. Furry in her investigation in the study of the durability of the crease resistant finish to severe and mild laundering. (15)

After ten launderings a loss of 2.5% and 1.9% in warp and filling elongation occurred at the low temperature and .7% increase and 2.6% loss at the high temperature. A 0.6% and 1.4% loss in the warp, and 1.5% and 2.2% loss in the filling, at the lower and higher temperatures respectively following the twenty-fifth laundering which is contrary to an increase in elongation which ordinarily bears a relationship to strength loss, indicates that resin-treated fabrics behave differently than the same fabric which has not been so treated.

DIMENSIONAL CHANGE

There was progressive shrinkage in both the warp and the filling at both launderings, ranging from approximately 0.75% to 1.5% but this constitutes a negligible change and is within the variations defined in the Rigmel processing guarantee. As was found by Gaston and Fletcher, (16) more shrinkage occurred in this fabric in the warp than in the filling.

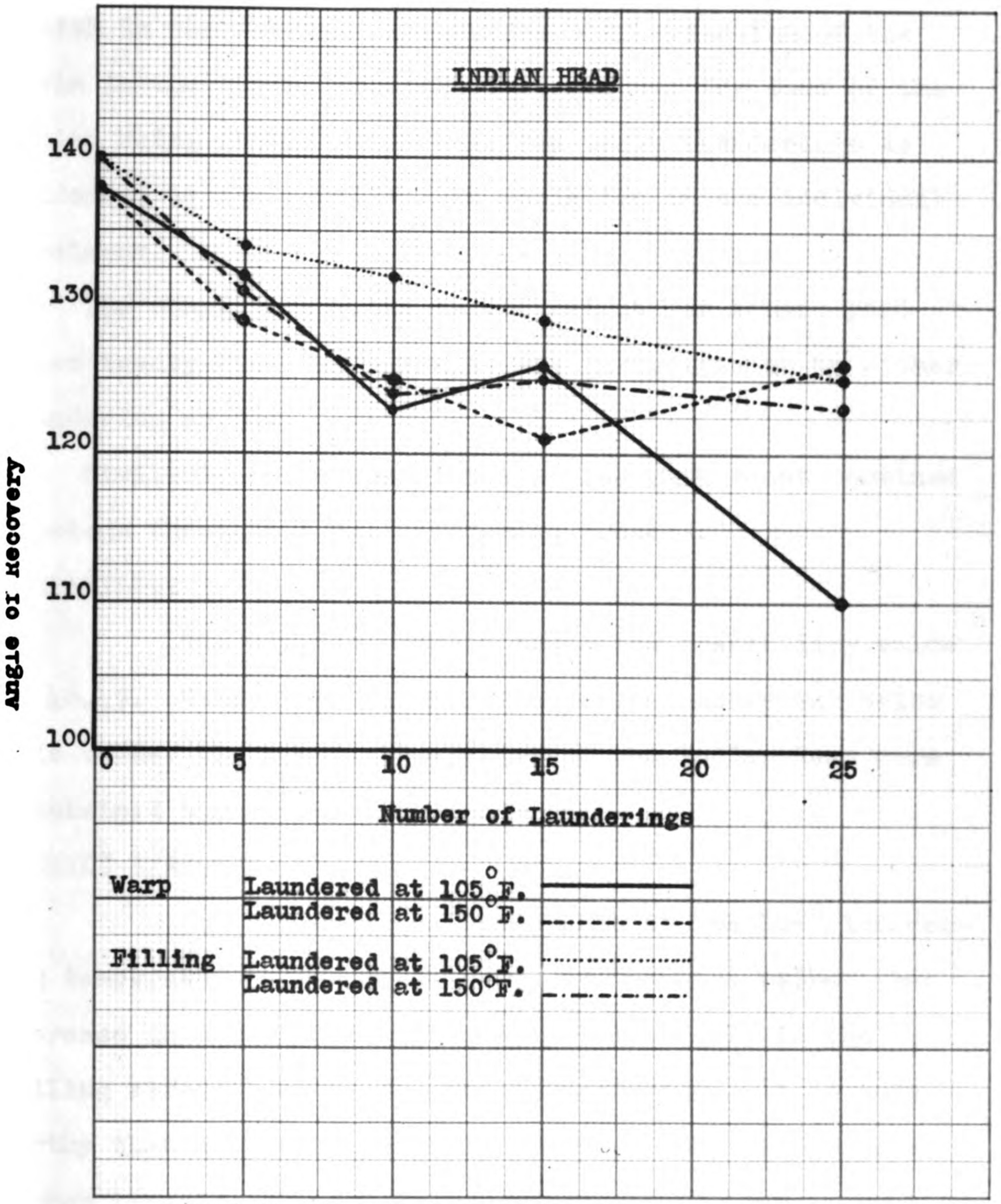
Indian Head

On analysis of the laboratory data, it was found that the original specimen of Indian Head had a recovery angle from creasing of 138° in the warp and 140° in the filling. A yarn count of 57 yarns in the warp and 48 in the filling, indicates a well balanced fabric. Similarity in the size of yarns in the construction of the fabric may partially explain the fact that this fabric has comparable crease resistance in the warp and the filling.

When the Indian Head was laundered twenty-five times at 105° there was a 20.2% loss in crease resistance in the warp and a 10.7% loss in the filling. The greatest percentage change occurred in the warp between the fifteenth and the twenty-fifth laundering, while in the filling the greatest percentage change occurred in the first five launderings. By the end of the twenty-fifth laundering at the higher temperature, the percentage change in the warp was less than one-half as great as at the lower temperature. The filling loss was practically the same at both temperatures. As in the case of the Tafetella, the greatest percentage change in both directions took place in the first five launderings, reaching its maximum change at the fifteenth laundering, but recovering 3.6% of this loss at the final laundering. This restored crease resistance in the last ten launderings is difficult to explain, although Honegger and Schnyder (34) found there was an increased resistance to bending on laundering cotton and linen fabrics. Plate II on page 55 graphically shows the effect of laundering on the crease resistant qualities of the Indian Head at the various laundering intervals at both temperatures.

PLATE II

EFFECT OF LAUNDERING ON CREASE RESISTANCE



Explanation of the wide variation in these crease resisting values may be partially explained by incomplete processing, undercuring, and uneven penetration of the resin finish in the fibers. Incomplete polymerization of the resin in the curing process might account for some of the finish being partly removed in the early launderings as evidenced by the considerable variation in the individual specimens.

The change occurring in the weight per square yard after twenty-five launderings, was insignificant by either laundering method.

Similarly, at either temperature, yarn count remained constant throughout the laundering process.

DRAPABILITY

The original fabric had a low drapability value of 46.47. Other than slight fluctuations above and below this value, the draping qualities of the Indian Head were maintained throughout the launderings.

TENSILE STRENGTH

It is significant that at the 105° laundering temperature this fabric shows an increase rather than decrease in strength except a slight loss (4%) in the filling strength after the final laundering. It is noteworthy that at the higher temperature, there was somewhat higher tensile strength in both warp and filling after the twenty-fifth laundering than for the original fabric. This increase in strength may be explained by some dimensional change which took place in the fabric.

The elongation results in the Indian Head remained fairly constant in the warp throughout the launderings at both temperatures. A slight increase of 1% in filling elongation at 105° and a decided increase of 4.4% at the higher was noted. This increase may be explained by the fact that on partial removal of the resin finish, the stabilizing property of the resin is lost and the fabric stretches more.

DIMENSIONAL CHANGE

When laundered at a temperature of 105° F., this fabric showed no change in the warp during the twenty-five launderings but showed shrinkage in the filling of 3.13%. When laundered at a temperature of 150°F., dimensional change was more marked. In the warp, a 0.78% change and in the filling a 1.5% change resulted after twenty-five launderings.

In addition to the crease resistant finish, this fabric had also been given the "evershrunk" finish for dimensional stability. Dimensional change fell within the limits set by this finishing process.

Voile

The original specimen of the voile had an angle of recovery of 142° in the warp and 141° in the filling, which is quite high and indicated good crease resistance in both directions. Yarn count was identical in both warp and filling which may account to some extent for the uniformity in crease resisting properties. At the lower temperature the durability of the finish is indicated by a 12% loss in warp crease resistance after five launderings and recovery of 5% of the loss from the fifteenth laundering through the final laundering. The filling showed a 4.3% loss at the fifth and remained remarkably stable through the balance of the launderings.

When the voile was laundered at a temperature of 150° F., its outstanding stability was evidenced. In the direction of the warp an approximate loss of one quarter that at the lower temperature resulted. The filling showed somewhat more erratic results, 2.1% loss and a 6.4% loss at the fifth and tenth launderings but by the fifteenth laundering the fabric had returned to its original value. In the last again, was the slight loss of less than 1.5% which is a little more than half that of the lower temperature. The comparative results of the variance at the two temperatures is effectively shown in Plate I on page 51.

The change in weight and yarn count resulting from laundering was so insignificant as to have no important bearing in the interpretation of the results.

DRAPABILITY

The drapability values of the voile indicate that either laundering procedure produced a softer, more supple hand to the fabric and is consistant with the wrinkle recovery results.

TENSILE STRENGTH

A loss of 9.16% in warp tensile strength occurred at the end of the tenth laundering, performed at the low temperature in contrast to 3.5% at the higher temperature. However, at the twenty-fifth laundering, a 5.1% and 6.6% loss would indicate that perhaps, the former high value might have been a result of poor sampling. The percentage loss which took place in the filling, progressed from 2.9% to 6.5% by the twenty-fifth laundering at a lower temperature as compared to 3.5% and 5.3% at 150°F.

Although these losses are not great, they may be attributed to either the severity of the laundering process itself or to the tentering effect of the resin finish on the fabric in successive launderings.

Changes in the percentage elongation of this fabric at either temperature was negligible.

DIMENSIONAL CHANGE

In laundering the voile at 105°F., remarkable stability of the warp yarns was maintained throughout the twenty-five launderings, showing warp shrinkage to be less than one percent. In contrast, the filling shrinkage amounted to 2.34% at the end of the laundering process.

Laundering at 150°F. showed the same stability and identical shrinkage throughout the entire sequence of launderings. Identical shrinkage was noted for the filling.

In spite of the open weave which is characteristic of voile, the stability which it exhibited was excellent. Although more shrinkage occurred in the filling than in the warp, this sanforized fabric still falls within the allowable limits established for dimensional stability by the Sanforizing method.

Salyna Cloth

This fabric exhibited much greater crease resistant properties in the filling than in the warp. The original specimen showed an angle of recovery of 126° in the warp in contrast to 152° in the filling. This difference may be accounted for by the difference in the yarn size and/or the degree of twist of the respective yarns in the two directions. The larger, more loosely twisted yarns are capable of absorbing more of the resin finish and thereby possess greater crease resistance.

In laundering, some of these crease resisting properties were lost. After the first five launderings at 105°F. there was no appreciable change in crease resistant properties of the warp. A 4% loss at the tenth laundering did not change significantly until the final laundering when a 11.9% loss was recorded. The greatest loss came between the fifteenth and twenty-fifth laundering.

In the filling, there was a progressive loss of crease resistance from 4.6% at the fifth to 14.5% by the twenty-fifth. The greatest loss in this case occurred between the fifth and tenth launderings.

Of the specimens of Salyna Cloth, which were laundered at 150°F., there was a progressive decrease in warp crease resistance through the tenth laundering with a 5.5% loss recorded. However, at this point the cloth recovered a 0.79% loss at the final laundering.

In the filling a 5.9% loss occurred at the fifth laundering, increasing 2% more at the conclusion of the launderings. It is significant that the loss sustained at the lower temperature is practically twice that of the higher temperature in both warp and filling.

The progressive change and comparative durability of the finish to laundering at the different temperatures is shown in Plate III appearing on page 62.

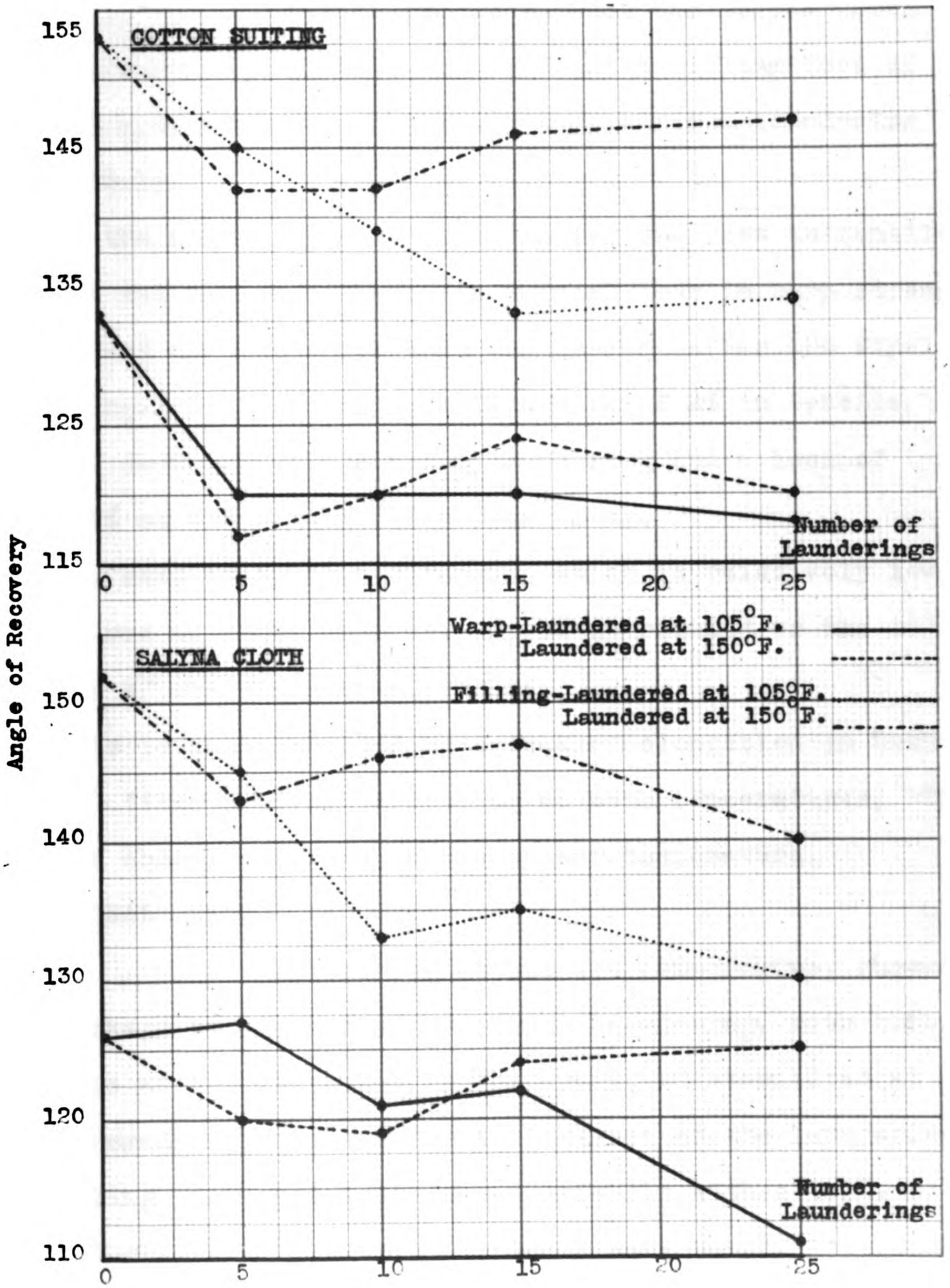
Yarn count and weight per square yard varied so slightly from the original after laundering, that the results are of no significance in this interpretation.

DRAPABILITY

There was a considerable loss of stiffness in the fabric on laundering. From an original draping value of 53.44 the value dropped to 45.78 at the end of the fifth laundering at the low temperature, remaining stable throughout the balance of the launderings. The same effect was evident at the high temperature, only to a more marked extent. This shows a decided loss of the resin finish and

PLATE III

EFFECT OF LAUNDERING ON CREASE RESISTANCE



would explain the loss in crease resistance values.

TENSILE STRENGTH

On laundering at 105°F., the Salyna Cloth showed a warp loss of 2.4% and 8.7% and a filling loss of 2.5% and 4.8% after the tenth and twenty-fifth laundering respectively.

At the high temperature laundering the loss in tensile strength was not so marked. An initial loss in warp strength of 4.8% and 5.9% was less than one percent after the final laundering. In the filling an increase of 2% in tensile strength occurred at the tenth laundering and a loss of only 0.6% at the twenty-fifth laundering.

The loss in tensile strength, which is relatively low as compared to other fabrics, may be attributed to the severity of the laundering process.

This is substantiated by increased elongation in both warp and filling after laundering at both temperatures. The greatest change occurred at the higher temperature.

DIMENSIONAL CHANGE

Laundering at the low temperature, showed no shrinkage at the end of the first laundering, with 1.56% shrinkage at the fifth but by the tenth had stabilized at 0.78%, remaining constant for the balance of the launderings. The filling yarns behaved more erratically with a 3.1%, 1.6%, and 3.9% shrinkage occurring at the first, tenth, fifteenth, and twenty-fifth launderings respectively.

At the higher temperature, shrinkage was greater in both the warp and the filling. The warp showed a progressive shrinkage of less than 1% at the first laundering to 3% at the tenth, remaining unchanged through the twenty-fifth. The filling yarns shrank three times as much after the first laundering and fluctuated widely through the fifteenth, returning to a 4.69% shrinkage at the twenty-fifth laundering.

These figures show a fairly high percentage change occurring in the fabric in consideration of the fact that the fabric had been treated for stabilization. It is probably due to the rayon fiber.

Reeve Weave Cotton Suiting

On laboratory analysis of the cotton suiting it was found that the filling possessed greater crease resistant properties than the warp. On being creased and tested the warp was found to have a 133° angle of recovery compared to a 153° angle of recovery for the filling.

In this case, the fabric had a higher yarn count in the filling than in the warp, indicating that the warp yarns are the larger. However, the filling threads still possessed considerably more crease resistance than the warp. This may be due to the low amount of twist in the filling yarns, but is more probably due to the structure of the weave of this fabric. (See sample in the appendix page 135)

On laundering five times, at 105° F., the warp showed a 9.8% loss of crease resistance. However, there was no further change till the twenty-fifth laundering where the loss totalled 11.3%.

Crease resistance decreased progressively in the filling of the fabric. The greatest percentage loss occurred in the first five launderings, amounting to 5.2%. This progressed to 13.1% at the fifteenth and remained practically constant for the balance of the launderings.

On laundering at the higher temperature, a 12.0% loss in crease resistance was recorded for the warp, but by the tenth laundering there was a 9.8% loss, remaining unchanged through the twenty-fifth laundering.

In the filling, a loss of 7.2% occurred at the fifth laundering with no further change taking place until the fifteenth laundering, after which the fabric recovered some of its crease resistance. This sustained loss was approximately 4%, which is less than half that in the warp direction.

It is evident from reading Plate III on page 62 that although there was greater percentage loss in both warp and filling after five launderings at the higher temperature succeeding launderings showed less loss at the lower temperature.

DRAPABILITY

The draping qualities of the fabric varied slightly on laundering but the larger decrease did occur when laundered at the higher temperature. This resulted in making the specimens less stiff.

Negligible changes occurred in weight and yarn count.

TENSILE STRENGTH

In measuring the effect of laundering on tensile strength at the low temperature, there was an 8.1% and a 5.2% warp loss respectively at the tenth and twenty-fifth laundering. The filling, on the other hand showed, at the same laundering intervals, a very much smaller loss of tensile strength. (0.9% and 1.3%)

At the higher temperature laundering, the sustained loss in warp tensile strength (13.6%)was more than twice as great for the warp, and nine times as great in the filling. (11.5%)

The higher temperature obviously seems to account for strength loss in this particular fabric and the type of resin used would seem to be more responsible than was evidenced in the fabric previously discussed.

Elongation of the cotton suiting, in both warp and filling, increased during laundoring at both temperatures. A slight decrease in the filling was noted at the twenty-fifth laundering at the higher temperature.

DIMENSIONAL STABILITY

The Cotton suiting showed remarkable dimensional stability at the lower temperature especially in the warp wise direction (0.78%). In the filling, however, the initial 0.78% shrinkage after the first laundering increased to a 2.34% by the fifteenth laundering, and 1.56% at the final laundering. In laundering at the higher temperature, the warp yarns again showed remarkable stability, (0.78%) at the first washing with no further increases.

The filling behaved with a 0.78%, 2.34%, -0.78%, 1.56%, 0.78% change after the first, fifth, tenth, fifteenth, and twenty-fifth laundering respectively.

This fabric, having been treated with the "Evershrunk" finish for dimensional stability, shows very good stability to laundering at both temperatures.

Czecho-Slovakian Linen

This fabric produced an extremely low angle of recovery. In the warp, the size of the angle was but 62°, while that in the filling was 76°. Such results would indicate that this fabric had very low crease resisting,powers, and according to Powers (25) would not be regarded as commercially acceptable for crease resistance.

At both laundering temperatures, there was a slight increase in the crease resisting properties of the warp and a slight decrease in the filling. However, the resulting increase would be insignificant in making the fabric anywhere near acceptably crease resistant.

On the basis of this test, it is the investigators opinion that the fabric had not been treated for crease resistance, and the so called "crease resistance" was more promotional than reliable.

On page 69 Plate IV depicts the effect of laundering on the crease resistance of the fabric.

Change in yarn count and weight due to laundering are too small to be significant.

DRAPABILITY

The Czecho-Slovakian linen exhibited a fairly stiff draping quality as evidenced by the draping value of 71.99 when measured with the drapemeter. The reading from the drapemeter increased progressively to a value of 79.16, by the twenty-fifth laundering at the low temperature, thus indicating an increase in the stiffness of the fabric. There was a similar increase in the fabric laundered at the higher temperature but the effect was not so marked falling to a final value of 73.84.

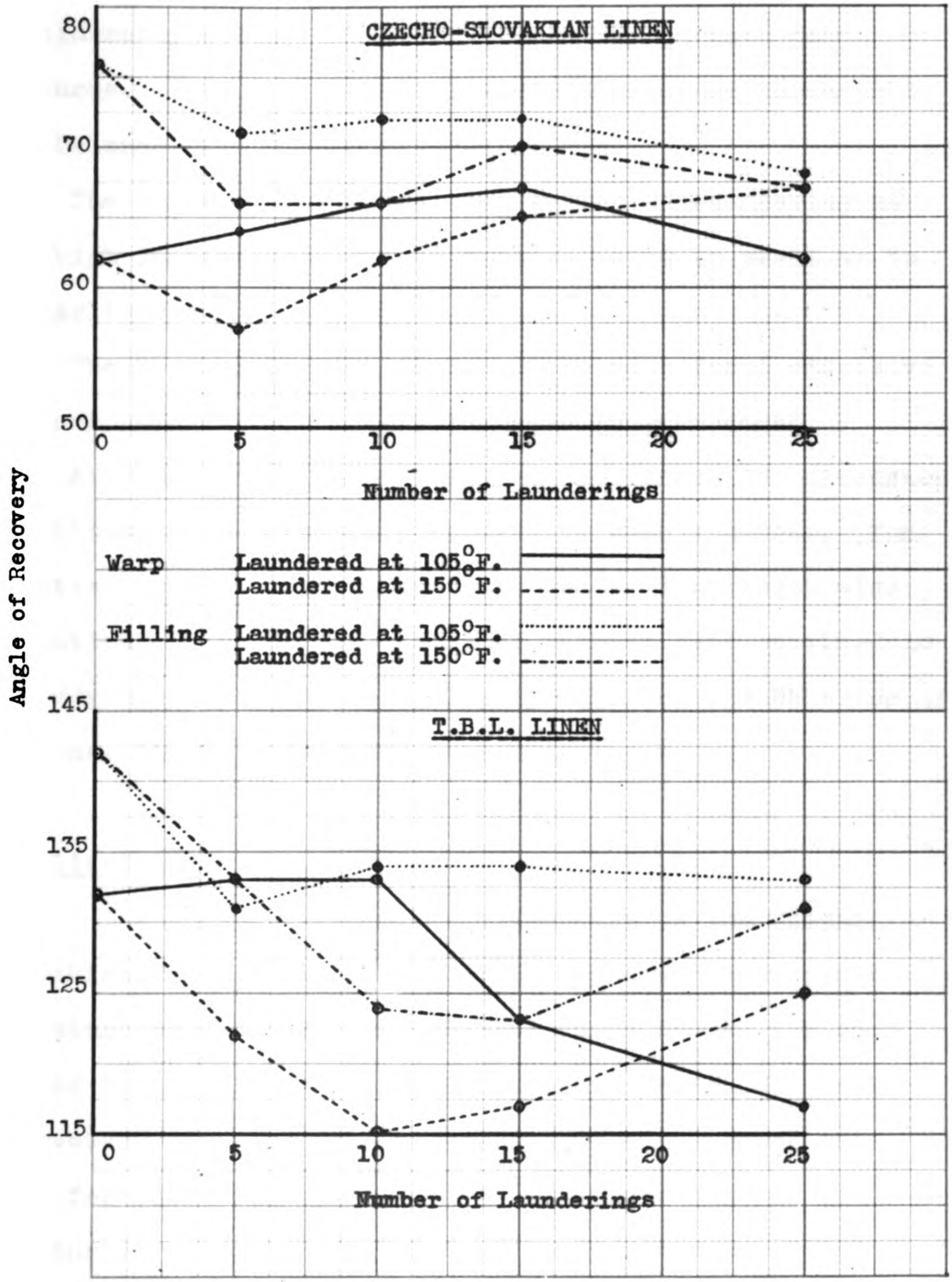
TENSILE STRENGTH

The warp tensile strength of the Czecho-Slovakian linen after laundering at 105°F. showed a maintained loss of 12.1% and 10.5% whereas, in the filling an increase of 23.4% was recorded at the tenth and a decrease of 1.5% at the twenty-fifth laundering.

On laundering at the high temperature, comparable results were obtained in the warpwise direction, but a 13.2% increase in filling strength took place at the tenth laundering and a 13.4% loss occurred by the twenty-fifth laundering. Loss in tensile strength may have been due to

PLATE IV

EFFECT OF LAUNDERING ON CREASE RESISTANCE



the severity of the laundering process.

The elongation in both warp and filling increased considerably after laundering five times at both temperatures. This increased value was maintained throughout the balance of the launderings.

The linen behaved in a similar way on laundering at the high temperature, any difference being so small as to be negligible.

The 3% shrinkage which cannot be considered excessive was accompanied by a slight increase in yarn count.

Although this fabric was given no finish for dimensional stability, it behaved in a remarkably stable manner. The greatest amount of shrinkage occurred in the length wise direction of the fabric. Similar results were obtained in a study made by Gaston and Fletcher (22) on the behavior of cottons, linens and rayons in laundering.

Tebelized Linen Suiting

In sharp contrast to the Czecho-Slovakian linen, this fabric exhibited excellent crease resistant properties. The filling yarns showed a higher crease resistant property than the warp yarns, the angle of recovery for the filling being 142° as compared to 132° for the warp. Here again, the larger size of the filling yarns would account for the difference occurring between the warp crease resistance and the filling crease resistance.

In laundering the fabric at 105° F., marked retention of the original crease resistant properties in the warp resulted in only a 6.8% loss being evidenced at the fifteenth laundering. This however, increased to 11.4% at the end of the twenty-fifth laundering. In the filling the greatest percentage loss occurred in the first five launderings, ranging from 7.7% through subsequent launderings to a loss of 6.3% at the final laundering.

When the specimens were laundered five times at 150° F., a 7.6% loss in warp crease resistance constituted the largest percentage change. However, losses of 12.9% and 11.4% took place at the tenth and fifteenth laundering respectively, but a 5.3% loss was recorded at the final laundering, which shows an unexplainable recovery of the fabric.

The same general pattern was apparent in the behavior of the filling, the greatest percentage change occurring in the first five launderings. From a 6.3% loss at the first, there was a 13.4% loss at the fifteenth laundering and a 7.7% loss by the twenty-fifth laundering. The progress of the effect of laundering on the fabric may be followed more closely by studying Plate IV on page 69.

No significant changes occurred during the entire laundering process in the weight, or yarn count of the fabric.

DRAPABILITY

Here again, as in the Czecho-Slovakian linen, there was an increase in the stiffness of the fabric on laundering it at both temperatures. The greatest increase took place during the first ten launderings at the lower temperature, but a gradual reduction in stiffness occurred in both specimens at the twenty-fifth laundering.

TENSILE STRENGTH

The effect of laundering on the tensile strength of the fabric is brought out clearly on analyzing the data. On laundering the fabric ten times at 105° F., there was no apparent loss in tensile strength in either warp or filling. However, by the twenty-fifth laundering there was a 12.2% loss in the warp and a 7.2% loss in the filling.

On laundering the fabric at the higher temperature, there was a 3.6% and a 10.7% loss in the warp strength at the tenth and twenty-fifth laundering respectively. However, in the filling a 16.1% and 8.9% increase in tensile strength took place at the tenth and twenty-fifth laundering. This increase in tensile strength is probably due to the increase in yarn count within the fabric.

Elongation of both the warp and filling threads of the fabric increased after being laundered five times. No significant differences occurred between specimens laundered at the two temperatures.

DIMENSIONAL CHANGE

During laundering at 105°F., remarkable stability was apparent in the warpwise yarns of the fabric. A percentage shrinkage of only 0.78% occurred at the tenth laundering through to the fifteenth laundering and the fabric returned to its original shape by the twenty-fifth laundering. In the filling yarns, the change was more erratic, progressing from a percentage shrinkage of 0.78%, 5.47%, 1.56% to 1.56% at the prescribed laundering intervals.

On laundering the fabric at 150° F. the percentage change occurring in the warp yarns was most unpredictable. Losses ranged from 0.78% through 2.3%, 1.56%, 2.3% to 0.78%.

Although this fabric was not treated especially for dimensional stability it exhibits fairly stable dimensional qualities.

Evaluation and Comparison of Crease Treated Fabrics

In comparing the effectiveness in the crease resistant finishes applied to the seven fabrics previously discussed, the results of the laboratory tests indicate, that they all, with but one exception, the Czecho-Slovakian linen, possessed excellent initial crease resisting properties. The Reeve Weave cotton suiting ranked highest with voile, Indian Head, Salyna Cloth and tebelized linen suiting of practically equivalent values, the Tafetella was considerably lower, while the Czecho-Slovakian linen was significantly lower.

From the consumer-buyers point of view, the relative crease resistant value and its permanency, should not be the only consideration in purchasing a fabric treated for crease resistance. Such factors as increased cost, the effect of the finish on tensile strength of the fabric, appearance and dimensional stability in laundering, are also very important consumer considerations. In the light of these combined factors, a relative evaluation of this group of treated fabrics will be made.

The chart on the following page shows a subjective comparison of their initial crease resistant properties and after the fabrics had been laundered twenty-five times.

The Reeve Weave cotton suiting possessed the greatest degree of initial crease resistance, but placed second to the voile in permanency after laundering. Both can be considered as superior in performance. The investigator believes that it is a combination of weave construction, use of heavy loosely twisted yarns and the thickness of the fabric, which with natural resistance to bending, makes possible, when properly treated, a fabric which would excel in resisting creases. Therefore its performance may not be a true expression of the value of the finish. The same finish applied to a fabric of different yarn and weave structure would most likely have shown variation in effectiveness. The cotton suiting is a strong fabric and although it showed almost 10% loss in tensile strength, even that

SUBJECTIVE COMPARISON OF FABRICS FOR CREASE RESISTANCE

Original Fabric				Laundered 25 times at 105°F				Laundered 25 times at 150°F			
	W*	F*	**		W*	F*	**		W*	F*	**
Reeve Weave Cotton Suiting	133	153	1	Voile	131	133	1	Voile	140	139	1
Voile	142	141	2	Reeve Weave Cotton Suiting	118	134	2	Reeve Weave Cotton Suiting	120	147	2
Indian Head	138	140	3	Tebelized Linen	117	133	3	Salyna Cloth	125	140	2
Salyna Cloth	126	152	3	Salyna Cloth	111	130	4	Tebelized Linen	125	131	3
Tebelized Linen	132	142	3	Tafetella	119	121	4	Tafetella	123	129	3
Tafetella	126	127	4	Indian Head	110	125	5	Indian Head	126	123	3
Czecho-Slovakian Linen	62	76	5	Czecho-Slovakian Linen	62	68	6	Czecho-Slovakian Linen	67	67	4

*The value for warp and filling is the size of the angle of recovery as measured in the Monsanto Wrinkle Recovery Meter

** Relative evaluation

loss would not seriously affect its ultimate serviceability as an apparel fabric.

Its dimensional stability, color fastness to laundering and draping properties were not impaired by laundering, but the cost of $1.69 per square yard is relatively high. On the other hand, in consideration of a given end use, when compared to Salyna Cloth at a cost of $1.74 per square yard, the cotton suiting would be a better value for the consumer-buyer, for example, in a summer suit where hard wear was expected.

The "tebelized" voile is practically as crease resistant as the cotton suiting. It retains its crease resistance on laundering and for this reason it has been rated as best in permanency of finish. Furthermore, equally good crease resisting properties which are evidenced in both warp and filling, are probably due to a balanced number of yarns in warp and filling and an open weave structure. These factors aid in producing a more crease resistant fabric, as was pointed out by Buck and Mc Cord. (3)

The considerable loss in tensile strength in laundering, somewhat confines its ultimate use to garments from which less severe wear is expected. However, the voile was excellent in color fastness, drapability, and dimensional stability. This makes the fabric an excellent choice for a cool, crease-resisting summer dress. Its relatively high cost of $1.36 per square uard would be a limiting factor for many consumer-buyers, but this is offset by the improved crease resisting characteristic. Price relationships to an untreated voile would constitute a more valid price comparison.

Appearing in third place in the comparative rating of the group of crease resistant treated fabrics is the Indian Head. Even with its appreciable crease resistance loss in laundering, it was still within the limits of commercial acceptance for crease resistance. Its outstanding advantage is an increase in tensile strength rather than loss. Inasmuch as its draping properties and color fastness are in no way impaired and the dimensional stability of the fabric is also good, its cost of $1.19 per square yard as compared to $.79 per square yard for untreated fabric is maybe justified although finishing costs of forty cents per yard seem excessively high and unwarranted.

The Salyna Cloth, with the same initial crease resistance as the Indian Head retained its crease resistance better on laundering. Tensile strength impairment and shrinkage of 4.7% filling wise, combine to evaluate it lower than that of the Reeve Weave cotton suiting and the Indian Head which are sufficiently similar for the same end use by the consumer. Its cost at $1.74 seems high by comparison.

The "tebelized" linen suiting retained its finish very well in comparison to the other fabrics. The considerable loss of strength when related to its higher initial cost of $2.98 per square yard does not justify a higher evaluation. However, there are essential differences in appearance value and to many consumers this is a sufficient justification for the higher price. Linens are traditionally higher in price than cotton fabrics due to the fact that better qualities are always imported.

The Tafetella, a new fabric this season, showed the poorest crease resistance among the cotton fabrics. Its very high thread count and compact weave, which one would expect to resist thorough impregnation of the resin into the fiber, suffers by comparison in performance, particularly when related to price. Its high percentage loss of tensile strength, on laundering limits its serviceability although its draping qualities, color fastness and dimensional stability are good. As in the case of the tebelized linen suiting, it is its appearance and high fashion value which account for the cost. If price is of primary consideration to the consumer-buyer, it is not to be recommended.

The Czecho-Slovakian linen, on analysis, possessed very poor crease resisting characteristics. The considerable loss of tensile strength, some loss of color, and an increase in the stiffness of the fabric show it to be obviously less satisfactory than the other linen fabric. However, at $1.00 per square yard, as compared to $2.98 it compares more favorably. Fundamentally, the only appreciable difference between the two fabrics is the crease resistant characteristic. Inasmuch as both fabrics serve the same end use, it is a question as to whether or not crease resistance merits this price differential. Even when price is related to the Reeve-Weave cotton suiting at $1.69, the Indian Head at $1.19 and Salyna Cloth at $1.74, all of which serve similar uses, its cost is still favorable.

II. PERMANENT CRISP TREATED FABRICS

The five fabrics used in this study which were treated for permanent crispness were: dotted swiss, matelassé organdy, organdy, plissé and printed percale. The crispness or stiffness of the fabric was evaluated by the drapemeter. Values for both warp and filling were recorded and the draping quality of the fabric was expressed as the geometric mean of the warp times filling. A high value obtained in this way is an indication that the fabric is stiff and crisp. As the values decrease there is a corresponding loss of crispness in the fabric and it becomes softer and more supple. From these readings it is possible to compare the drapability values after laundering at two different temperatures, with their original values.

Dotted Swiss

The dotted swiss, when new had a drapability value of 73.45, which indicates that the fabric was quite stiff and crisp. After five launderings at the low temperature a loss of 22.4% of the crispness had taken place and after twenty-five launderings a 37% loss. At the higher temperature a 30.5% and 35% loss occurred, showing the more severe treatment less satisfactory, but in both cases, the greatest loss came in the first five launderings. This is most significant in view of the end use of the fabric.

By studying the graph in Plate V on page 81 the effect of laundering on the permanent crispness of this fabric is seen.

There was an insignificant change in weight and yarn count in this fabric on laundering.

CREASE RESISTANCE

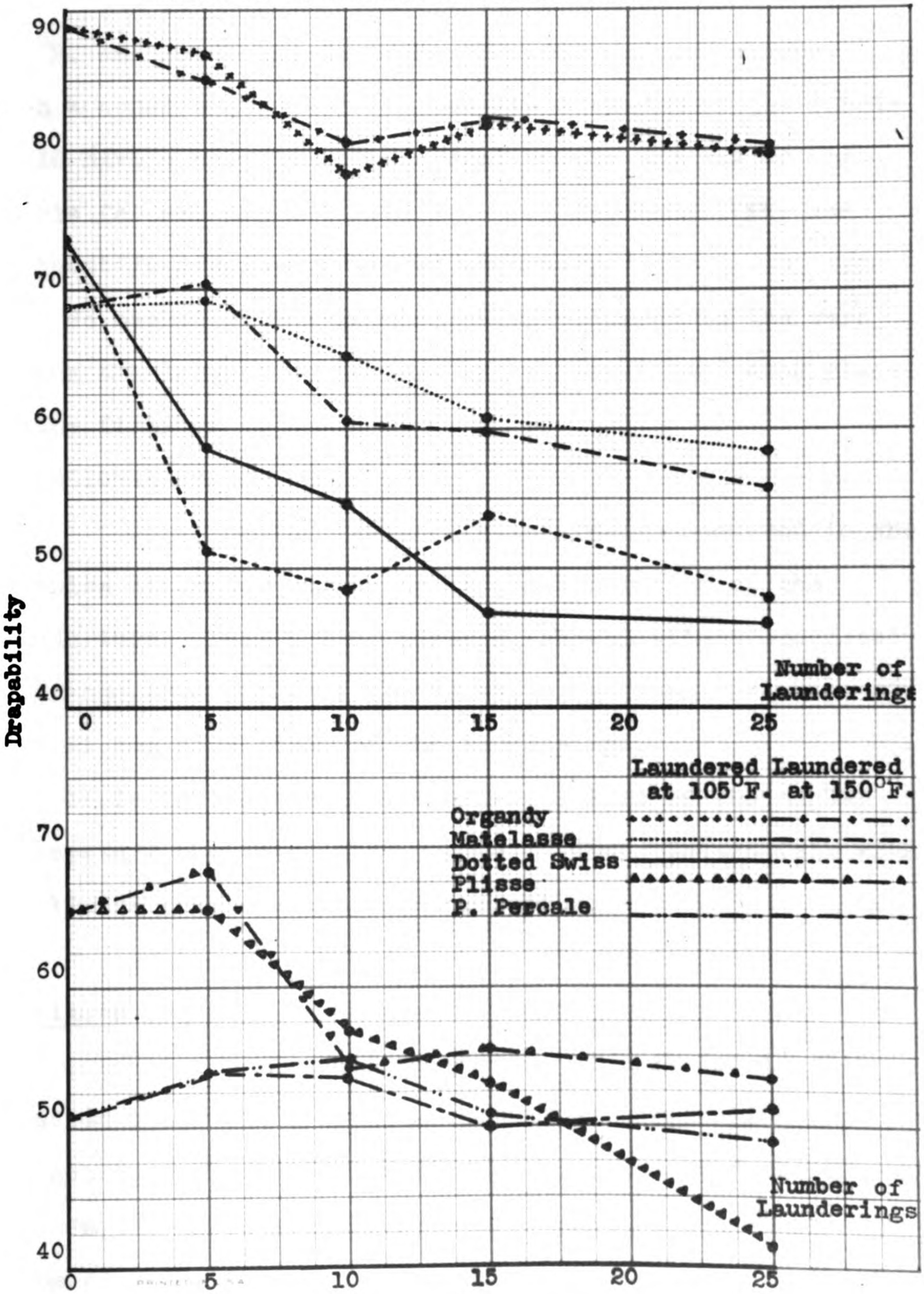
It is interesting to observe, that with a loss of crispness there was a gain in the crease resisting properties of the dotted swiss. A greater and more stable resistance to creasing was apparent in the filling than in the warp. No appreciable difference was noted between the fabrics laundered at the two temperatures.

TENSILE STRENGTH

A loss in warp tensile strength of 17.4% and 12.5% after the tenth and twenty-fifth laundering at the lower temperature occurred while a 17.7% and 20.9% loss

PLATE V

EFFECT OF LAUNDERING ON DRAPABILITY



took place at the higher temperature. In the filling there is an even greater loss (18.7% and 25.2%) when laundered at 105°F. and 30.9% and 20.9% at the 150° F. temperature. Such a considerable loss in tensile strength of the fabric would have a very limiting effect on the end use of this fabric for any apparel item in which serviceability and frequent launderings would be necessary.

No marked change in elongation occurred in the warp during the laundering process but a slight loss took place in the filling.

DIMENSIONAL CHANGE

Inconsequential shrinkage occurred in the warpwise direction during or at the conclusion of the launderings. The filling however, showed slight progressive shrinkage from 0.78% at the first, to a final shrinkage of 3.9% at the completion of the launderings.

It is interesting that shrinkage loss at the higher temperature was only half as great. These losses fall within the limits guaranteed in sanforization.

<u>Matelassé Organdy</u>

The draping quality of this fabric when measured using the drapemeter was 68.71, indicating that it did not have the initial crispness of the dotted swiss.

In the first five launderings, this fabric at the low temperature, showed a slight increase in crispness, while at the high temperature a slightly greater increase occurred. On continued laundering the fabric showed a progressive loss of crispness at both laundering temperatures, increasing to a 14.8% and 19% loss by the twenty-fifth laundering at the 105° and 150° temperatures respectively.

While greater loss of crispness resulted in laundering at the higher temperature, it was unlike the dotted swiss in that the greatest loss occurred at the low temperature between the tenth and fifteenth laundering, while by the more severe laundering method, the greatest loss came between the fifth and tenth laundering. This would indicate that the low temperature laundering would be more satisfactory for use on this fabric.

Plate V appearing on page 81 points up the effect laundering has on the drapability of the fabric. Loss of crispness in the fabric can be explained by the fact that there was a considerable loss in weight of the matelassé at the fifth laundering and still more by the twenty-fifth laundering regardless of the temperature of the laundering process. This shows a loss of the finishing material that was used to impart crispness to the fabric.

CREASE RESISTANCE

Because of the crisp quality and the irregular surface of the fabric, the crease resisting properties were very unpredictable. In general, they were very low and no marked increase or decrease resulted from the laundering process.

By the fifth laundering, there was a considerable increase in the yarn count in the warpwise direction. This increase was maintained throughout the launderings and no great difference occurred between the launderings at different temperatures.

There was no significant change in the yarn count in the filling during the laundering process.

TENSILE STRENGTH

During the first ten launderings, there was very little loss in the tensile strength of the fabric, at either temperature. However, by the twenty-fifth laundering, there was a sustained loss of warp strength of 4.5% and 15.3% at the low and high temperature respectively, and a filling strength loss of 8.0% and 11.2% at the low and high temperature respectively. This loss of tensile strength may be a result of the severity of the laundering process and/or the embrittling or tentering effect of the finish applied to the fabric.

A slight loss in elongation in both directions of the fabric was noted under both laundering temperatures.

DIMENSIONAL STABILITY

On laundering at the low temperature the fabric stretched 1.56% in the warp during the first laundering, and with slight variations, remained constant through the remaining ones. The filling, on the other hand showed a shrinkage of 3.9% and stretchage to a maximum of over 2% at the final laundering.

At the higher temperature the warp behaved in the same manner as before but in the filling a shrinkage of over 1.5% was recorded at the final laundering.

Although this fabric was not treated for dimensional control, the permanent crisp finish appears to have imparted a stabilizing effect on the fabric, as the percentage change in laundering was slight.

Organdy

One of the oldest and most commonly known permanent crisp finishes is the one which is used on organdy. This fabric showed a value of 88.18 in drapability. This value is very high and indicates that the fabric is extremely stiff and crisp.

On laundering the fabric at the low temperature only a 1.66% loss in crispness was noted through the first five launderings. However, in the subsequent launderings losses of 11%, 7% and 9% occurred at the higher temperature. Certain inconsistancies may be due to the method of pressing and relative dampness of the specimen when it was pressed. A clear picture of the effect of laundering at the two different temperatures on the crispness of the organdy, can be seen in Plate V on page 81.

There was no appreciable change in yarn count or weight of the fabric during the subsequent laundering processes.

CREASE RESISTANCE

Due to the crisp nature of the fabric, crease resistance was poor. However, on testing a progressive increase in crease resistance value was noted for both warp and filling at low and high temperature launderings. At no laundering interval did the value for crease resistance approach a commercially acceptable value as described by Powers (25).

TENSILE STRENGTH

The organdy used in this study had low initial tensile strength of 28 pounds in the warp and 20 pounds in the filling. Considerable loss of this strength occurred in laundering.

At the lower temperature, there was a warp loss of 7.4% and 9.6% and filling loss of 19% and 16.5% at the tenth and twenty-fifth laundering respectively. This was a significant loss inasmuch as its original strength limited its use.

At the higher temperature, no loss in warp strength was noted in the first ten launderings, but by the twenty-fifth a 11.7% loss had taken place. A 7% loss in filling strength was recorded at the tenth laundering which was sustained throughout the balance of the launderings.

On the basis of these results, there was less loss of strength when the organdy was laundered at the higher temperature and this occurred in the last launderings rather than during the first ones, which is of course somewhat better from the consumer's point of view.

Elongation of the fabric remained fairly constant in the warp wise direction at both temperatures, but showed considerable increase in the filling at both temperatures.

DIMENSIONAL STABILITY

Very little change occurred in the warp dimension of the fabric during laundering at either temperature. At the lower temperature laundering, the warp yarns showed practically no change. The filling however, behaved, erratically, showing a 5 to 7% shrinkage.

On laundering at 150° F., no shrinkage occurred in the warp. In the filling the fabric shrank similarly to the other method being slightly lower at the end of the study.

Plissé

The construction of the plissé, probably accounts for the lower drapability value of 65.43 shown by this specimen. It is a fabric apparently designed for a different use than the others in this grouping, as it is not as crisp and stiff as the previous fabrics studied.

The durability of the fabric to the laundering process is depicted on the graph, Plate V on page 81.

The first five launderings at the low temperature, showed an insignificant change in the crispness of the fabric, but subsequent launderings showed losses mounting to 13.15%, 18.8% and 36%. On the other hand, at the higher temperature losses at comparable intervals were 4.5%, 17.1%, 15.1% and 18.3%. Because of the lack of uniformity in the construction of the cloth it is difficult to compare the effect of the two different launderings, for the individual specimens varied considerably. However, a progressive loss of crispness in laundering does seem to be clearly indicated.

Considering the nature of the fabric, yarn count and weight per square yard of the fabric seemed fairly constant throughout the laundering process.

CREASE RESISTANCE

Crease resistant properties in the filling direction of this fabric were very good, both in the original and throughout both laundering processes. Crease resistance in the warp was considerably lower, but the results were so diversified that no generalization is possible.

TENSILE STRENGTH

This fabric has an extremely low tensile strength in the filling direction being only 9.2 pounds per inch, in contrast to an initial warp strength three times as great. This shows very poor balance in strength. Although elongation amounted to 22.4% in the filling and 19.3% in the warp, the brittleness of the fabric would definitely limit its use.

The cause of the low tensile strength is likely due to the severe caustic soda treatment (8), together with the finishing material that was used to produce crispness, and the tensions that were applied to the cloth to produce the plissé effect.

However, on laundering at the lower temperature there was a considerable increase (10%) in warpwise strength through the first ten launderings, but by the twenty-fifth, a 1.9% loss had occurred. At the higher temperature, the increase in strength was sustained. In the filling, 17.3% and a 25% increase occurred at the lower temperature, while at the higher temperature strength had appreciated by 50%.

This low tensile strength may be caused to some extent by the embrittling effect that the permanent crisp producing resin had on the fibers.(30) This on removal would tend to retard strength losses. The shrinkage which occurred probably affected strength changes also.

DIMENSIONAL STABILITY

The plissé behaved similarly at both laundering temperatures. Warpwise stretching occurred to a considerable extent by the tenth laundering, 4.60% and 3.13% at the low and high temperatures. In the filling 6% to 7% shrinkage in the first five launderings was followed by lower losses, being slightly over 4.5% at the end of the final laundering. The filling at the high temperature laundering followed the same general pattern.

It is obvious that the permanent crisp finish applied in this fabric had no stabilizing effect on the dimensions of the fabric.

Printed Percale

In the interpretation of results of the laboratory tests for this fabric, a comparison will be made with untreated grey cloth of identical construction. From this comparison the effect of the permanent crisp finish on the fabric will permit fewer variables, which might be contributory to performance changes due to laundering.

The drapability of the printed percale was 50.99 while that of the grey cloth was 46.30.

On laundering the percale at the low temperature, a 5.6% and 7.56% increase in stiffness took place at the fifth and tenth launderings respectively, with reduced losses (0.2% and 4.14%) in the subsequent launderings.

At the higher temperature laundering, 5.8% and 5.0% increases in crispness took place at the fifth and tenth laundering, while 1.56% and 0.76% losses were noted at the fifteenth and twenty-fifth launderings. These results indicate remarkable stability and permanence of the finish at both laundering temperatures.

On the other hand, the untreated grey cloth showed a 5% loss in stiffness after five launderings at both temperatures. By the final laundering a 6.2% loss of stiffness was evident, with negligible difference at the different temperatures. This indicates less stability in draping qualities in the grey cloth. The method of pressing and the degree of dampness of the specimens when they were pressed, may account for some of this difference, since moisture absorption is affected by the resinous coating of the fibers. By this comparison, it is evident that the permanent crisp finish on this fabric is effective and durable.

No appreciable change in weight per square yard or yarn count occurred in either fabric on laundering.

CREASE RESISTANCE

The printed percale exhibited much better crease resisting properties than the grey cloth. The crease resistant values remained fairly constant for both fabrics during laundering. The crease resistant values of the printed percale were sufficiently high to meet Powers (25) requirements for commercially acceptable crease resistance. On the other hand the untreated grey cloth did not meet these requirements.

TENSILE STRENGTH

In the original fabrics, there was no significant difference in their tensile strength.

In the warpwise direction of the percale, at either temperature throughout the laundering process, there was no appreciable loss in tensile strength. In the filling however, there was a marked percentage loss (7.9% - 20.0%) at the low laundering temperature. At the higher temperature, even greater losses (28.7 and 19.4%) occurred.

On the other hand, the grey cloth likewise, showed loss in strength in both warp and filling. At the lower temperature losses of 7% and 11% in the warp and 15% and 10% in the filling were noted. At the high temperature laundering, losses of 2.4% and 7.7% in the warp and 11% and 18% in the filling were recorded. Loss in the tensile strength of the grey cloth may be accounted for by the severity of the laundering process.

In comparing the two fabrics for tensile strength, the printed percale exhibits much better warp strength than the grey cloth, but the grey cloth shows a better retention of filling strength. While it is difficult to draw any definite conclusions as to the effect of the finish on the strength of the fabrics, it would seem that continuous laundering is probably more responsible than finish in strength performance.

In comparing the two fabrics for elongation, the printed percale and the grey cloth, had a percentage change in elongation in both directions which were similar throughout the launderings.

DIMENSIONAL STABILITY

The printed percale showed remarkable stability in laundering at both temperatures, not exceeding a shrinkage of 1.5% in either direction throughout the laundering process. On the other hand, the grey cloth showed almost twice as much shrinkage in both directions regardless of temperature.

From these results we can conclude that the permanent crisp finish applied to the printed percale has shown a stabilizing effect, but whether or not a mechanical shrinkage accompanied or preceded the application of the resin finish is unknown.

Evaluation of the Permanent Crisp Finished Fabrics

The nature of the permanent crisp fabrics used in this study, vary so much in respect to their end use and to type of finish applied, that it is difficult to rate them for permanent crispness as was done in the crease resistant finished fabrics. However, the following chart will give the reader an idea of the comparative crispness of the original fabrics.

Rating	Fabric	Drapability Value
1	Organdy	88.18
2	Dotted Swiss	73.45
3	Matelassé Organdy	68.71
4	Plissé	65.43
5	Printed Percale	50.99

The wide range in the crispness of these fabrics for the purpose of serving different consumer use and preference does not necessarily indicate that the cloth construction of these fabrics limits the degree of permanent crispness possible. As was pointed out by Powell (29) and Martin (19) many degrees of crispness are possible on a single fabric, and although yarn structure and cloth construction do influence the stiffness of the fabric (23), it is primarily the finish itself that is the most significant factor.

The three fabrics, dotted swiss, organdy and matelassé organdy, because of their similar end uses, will be compared in terms of ultimate performance or degree of permanence.

Organdy

The organdy shows not only the greatest degree of crispness, but retains this property exceedingly well on laundering at both temperatures. However, due to considerable shrinkage in the filling direction and appreciable loss in the tensile strength of the fabric, loss of color and obvious yarn slippage, its crispness retainment quality alone, does not recommend it as a superior fabric. While excellent in one characteristic, real value to the consumer-buyer is in balanced quality. The price of the organdy at $ .95 per square yard, is very low when compared to the cost of the matelassé organdy and dotted swiss.

Dotted Swiss

From the standpoint of the consumer-buyer, the performance of the dotted swiss would prove very unsatisfactory in two respects. A high percentage loss of crispness in the fabric in the first five launderings, and the appreciable loss in tensile strength in the fabric, would definitely limit the wear expectancy of the fabric and in turn limit its end use.

Although this fabric was characterized by good dimensional stability and colorfastness to laundering, other factors offset these advantages. Considering the price of the fabric at $1.33 per square yard and its performance in comparison to the organdy, it is highly improbable that the consumer-buyer would derive sufficiently greater satisfaction at the higher cost.

Matelassé Organdy

For the first five launderings the consumer would be satisfied with the permanent crispness in the matelassé organdy. Inasmuch as crispness was lost in the subsequent launderings it is likely that dissatisfaction would result. Because this is a novelty fabric and its use is limited, it is unlikely that it would be laundered more than a total of ten times. Therefore, the loss in tensile strength which occurred after the tenth laundering is not a significant factor. Color change was so slight as to be negligible and the general appearance of the fabric remained unchanged. The fabric was dimensionally stable, but its cost at $1.53 per square yard is high. In the light of these facts, the consumer-buyer should carefully consider the end use of this fabric before purchasing. Inasmuch as matelassé organdy is a novelty fabric and effective in appearance it should be regarded as essentially a prestige and fashionable fabric rather than a utilitarian one.

Plissé

This fabric, in view of its very low tensile strength, its loss of crispness, its dimensional instability and comparatively high price at $1.29 per square yard makes the investigator feel that the consumer-buyer would not derive satisfaction in the purchase of this fabric.

Printed Percale

From the interpretation of the laboratory tests performed on this fabric, it is definitely evident that the permanency of the finish on this fabric is excellent. In dimensional stability, tensile strength, drapability and appearance it is also superior. However, its cost of $1.19 per square yard compared to the untreated percale of similar construction at $ .49 per square yard, makes it doubtful if the consumer-buyer would feel the advantage of permanent crispness is justified by a price which is almost two and one half times as great.

III <u>DIMENSIONALLY STABILIZED FABRICS</u>

The following fabrics were finished for dimensional stability, namely: dotted swiss (Sanforized), Tafetella (Rigmel), Indian Head (Evershrunk), Salyna Cloth (shrink resistant), voile (Sanforized), Reeve Weave cotton suiting (Evershrunk).

Inasmuch as the dimensional stability of these fabrics was interpreted and related to other characteristics in the previous discussions, only a summary will be presented here.

The "Sanforized" and "Rigmel" processes guarantee average residual shrinkage within 1%. The "Evershrunk" process guarantees that average residual shrinkage will not exceed 2%. There was no guarantee as to the amount of shrinkage control of the finish on the Salyna Cloth.

All the fabrics tested except the Salyna Cloth fell quite closely within the limits specified by the finish. The consumer when purchasing fabrics which have "Sanforized", "Rigmel" or"Evershrunk" labels can be assured of good dimensional control.

In the case of the dimensional stability finish applied to the Salyna Cloth, the results of testing indicated that, at the high temperature laundering especially, dimensional control was not sufficiently good to be depended upon. The fact that filling shrinkage amounted to as much as 3.9% at the low temperature laundering and 4.7% at the higher temperature laundering, it would seem that the present finish does not adequately control dimensional change.

CONCLUSION

Based on the interpretation of the laboratory tests performed in this study, the author arrived at the following conclusions in regard to crease resistant, permanent crisp and dimensional stability finishes applied to a selected group of apparel fabrics.

On the seven crease resistant treated fabrics investigated, it appears, that in general, the initial effectiveness of the crease resistant finishes used on these fabrics was good. The one exception, was in the case of the Czecho-Slovakian linen, which is believed to have not been treated for crease resistance.

This study shows likewise, that by either laundering process, there is a loss of crease resisting properties. In general, the greatest percentage loss in crease resistance occurred during the first five launderings, and that in subsequent launderings, the fabrics tend to show less change in this characteristic. However, in two fabrics, progressive loss continued throughout the first ten launderings.

In every fabric, loss of crease resistance was greater throughout the first ten launderings on specimens laundered at the higher temperature. On the other hand, these fabrics with two exceptions showed recovery following the twenty-fifth laundering to the extent that they possessed higher crease resistant values than matching specimens laundered at the lower temperature.

It was also found that, in every fabric except the voile, the filling yarns possessed greater crease resistance than the warp. Of these fabrics, all but the Reeve Weave cotton suiting, had a lower yarn count in the filling direction of the cloth than in the warp. This would indicate that the coarser, loosely twisted yarns inherently have better crease resistance than the finer yarns. This can also be partially explained by the fact that there is greater penetration of the finishing resin on the fibers which have a low twist. It appears too, that yarn structure and weave construction of a fabric are significant factors in the initial effectiveness as well as permanency of the crease resistant finish on the fabric.

Draping properties of the crease treated fabrics were not appreciably affected by laundering, nor was yarn count and weight per square yard of the fabrics altered significantly by laundering at either temperature.

With but one exception, there was a considerable loss of tensile strength during laundering at both low and high temperatures. However, no generalizations can be made in regard to the effect of either laundering temperature, or the number of launderings, on the tensile strength of the fabrics. This is probably due to the limited number of samples used in this study, and to the diversity in these fabrics in fiber content, yarn structure and weave construction.

With one exception, elongation percentage increased slightly during laundering and showed a direct relationship to loss of strength.

Even from the five permanently crisp fabrics used in this study, it is evident that there are numerous finishes designed to produce variation in draping qualities on fabrics for different effects and appearance as well as for different uses.

Because of the diversity in the draping qualities and structure of fabrics tested, it is impossible to make generalizations concerning permanent crisp finishes. Each permanent crisp treated fabric in itself constitutes an entity. For that reason, the conclusions concerning each crisp treated fabric tested in this study is to be found in the section on interpretation of results.

From this study we can only generalize, that on repetitive launderings, there is a loss of crispness, which varies in amount and bears a relationship to the number of launderings, the temperature used in laundering and the type of "finish" applied.

Yarn count and weight per square yard were negligibly affected by the laundering process.

No generalization of the effect of laundering on the tensile strength is possible, as the type of finish combined with the type of fabric, seems to produce varying results. In general, these fabrics showed an increase in elongation on laundering.

It was found in this study that the "Sanforized" shrunk, "Rigmel" shrunk and "Evershrunk" methods of controlling dimensional change applied to the five cotton fabrics, were satisfactory, and substantiated the claims made by their manufacturers. In the case of the rayon stabilization finish applied to the Salyna Cloth, the dimensional change was too great to be considered satisfactory.

This study shows that shrinkage was greater in the filling direction than in the warp direction, which is contrary to the findings in most studies. The method of pressing used in this investigation may, to some extent, explain these results but, it is also to be kept in mind that in the application of finishing compounds to the fabric, one might expect deviations from findings made on "untreated" fabrics.

As this study was set up for exploratory purposes, where the sampling was small, the author feels that similar, more comprehensive studies should be undertaken before definite conclusions can be drawn on performance in laundering of crease resistant treated fabrics and permanently crisp treated fabrics.

In the future studies, the following recommendations might prove of use to the investigator. First, a sufficient number of specimens would be desirable so that statistical analysis of the data could be made. Secondly, because this study showed that greater shrinkage occurred in the filling-wise direction of the fabric than in the warp which is contrary to the findings in most studies, various methods of pressing the fabrics should be investigated to ascertain whether the procedure used in this study was accountable for the results obtained. Thirdly, additional tests for thickness measurements of the fabric, determination of yarn twist, size and weave analysis, together with the tests performed in this study, would assist greatly in the interpretation of the performance characteristics of these functional finishes in laundering.

Additional studies could be carried out using these recommended procedures in which crease resistant fabrics of different weave structures could be compared. An interesting comparison could be made on the effectiveness and durability of crease resistant fabrics of different fiber content or fiber blends. More information is also needed in respect to the effect of the laundering temperature and a greater number of launderings on crease resistant properties of the fabric. A comparison of the effectiveness in laundering, of different trade-named finishes would aid the consumer-buyer considerably in making wise selections of crease resistant fabrics. "Treated" versus "untreated" fabrics of identical specifications make for an interesting study in the evaluation of crease resistant treated fabrics in price performance relationship.

In regard to the permanent crisp finishes, it is evident from investigation that a considerable number of studies could be set up to evaluate more extensively the performance of the various types of crisp finishes. A larger number of fabrics of different yarn and weave construction treated with the same finish would clarify the value of that particular finish.

In the field of dimensional control, additional studies to determine the relative effectiveness in new stabilization finishes applied to rayon and rayon blended fabrics in laundering and/or dry cleaning could be made.

Already a great deal has been accomplished by the finisher in producing durable crease resistant, permanent crisp and dimensionally stable fabrics. Cost however, is high in relation to inherent value. As seen from this and other studies, there is need for technological improvement in functional finishes which will be more durable in laundering and which at the same time retain desirable initial physical characteristics, appearance, and other utility values.

SUMMARY

The purpose of this study was primarily to serve as a pilot study for methods and procedures to be used in evaluating the performance of crease resistant, permanent crisp and dimensional stability finishes applied to a selected group of apparel fabrics. Specifically this study was to determine the initial effectiveness of these treated fabrics and relate their performance in laundering to cost and utility value to the consumer-buyer.

In all twelve apparel fabrics that were investigated, seven had been treated for crease resistance and five for permanent crispness. Of these twelve, five were additionally treated for dimensional stability. One untreated fabric was used for price-performance comparison with a similarly constructed "finished" fabric.

The original fabrics were analyzed in the laboratory for the following initial properties with appropriately approved instruments of test. Yarn count (micrometer); weight per square yard (chainomatic balance); tensile strength and elongation (Scott Tensile Strength Machine); crease resistance (Monsanto Wrinkle Recovery Meter); drapability (drapemeter) were the tests and instruments

used. Tests were made under standard conditions of temperature and relative humidity.

All of the fabrics were then laundered in the Atlas Launder-Ometer; (one half of the specimens being laundered at 105° F., the other half at 150° F.) for a total of twenty-five launderings. Specimens from each fabric were withdrawn for testing following the fifth, tenth, fifteenth, and twenty-fifth laundering. Dimensional changes in the fabrics were measured following the first, fifth, tenth, fifteenth and twenty-fifth laundering.

Analysis of laboratory data, showed that, in general, the effectiveness of the crease resistant finishes on the original fabric was good. However, on laundering, there was variable loss in this property. The greatest percentage loss occurred during the first five launderings. Fabrics laundered at the higher temperatures showed a decidedly greater loss during the first ten launderings than those laundered at the lower temperature. However, by the twenty-fifth laundering recovery had occurred to such an extent, that specimens laundered at the higher temperature possessed greater crease resistance values than those laundered at the lower temperature.

With but one exception, it was found that filling yarns possessed greater crease resistance than warp yarns. These coarser more loosely twisted yarns permitted more complete penetration of the resin and better crease resistance resulted. Yarn and weave construction was found to play an important role in the wrinkle recovery values of the original and laundered fabrics.

Accompanying the improvement of crease resistant qualities in these new fabrics however, was significant but variable losses in tensile strength on laundering at both temperatures.

In respect to the permanently crisp fabrics used in this study it is evident that there was a considerable variation in the degree of crispness that can or is intentionally imparted to a fabric. Because of this variable factor and the diversified yarn and weave construction in the fabrics in this group, any generalizations concerning this functional finish were extremely difficult to make. However, it was found that, generally speaking, there was a loss of crispness which varied in degree but showed relationship to the number of launderings, temperature and the type of"finish" applied.

The mechanical methods for dimensional stability (Sanforized, Rigmel, and Evershrunk) were found to be successful in controlling shrinkage within the residual percentage changes claimed by their manufacturer. The rayon stabilization method tested in this study was found to be less efficient than stabilization by mechanical methods applied to the cotton fabrics.

Because of the exploratory nature of this study, certain recommendations for improved procedures were noted. A larger number of specimens is essential to provide a more valid basis from which to draw conclusions. Thickness of the fabric, and more complete analysis for twist, yarn size etc., would be beneficial in more objective interpretations of results.

This study has brought to the fore many pertinent questions regarding the performance of the various crease resistant, permanent crisp, and dimensional stability finishes and has suggested possibilities for additional and more comprehensive laboratory investigations and wear studies.

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APPENDIX

CHART I

CREASE RESISTANT FINISHES

Trade Name	Manufacturer	Applied to*				Properties
		C	R	L	Bl	
Aeroset	American Cyanamid Co.		X			Crease resistant, shrinkage, stretch, sag control
Aerotex	American Cyanamid Co.	X	X			Crease resistant shrinkage, stretch, sag control
Aqua Perm	Aqua Sec Corp.	X	A			Crease resistant, shrinkage control
BraDlainA	Bradford Dyeing Association		A		B	Crease resistant, shrinkage control
BraDpermA	Bradford Dyeing Association	X	X		B	Crease resistant
BraDurA	Bradford Dyeing Association		A		X	Crease resistant, shrinkage control
Colorset	Duplex Fabrics		A			Crease resistant, shrinkage control
Flexamine 25	Hart Products Co.	X				Crease resistant
Formaset	Warwick Chemical Co.	X				Crease resistant, shrinkage control
Glenlyon	Sayles Finishing Plants Inc.	X	X		X	Crease resistant, color fastness
N C F Special	Onyx Oil & Chemical Co.	X	X	X	X	Crease resistant
Perm-Allied	Allied Textile Printers	X	X	X		Crease resistant, shrinkage control

*C - Cotton
R - Rayon
L - Linen
Bl- Blends of fibers

A - Spun Rayon
B - Rayon blends only

CHART I (cont.)

CREASE RESISTANT FINISHES

Trade Name	Manufacturer	Applied to*				Properties
		C	R	L	Bl	
Raylin	Sanco Piece Dye Works	X	X			Crease resistant
Resloom	Monsanto Chemical Co.	X	X	X	X	Many varied results can be obtained
Rhonite	Rhome & Haas Co.	X	X	X		Crease resistant
Tebelized	T. B. Lee Co.	X	X	X		Crease resistant
Unidure	United Piece Dye Workers		X		X	Crease resistant
Vitalized	U. S. Finishing Co.	X	A		X	Crease resistant
Vita-Perm	Puritan Piece Dye Works	X	X			Crease resistant

CHART II

PERMANENT CRISP FINISHES

Trade Name	Manufacturer	Applied to:*				Properties
		C	R	L	Bl	
Apponized	Apponaug Finishing Co.	X	X			Permanent crisp, durable finish
Basco	J. Bancroft & Sons	X				Permanent crisp, lintless, lustrous
Bellamized	Bellman Brook Bleachery Co.	X				Permanent crisp, crease resistant
Ceglin	Sylvania Industrial Corporation	X				Permanent crisp, shrinkage control, lintless
Everglaze	Jos. Bancroft & Sons	X	X			Glazed, permanent crisp, durable finish
Kandar	U. S. Rubber Co.	X	X		X	Permanent crisp
Kopan	Dexter Chemical Co.	X	X			Shrinkage control, lintless, permanent crisp
Lacet	American Cyanamid Co.	X				Permanent crisp, shrinkage control
Sabel	Kendall Co.	X	X			Permanent crisp, lustrous, lintless
Saylerize	Sayles Finishing Plant	X				Permanent crisp, lustrous
Sheerset	American Cyanamid Co.	X				Permanent crisp, lustrous for sheer fabrics
Staze--Rite	J. Bancroft & Sons	X	A	X		Permanent crisp, lustrous

A - Spun Rayon

CHART II (cont.)

PERMANENT CRISP FINISHES

Trade Name	Manufacturer	Applied to:*				Properties
		C	R	L	Bl	
Vita-Glaze	U. S. Finishing Co.	X				Permanent crisp, glazed
Vita-Last	U. S. Finishing Co.	X				Permanent crisp for sheer cottons
Wat-A-Set	Mount Hope Finishing Co.	X	X			Permanent crisp resists dampness

*C - Cotton
R - Rayon
L - Linen
Bl- Blends of fibers

CHART III

DIMENSIONAL STABILITY FINISHES

Trade Name	Manufacturer	Applied to C	R	L	Bl	Properties
Austinized	Traub Lyons Oppenheim, Inc.	X	X	X		Shrinkage control, abrasion resistant
Banco Shrink	J. Bancroft & Sons	X				Shrinkage control
BraDcorsA	Bradford Dyeing Association	X	X			Shrinkage control, stretch, sag resistant
BraDfaset	Bradford Dyeing Association	X			B	Shrinkage control
BraDlustrA	Bradford Dyeing Association	X				Shrinkage control,
Ceglin	Sylvania Industrial Corp.	X	X			Shrinkage control, permanent crisp, lintless
Definized	Aqua Sec Corp.		X			Shrinkage control
Definized G	Aqua Sec Corp.		X		X	Shrinkage control
Diapene "U"	Quaker Chemical Products	X	X			Shrinkage control
Duralana	Warwick Chemical Co.				X	Shrinkage control
Kopan	Dexter Chemical Co.	X	X			Shrinkage control, lintless, permanent crisp
Lacet	American Cyanamid Co.	X				Shrinkage control, permanent crisp
Ray-O-Set	Capitol Piece Dye Works	X	X			Shrinkage control

CHART III (cont.)

DIMENSIONAL STABILITY FINISHES

Trade Name	Manufacturer	Applied to*				Properties
		C	R	L	Bl	
Rigmel Shrunk	Bradford Dyeing Association	X	X			Shrinkage control
River Shrunk	Dan River Mills	X				Shrinkage control
Sanforized	Cluett Peabody and Co.	X				Shrinkage control
Sanforset	Cluett Peabody and Co.	X			X	Shrinkage control
Sayl-A-Set	Sayles Finishing Plant		X		X	Shrinkage control
Sayl-A-Shrunk	Sayles Finishing Plant	X	X		X	Shrinkage control
Vat Fast	United Piece Dye Workers		X		X	Shrinkage control

* C - Cotton
R - Rayon
L - Linen
Bl- Blends of fibers

TABLE I

CREASE RESISTANT VALUES

Fabric	Original				No. of Laund.	Laundered at 105°F				Laundered at 150°F			
	Angle of Recovery*		Chord Length			Angle of Recovery*		Chord Length		Angle of Recovery*		Chord Length	
	W	F	W	F		W	F	W	F	W	F	W	F
Dotted Swiss	108	119	3.2	3.4	5	125	139	3.5	3.8	122	138	3.5	3.7
					10	133	126	3.7	3.6	131	138	3.6	3.7
					15	114	136	3.4	3.7	128	137	3.6	3.7
					25	121	140	3.5	3.8	116	137	3.4	3.7
Matelassé Organdy	87	97	2.7	3.0	5	77	85	2.5	2.7	77	89	2.5	2.8
					10	69	85	2.5	2.7	94	84	2.9	2.7
					15	93	84	2.9	2.7	84	85	2.7	2.7
					25	80	82	2.6	2.6	87	97	2.8	3.0
Organdy	52	42			5	55	61	1.9	2.1	61	43	2.0	1.7
					10	67	57	2.2	1.9	65	64	2.2	2.1
					15	70	63	2.3	2.1	73	71	2.4	2.3
					25	78	66	2.5	2.2	83	78	2.6	2.5
Plissé	101	160	3.1	3.9	5	91	140	2.8	3.8	107	134	3.2	3.7
					10	121	132	3.5	3.6	99	131	3.0	3.6
					15	115	137	3.4	3.7	113	139	3.3	3.7
					25	102	129	3.1	3.6	118	131	3.4	3.6
Printed Percale	121	124	3.4	3.5	5	116	106	3.4	3.2	101	104	3.1	3.1
					10	117	114	3.4	3.3	115	112	3.4	3.3
					15	108	108	3.2	3.2	111	105	3.3	3.2
					25	105	113	3.1	3.4	108	117	3.2	3.4
Tafetella	126	127	3.6	3.6	5	117	118	3.4	3.4	105	114	3.2	3.4
					10	125	123	3.6	3.5	122	114	3.5	3.4
					15	116	124	3.4	3.5	114	124	3.4	3.5
					25	119	121	3.4	3.5	123	129	3.5	3.6
Indian Head	138	140	3.8	3.8	5	132	134	3.7	3.7	129	131	3.6	3.7
					10	123	132	3.5	3.6	125	124	3.5	3.5
					15	126	129	3.5	3.6	121	125	3.5	3.5
					25	110	125	3.3	3.5	126	123	3.5	3.5
Voile	142	141	3.8	3.8	5	125	135	3.5	3.7	138	138	3.7	3.7
					10	127	137	3.6	3.7	138	132	3.6	3.6
					15	132	136	3.7	3.7	140	141	3.8	3.8
					25	131	133	3.7	3.7	140	139	3.8	3.8

*Average of 5 determinations

TABLE I (cont.)

CREASE RESISTANT VALUES

Fabric	Original				No. of Laund.	Laundered at 105°F				Laundered at 150°F			
	Angle of Recovery*		Chord Length			Angle of Recovery*		Chord Length		Angle of Recovery*		Chord Length	
	W	F	W	F		W	F	W	F	W	F	W	F
Salyna Cloth	126	152	3.6	3.9	5	127	145	3.6	3.8	120	143	3.5	3.8
					10	121	133	3.5	3.7	119	146	3.5	3.8
					15	122	135	3.5	3.7	124	147	3.5	3.8
					25	111	130	3.3	3.6	125	140	3.6	3.7
Reeve Weave Cotton Suiting	133	153	3.7	3.9	5	120	145	3.5	3.8	117	142	3.4	3.8
					10	120	139	3.5	3.8	120	142	3.5	3.8
					15	120	133	3.5	3.7	124	146	3.5	3.8
					25	118	134	3.4	3.7	120	147	3.5	3.8
Czecho-Slovakian Linen	62	76	2.1	2.4	5	64	71	2.1	2.3	57	66	1.9	2.2
					10	66	72	2.2	2.4	62	66	2.0	2.2
					15	67	72	2.2	2.4	65	70	2.1	2.3
					25	62	68	2.1	2.3	67	67	2.2	2.2
Tebelized Linen Suiting	132	142	3.7	3.8	5	133	131	3.7	3.7	122	133	3.5	3.7
					10	133	134	3.7	3.7	115	124	3.4	3.5
					15	123	134	3.5	3.7	117	123	3.4	3.5
					25	117	133	3.4	3.6	125	131	3.5	3.6
Grey Cloth (Percale)	106	106	3.2	3.2	5	95	97	2.9	3.0	95	89	2.9	2.8
					10	100	101	3.1	3.1	92	92	2.9	2.9
					15	113	93	3.4	2.9	96	93	3.0	2.9
					25	106	101	3.2	3.1	97	90	3.0	2.8

*Average of 5 determinations

TABLE II

PERCENTAGE CHANGE IN CREASE RESISTANCE

IN LAUNDERING

Fabric	No. of Laund.	Laundered at 105°F		Laundered at 150°F	
		W	F	W	F
Tafetella	5	-7.1	- 7.1	-16.7	-10.2
	10	- .8	- 3.1	- 3.2	-10.2
	15	-7.9	- 2.4	- 9.5	- 2.4
	25	-5.6	- 4.7	- 2.4	+ 1.6
Indian Head	5	-4.4	- 4.3	- 6.5	- 6.4
	10	-10.9	- 5.7	- 9.4	-10.7
	15	- 8.7	- 7.9	-12.3	-13.6
	25	-20.2	-10.7	- 8.7	-12.1
Voile	5	-12.0	- 4.3	- 2.8	- 2.1
	10	-10.6	- 4.0	- 2.8	- 6.4
	15	- 7.0	- 3.5	- 1.4	0
	25	- 7.2	- 5.7	- 1.4	- 1.4
Salyna Cloth	5	+ .8	- 4.6	- 4.8	- 5.9
	10	- 4.0	-12.5	- 5.5	- 3.9
	15	- 3.2	-11.2	- 1.6	- 3.3
	25	-11.9	-14.5	- .8	- 7.8
Reeve Weave Cotton Suiting	5	- 9.8	- 5.2	-12.0	- 7.2
	10	- 9.8	- 9.2	- 9.8	- 7.2
	15	- 9.8	-13.1	- 6.8	- 4.6
	25	-11.3	-12.4	- 9.8	- 3.9
Czecho-Slovakian Linen	5	+ 3.2	- 7.0	- 8.1	-14.0
	10	+ 6.5	- 5.6	0	-14.0
	15	+ 8.1	- 5.6	+ 4.8	- 8.5
	25	0	-11.4	+ 8.1	-12.7
Tebelized Linen Suiting	5	+ .8	- 7.7	- 7.6	- 6.3
	10	+ .8	- 5.6	-12.9	-12.7
	15	- 6.8	- 5.6	-11.4	-13.4
	25	-11.4	- 6.3	- 5.3	- 7.7

TABLE III

DRAPABILITY VALUES

Fabric	Original	No. of Laund.	Laundered at 105°F	Laundered at 150°F
Dotted Swiss	73.45*	5	58.45*	51.39*
		10	54.62	48.57
		15	46.87	53.78
		25	46.07	47.79
Matelassé Organdy	68.71	5	69.33	70.46
		10	65.36	60.64
		15	60.81	59.78
		25	58.56	55.75
Organdy	88.18	5	86.72	85.13
		10	78.32	80.54
		15	81.80	82.21
		25	79.86	80.30
Plissé	65.43	5	65.49	68.37
		10	56.83	54.26
		15	53.1	55.52
		25	41.86	53.43
Printed Percale	50.99	5	53.86	53.96
		10	54.85	53.52
		15	50.85	50.20
		25	48.89	51.39
Tafetella	48.50	5	51.16	51.13
		10	47.16	47.53
		15	44.29	46.92
		25	44.86	43.86
Indian Head	46.47	5	44.96	46.15
		10	50.27	46.20
		15	44.62	53.27
		25	46.16	44.94
Voile	62.79	5	53.76	59.02
		10	55.30	53.43
		15	52.80	50.48
		25	50.06	48.07

*Geometric mean of warp X filling based on average of three determinations each for warp and filling

TABLE III (cont.)

DRAPABILITY VALUES

Fabric	Original	No. of Laund.	Laundered at 105°F	Laundered at 150°F
Salyna Cloth	53.44*	5	45.78*	41.48*
		10	48.52	41.74
		15	43.31	43.00
		25	45.29	41.79
Reeve Weave Cotton Suiting	63.65	5	61.56	58.56
		10	59.33	57.94
		15	65.01	60.02
		25	64.77	60.66
Czecho-Slovakian Linen	71.99	5	72.61	76.19
		10	77.34	75.50
		15	76.98	76.02
		25	79.16	73.84
Tebelized Linen Suiting	61.97	5	75.51	69.42
		10	76.08	72.61
		15	74.63	72.85
		25	72.19	66.95
Grey Cloth (Percale)	46.30	5	43.80	43.58
		10	46.43	46.76
		15	46.88	47.04
		25	43.45	42.63

*Geometric mean of warp X filling based on average of three determinations each for warp and filling

TABLE IV

PERCENTAGE CHANGE IN DRAPABILITY

IN LAUNDERING

Fabric	No. of Laund.	Laundered at 105°F	Laundered at 150°F
Dotted Swiss	5	-20.4	-30.0
	10	-25.6	-33.9
	15	-36.2	-26.8
	25	-37.3	-35.0
Matelassé Organdy	5	+ .8	+ 2.7
	10	-4.8	-11.7
	15	-11.5	-13.0
	25	14.8	-18.9
Organdy	5	-1.66	-3.46
	10	-11.2	-8.66
	15	-7.24	-6.77
	25	-9.44	-8.94
Plissé	5	+ .09	-4.5
	10	-13.15	-17.1
	15	-18.8	-15.1
	25	-36.0	-18.3
Printed Percale	5	+5.6	+5.8
	10	+7.56	+5.0
	15	- .21	-1.57
	25	-4.14	- .76
Grey Cloth (Percale)	5	-5.0	-4.9
	10	+ .3	+1.0
	15	+1.0	+1.6
	25	-6.27	-7.9

TABLE V

WEIGHT PER SQUARE YARD IN OUNCES

Fabric	Original	No. of Laund.	Laundered at 105°F	Laundered at 150°F
Dotted Swiss	2.0505*	5 25	1.9808 1.9488	1.9671 1.9362
Matelassé Organdy	1.7934	5 25	1.6905 1.6779	1.7591 1.7088
Organdy	1.3064	5 25	1.3225 1.3236	1.3773 1.4093
Plissé	2.7501	5 25	2.7581 2.5832	2.9386 2.7169
Printed Percale	3.6633	5 25	3.6050 3.5181	3.6085 3.6233
Tafetella	3.4004	5 25	3.3376 3.4004	3.3856 3.3478
Indian Head	5.1572	5 25	5.0932 5.2281	5.2875 5.2121
Voile	1.7076	5 25	1.6699 1.6642	1.7156 1.7054
Salyna Cloth	6.4659	5 25	6.2694 6.3574	6.4279 6.4637
Reeve Weave Cotton Suiting	6.3299	5 25	6.3608 6.2305	6.2670 6.1756
Czecho-Slovakian Linen	4.6897	5 25	4.7846 4.6714	4.8292 4.5411
Tebelized Linen Suiting	6.0259	5 25	6.0659 6.0716	6.4065 6.0990
Grey Cloth (Percale)	3.2701	5 25	3.4667 3.4679	3.4016 3.4484

*Average of 5 determinations

TABLE VI

YARN COUNT PER INCH

Fabric	Original		No. of Laund.	Laundered at 105°F		Laundered at 150°F	
	W*	F*		W*	F*	W*	F*
Dotted Swiss	78	58	5	80	59	81	59
			10	81	58	81	59
			25	81	59	81	59
Matelassé Organdy	98	85	5	106	84	109	84
			10	111	83	110	85
			25	108	83	111	86
Organdy	86	79	5	93	79	94	82
			10	94	80	95	80
			25	94	79	82	81
Plissé	114	96	5	119	91	121	92
			10	122	87	118	92
			25	120	86	122	89
Printed Percale	86	76	5	88	76	90	77
			10	88	77	90	77
			25	88	78	88	79
Tafetella	186	79	5	185	81	186	81
			10	181	80	182	80
			25	182	82	187	82
Indian Head	57	48	5	57	47	58	48
			10	57	47	57	48
			25	57	47	57	48
Voile	74	74	5	74	74	77	76
			10	76	74	73	76
			25	75	78	76	76
Salyna Cloth	50	42	5	50	41	51	42
			10	51	42	51	42
			25	51	43	51	43

*Average of 5 determinations

TABLE VI (cont.)

YARN COUNT PER INCH

Fabric	Original		No. of Laund.	Laundered at 105°F		Laundered at 150°F	
	W*	F*		W*	F*	W*	F*
Reeve Weave Cotton Suiting	70	81	5	69	83	71	83
			10	69	83	71	84
			25	69	83	70	82
Czecho-Slovakian Linen	47	42	5	48	43	47	45
			10	47	43	48	44
			25	47	44	47	43
Tebelized Linen Suiting	40	35	5	41	35	42	35
			10	41	35	41	35
			25	41	35	41	36
Grey Cloth (Percale)	89	77	5	89	79	91	79
			10	89	79	90	80
			25	90	80	90	81

*Average of 5 determinations

TABLE VII

TENSILE STRENGTH IN POUNDS AND

PERCENTAGE CHANGE IN LAUNDERING

Fabric	Original		No. of Laund.	Laundered at 105°F				Laundered at 150°F			
	W*	F*		W*	%	F*	%	W*	%	F*	%
Dotted Swiss	28.8	13.9	10	23.8	-17.4	11.3	-18.7	23.7	-17.7	9.6	-30.9
			25	25.1	-12.5	10.4	-25.2	24.0	-13.1	11.0	-20.9
Matelasse Organdy	22.2	17.8	10	21.7	- 2.0	17.7	- 0.5	23.0	- 3.6	17.5	- 1.6
			25	21.2	- 4.5	16.2	- 8.9	19.8	-15.3	16.0	-11.2
Organdy	28.1	20.0	10	26.0	- 7.47	18.0	-10.0	28.1	0	18.6	- 7.0
			25	25.4	- 9.6	16.3	-16.5	24.8	-11.73	18.6	- 7.0
Plisse	30.8	9.2	10	34.0	-10.4	10.8	-17.3	34.2	-11.03	13.8	-50.0
			25	30.2	- 1.94	11.5	-25.0	36.2	-17.5	13.5	-46.7
Printed Percale	39.8	31.4	10	40.3	- 1.25	28.9	- 7.96	39.5	- .75	22.4	-28.7
			25	40.7	- 2.26	25.1	-20.1	39.8	0	25.3	-19.4
Tafetella	79.3	28.2	10	68.2	-14.0	30.0	- 6.4	67.8	-14.5	23.1	-18.1
			25	64.0	-19.3	29.9	- 6.0	62.5	-21.2	25.8	- 8.5
Indian Head	52.5	32.0	10	56.1	- 6.8	33.2	- 3.75	53.8	- 2.5	32.8	- 2.5
			25	53.8	- 2.5	30.5	- 4.68	53.8	- 2.5	34.8	- 8.75
Voile	19.8	17.0	10	17.9	- 9.6	16.5	- 2.9	19.6	- 1.0	16.4	- 3.5
			25	18.8	- 5.1	15.9	- 6.5	18.5	- 6.6	16.1	- 5.3

Average of 5 determinations

TABLE VII (cont.)

TENSILE STRENGTH IN POUNDS AND

PERCENTAGE CHANGE IN LAUNDERING

Fabric	Original		No. of Laund.	Laundered at 105°F				Laundered at 150°F			
	W*	F*		W*	%	F*	%	W*	%	F*	%
Salyna Cloth	45.9	35.4	10	44.8	- 2.4	34.5	- 2.54	43.7	- 4.8	36.1	- 2.0
			25	41.9	- 8.7	33.7	- 4.8	43.3	- 5.9	35.2	- .6
Reeve Weave Cotton Suiting	79.2	67.8	10	72.8	- 8.1	67.2	- .9	76.8	- 1.8	63.4	- 6.5
			25	75.1	- 5.2	66.9	- 1.3	68.4	-13.6	61.0	-11.5
Czecho-Slovakian Linen	52.3	53.8	10	45.9	-12.23	66.4	-23.4	46.0	-12.0	60.9	-13.2
			25	46.8	-10.5	53.0	- 1.5	46.1	-11.9	46.5	-13.6
Tebelized Linen Suiting	67.2	40.3	10	67.4	- .3	39.4	- 2.2	64.8	- 3.6	46.8	-16.1
			25	59.0	-12.2	37.4	- 7.2	60.0	-10.7	43.9	- 8.9
Grey Cloth	41.4	32.2	10	38.5	- 7.0	27.3	-15.2	40.4	- 2.4	28.6	-11.2
			25	36.7	-11.4	28.9	-10.2	35.2	- 7.7	26.4	-18.0

*Average of 5 determinations

TABLE VIII

PERCENTAGE ELONGATION

Fabric	Original		No. of Laund.	Laundered at 105°F		Laundered at 150°F	
	W	F		W	F	W	F
Dotted Swiss	5.2	12.3	10	5.3	8.8	6.1	10.2
			25	5.3	10.1	5.4	11.0
Matelassé Organdy	13.2	21.6	10	10.3	17.6	10.9	20.0
			25	8.9	14.2	11.0	22.3
Organdy	6.8	7.0	10	6.7	10.3	6.7	11.2
			25	5.7	9.9	5.7	10.4
Plissé	19.3	22.4	10	18.7	23.4	18.8	26.2
			25	17.4	21.3	19.5	27.3
Printed Percale	6.4	20.1	10	7.3	16.6	7.7	16.5
			25	8.5	15.9	8.2	18.5
Tafetella	11.4	9.5	10	8.9	7.6	12.1	6.9
			25	10.8	8.1	9.9	7.3
Indian Head	6.0	17.9	10	5.7	18.6	7.0	19.9
			25	7.0	19.1	6.7	22.3
Voile	5.2	11.8	10	5.9	11.4	6.6	9.1
			25	5.6	11.8	6.4	12.7
Salyna Cloth	13.7	31.6	10	15.6	32.6	16.2	32.8
			25	15.7	35.0	18.3	37.8
Reeve Weave Cotton Suiting	3.6	14.8	10	3.7	14.1	5.3	16.6
			25	6.2	15.9	5.6	13.2
Czecho-Slovakian Linen	4.4	9.2	10	7.7	11.4	8.1	11.9
			25	7.7	11.8	7.4	11.6
Tebelized Linen Suiting	7.1	17.6	10	8.3	17.7	10.1	19.7
			25	9.1	19.9	8.7	19.8
Grey Cloth (Percale)	8.7	16.2	10	12.8	18.5	12.5	14.9
			25	12.9	17.6	13.8	18.6

TABLE IX

PERCENTAGE DIMENSIONAL CHANGE IN LAUNDERING

Fabric	No. of Laund.	Laundered at 105°F		Laundered at 150°F	
		W*	F*	W*	F*
Dotted Swiss	1	- .78	- .78	0	- .78
	5	0	-1.56	0	-1.56
	10	- .78	-2.34	0	- .78
	15	- .78	-2.34	0	-1.56
	25	- .78	-3.90	- .78	-1.56
Matelassé Organdy	1	+1.56	-1.56	+ .78	- .78
	5	+ .78	-3.91	+2.34	-2.34
	10	+2.34	+ .78	+1.56	+ .78
	15	+1.56	+ .78	0	- .78
	25	+1.56	+2.34	+1.56	-1.56
Organdy	1	+1.56	-5.47	0	-5.47
	5	0	-4.69	- .78	-7.80
	10	0	-6.25	- .78	-7.03
	15	0	-7.80	- .78	-7.03
	25	0	-7.03	-1.56	-5.47
Plissé	1	+1.56	-6.25	0	-5.47
	5	0	-7.03	0	-6.25
	10	+4.69	-1.56	+3.13	-2.34
	15	+2.34	-4.69	+3.91	-2.34
	25	+3.13	-4.69	+4.69	-4.69
Printed Percale	1	0	- .78	0	0
	5	-1.56	0	0	0
	10	- .78	-1.56	0	0
	15	0	0	-1.56	0
	25	- .78	-1.56	- .78	- .78
Tafetella	1	- .78	- .78	- .78	- .78
	5	-1.56	- .78	- .78	- .78
	10	-1.56	- .78	-3.13	- .78
	15	-2.34	- .78	-2.34	-1.56
	25	-2.34	-1.56	-2.34	-1.56
Indian Head	1	0	-2.34	- .78	-1.56
	5	- .78	-3.13	-1.56	-3.91
	10	0	-1.56	- .78	- .78
	15	0	-2.36	-1.56	-1.56
	25	0	-3.13	- .78	-1.56

*Average of 3 determinations

TABLE IX (cont.)

PERCENTAGE DIMENSIONAL CHANGE IN LAUNDERING

Fabric	No. of Laund.	Laundered at 105°F		Laundered at 150°F	
		W*	F*	W*	F*
Voile	1	0	-2.34	- .78	- .78
	5	- .78	-1.56	- .78	-2.34
	10	0	+ .78	- .78	-2.34
	15	0	- .78	- .78	-2.34
	25	- .78	-2.34	- .78	-2.34
Salyna Cloth	1	0	-3.13	- .78	-3.91
	5	-1.56	-1.56	-1.56	-4.69
	10	- .78	-3.13	-3.13	-1.56
	15	- .78	-3.13	-3.13	- .78
	25	- .78	-3.91	-3.13	-4.69
Reeve Weave Cotton Suiting	1	- .78	- .78	- .78	- .78
	5	- .78	- .78	- .78	-2.34
	10	- .78	-2.34	0	+ .78
	15	- .78	0	- .78	-1.56
	25	- .78	-1.56	- .78	- .78
Czecho-Slovakian Linen	1	- .78	0	- .78	+ .78
	5	-3.13	- .78	-2.34	- .78
	10	-2.34	0	-3.13	+ .78
	15	-2.34	0	-3.13	-1.56
	25	-3.13	0	-2.34	0
Tebelized Linen Suiting	1	0	- .78	- .78	-3.13
	5	0	-1.56	-2.34	-3.91
	10	- .78	-5.47	-1.56	-3.13
	15	- .74	-1.56	-2.34	-4.69
	25	0	-1.56	- .78	-1.56
Grey Cloth (Percale)	1	-2.34	- .78	-2.34	-3.13
	5	-3.13	-2.34	-3.13	-2.34
	10	-3.13	-2.34	-1.56	-2.34
	15	-3.19	-1.56	-1.56	-2.34
	25	-3.13	-2.34	-2.34	-2.34

*Average of 3 determinations

CREASE RESISTANT FABRICS

Tafetella*

Original

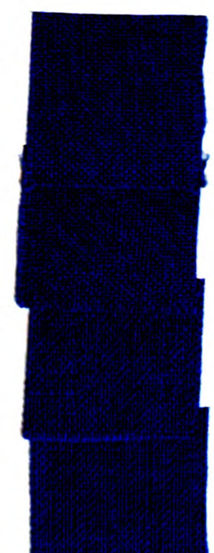
After Laundering
At 105°F   At 150°F

5
10
15
25

Indian Head*

Original

After Laundering
At 105°F   At 150°F

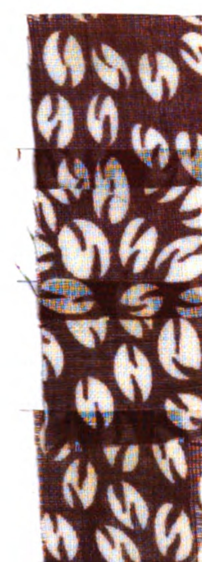


5
10
15
25

Voile*

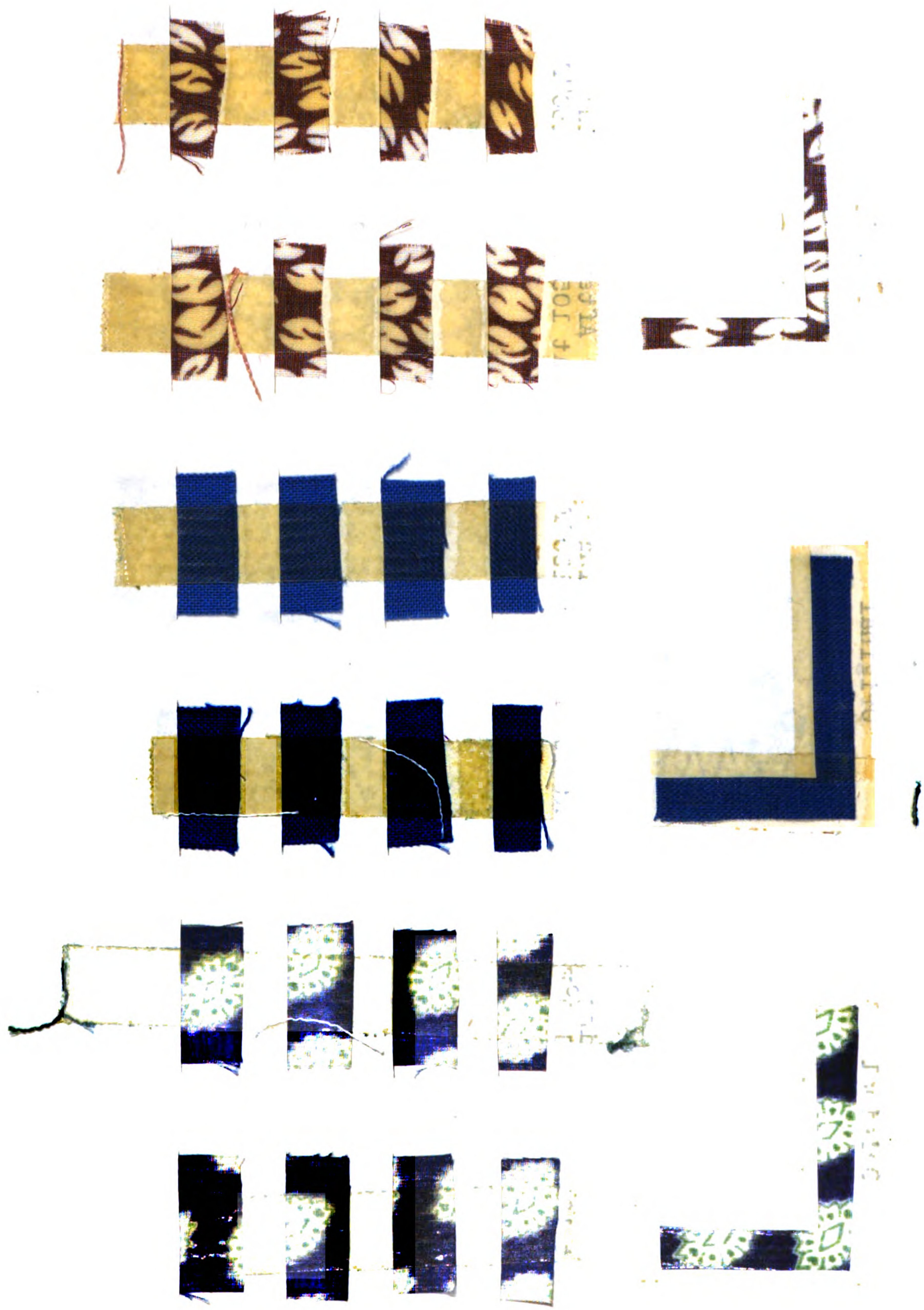
Original

After Laundering
At 105°F   At 150°F



5
10
15
25

*Also treated for dimensional stability



CREASE RESISTANT FABRICS

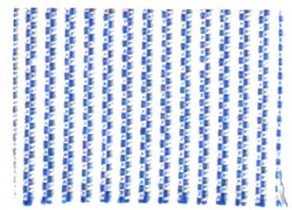
Salyna Cloth*

Original

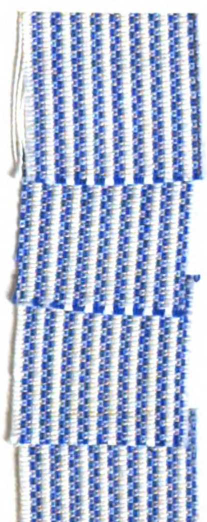
After Laundering
At 105°F At 150°F

5
10
15
25

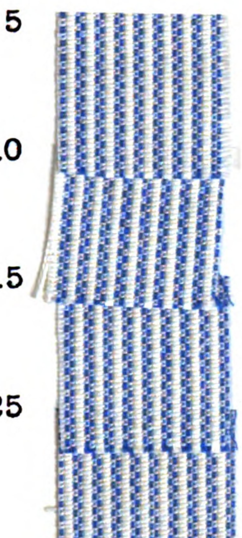
Reeve Weave*
Cotton Suiting
Original



After Laundering
At 105°F At 150°F

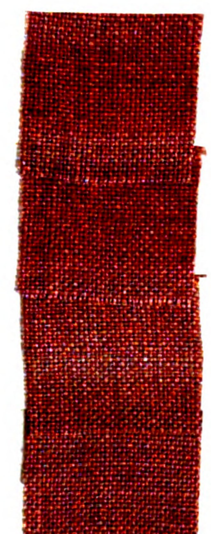


5
10
15
25



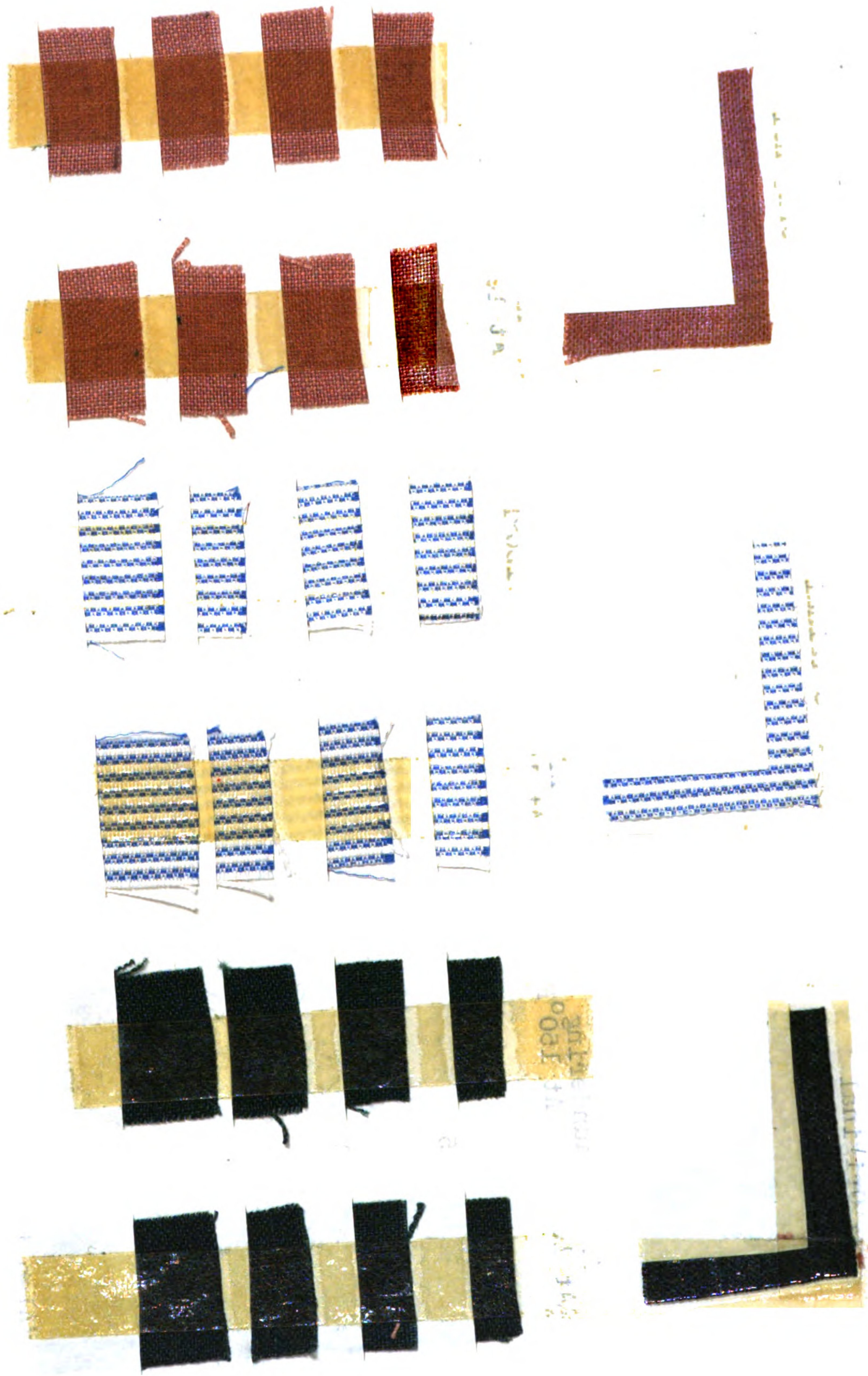
Czecho-Slovakian
Linen
Original

After Laundering
At 105°F At 150°F



5
10
15
25

*Also treated for dimensional stability



CREASE RESISTANT FABRICS

Tebelized Linen Suiting

Original

After Laundering
A5 $105^{\circ}F$ At $150^{\circ}F$

5

10

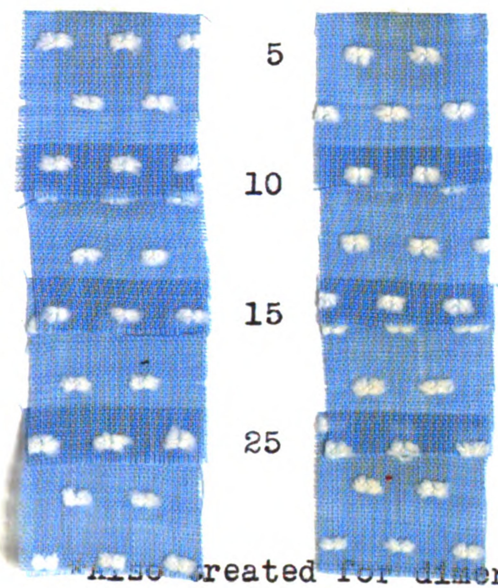
15

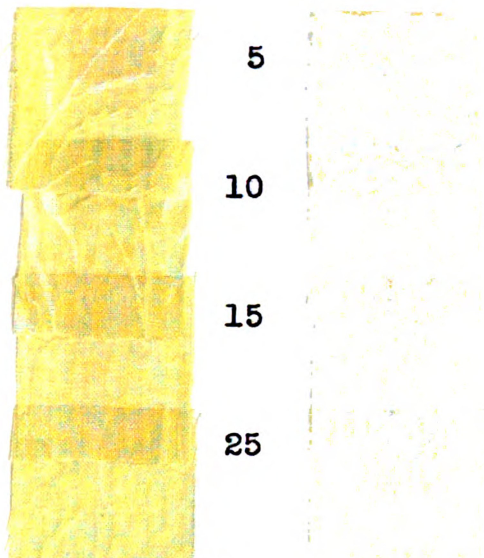
25

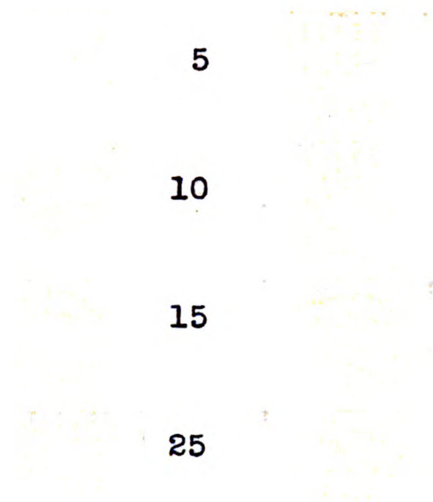
PERMANENT CRISP FABRICS

Dotted Swiss*	Matelasse Organdy	Organdy
Original	Original	Original

Dotted Swiss*		Matelasse Organdy		Organdy	
After Laundering		After Laundering		After Laundering	
At 105°F	At 150°F	At 105°F	At 150°F	At 105°F	At 150°F

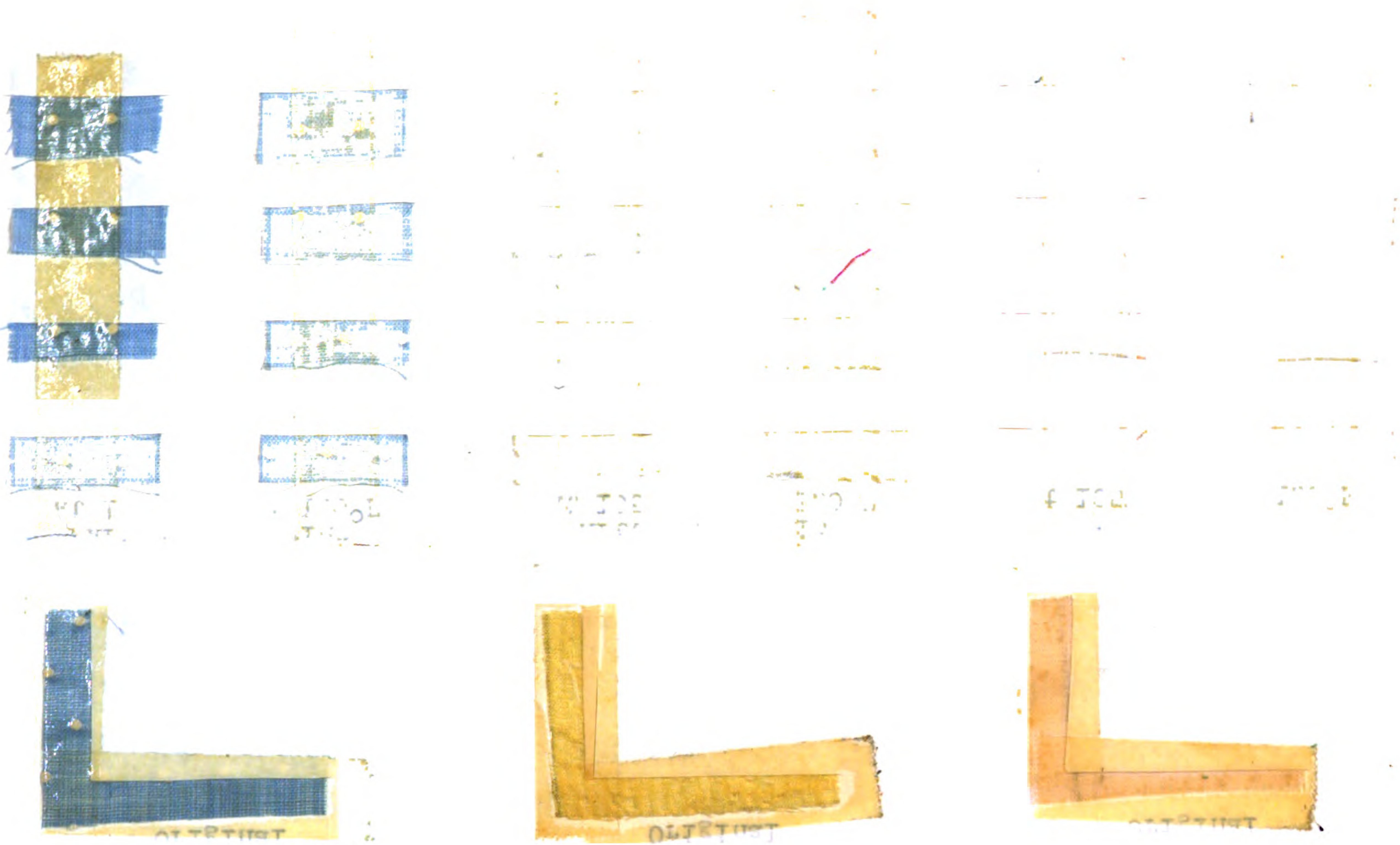






Dotted Swiss*	Matelasse Organdy	Organdy
5	5	5
10	10	10
15	15	15
25	25	25

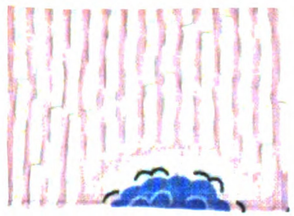
*Also treated for dimensional stability



PERMANENT CRISP FABRICS

Plisse

Original



After Laundering
At 105°F | At 150°F

5

10

15

25

Printed Percale

Original

After Laundering
At 105°F | At 150°F

5

10

15

25

Grey Cloth

Original

After Laundering
At 105°F | At 150°F

5

10

15

25

ROOM USE ONLY

Mr 10 '52

JE 11 '52

Jl 28 '52

Jl 28 '53

Ag 9 '53

Mr 15 '54

Feb 27 '56

Mar 12 '56

Aug 7 '56

Dec 10 '57

Jul 28 '58

~~NOV 3 '58~~ Paid