PHILLIPS, PENNY LYNNE. Surface Distortion Of Polyester Double Knit Fabrics Using A Rotary Abrasion Device. (1975) Directed By: Dr. Pauline E. Keeney. Pp 40.

Surface distortion of knit fabrics has received considerable attention from research personnel due to consumer complaints concernig excessive snagging and picking problems associated with the fabric. One reason for this problem of distortion of the surface of knit fabrics is the lack of an adequare test method to measure distortion propensity of a fabric before it is marketed. A second proposed reason is the effect of laundry temperature and technique on the polyester fiber structure. Another suggested reason is the effect of surface design.

The purpose of this study was to develop a test procedure to predict surface distortion propensity in polyester double knit fabrics. In order to test the effectiveness of the test procedure, the distortion propensity of different surface designs were investigated. Testing also included investigation of the effect of laundering temperature and technique on the surface distortion of the experimental fabrics.

The surface distortion apparatus developed for this study was a Taber Abraser Model E-4010 adapted with wire brush wheels instead of Calibrase or Calibrade wheels. A variac rheostat was used to slow the revolutions per minute from 69 down to 49 revolutions per minute.

The results of experimentation indicated that a rotary abraser of this type could be developed for the abrading of fabrics. Further experimentation might indicate that the number of cycles might be reduced to prevent immediate destruction of the fabric.

All samples were randomly tested on the surface distortion device. Each sample was placed individually on a grey peg board viewing apparatus with an overhead florescent light as the only source and evaluated on a rating scale of five to one. This rating scale was composed of five

separate samples of a plain white double knit fabric, that had been distorted to different degrees. A Class 5 indicated no surface distortion and a Class 1 indicated extreme surface distortion. So that each sample had a possibility of one to five scores.

All test fabrics were one hundred percent polyester, white, weft knits. The basis differences in the three fabrics were the surface design, which proved to be significant to surface distortion propensity to the .0001 level of confidence.

The experimental fabrics in this study were subjected to two different laundering techniques, machine and hand laundered. The difference in the effect of laundering techniques on evaluations of surface distortion were slightly significant at the .0006 level of confidence. It was observed that machine washed samples deteriorated slightly more than the hand washed samples.

The experimental fabrics in this study were subjected to four different laundry intervales, 0 (control), 1, 5, and 10 launderings. The difference in laundry intervals proved to be significant to the .0001 level of confidence. The only significant interaction was that between the fabrics and the laundering intervals.

SURFACE DISTORTION OF POLYESTER

DOUBLE KNIT FABRICS USING A

ROTARY ABRASION DEVICE

by

Penny Lynne Phillips

A Thesis Submitted to
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Approved by

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APPROVAL PAGE

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CHAPTER I

INTRODUCTION

In the last decade polyester double knit fabrics have become increasingly popular in apparel fashions. This popularity is due to the wearability, versatility and easy-care properties of polyester double knit fabrics. Polyester double knits have been used for fashion apparel ranging from women's coats, dresses, and pant suits to men's slacks and business suits. Factors such as the versatility in accepting a wide range of colors and the ability to achieve a variety in hand by the yarn and knit constructions contribute to the wearability. Since polyester double knit fabrics resist wrinkling in wear, can be machine or hand laundered when soiled, and do not need to be ironed after laundering, they are easy-care fabrics.

The popularity of polyester knits has been achieved in spite of characteristics which limit their acceptability in consumer use. A major disadvantage of knit fabrics is the inherent tendency of the fabric to become roughened or distorted by being brushed against or caught on a rough surface causing unsightly picks and snags. These surface distortion effects detract from the appearance of a garment, causing it to look worn and old. Such surface damage which can occur in relatively new garments tends to reduce the value of the apparel item. Hence, the problem is of particular concern to manfacturers of polyester knit manufacturers of polyester knit fabrics.

Surface distortion of knit fabrics has received considerable attention from research personnel. A report of the American Association of Textile Chemists and Colorists indicated the importance of surface distortion of knit fabrics by ranking the processing of knit fabrics with no snags as "one of the five trouble spots plaguing textile chemical treatment and finishing."[1]

Factors contributing to this distortion have been related to the fiber properties, yarn type, fabric design, and also to the effects of laundering temperatures and techniques on the fiber and fabric structures. Related to these changes in physical characteristics is the inability to anticipate the fabric performance in consumer use. Neither testing equipment nor procedures have been effective in predicting the various forms of surface distortion. The need for laboratory techniques which simulate wear action has been cited as an area of concern for the textile industry.

STATEMENT OF THE PROBLEM

This study has been designed to investigate the problem of surface distortion of selected polyester knit fabrics and to attempt to develop a method of predicting and evaluating surface distortion.

Objectives

The objectives of this study were to:

1. Develop a testing procedure to predict and evaluate surface distortion propensity in polyester double knit fabrics.

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[1]American Association of Textile Chemists and Colorists, Special Report, "Zeroing In On Five Top Trouble Spots," Textile World, CVIII (October, 1971), 4, 66, 69.

2. Test the effectiveness of the instrument and procedure on different surface designs of polyester knit fabrics.

3. Determine the effect of laundering temperatures and techniques on the surface distortion of the experimental fabrics.

Limitations

The study was limited in the following ways:

1. A testing device was adapted from a Taber Abraser Model E-4010 equipped with a Variac rheostat.

2. Three polyester double knit fabrics were selected for experimentation as being representative of fabrics in consumer use.

3. The treatments of the fabrics were limited to home laundering procedures similar to those in consumer use.

Assumptions

In this study it was assumed that:

1. Fabrics would show effects of distortion.

2. Fabric distortion is a characteristic which can be evaluated.

Hypotheses

The hypotheses of this study stated in the null form, were:

1. There was no significant difference at the .001 level of confidence in surface distortion among the three fabrics.

2. There was no significant difference at the .001 level of confidence in the surface distortion of the fabrics subjected to the three laundering treatments.

3. There was no significant difference at the .001 level of confidence of interaction between fabrics and treatments.

DEFINITION OF TERMS

The terms defined for this study are as follows:

Surface distortion. Abrasion of the fabric resulting in picking and/or snagging of the fabric surface.

Picking. Breaking of the individual fibers.

Snagging. Extraction of an entire weft yarn.

Double knit. Knit fabric in which a weft yarn is interlocked with loops in the preceding row to form a fabric.

Surface Distortion Evaluation. Measurement of the extent to which the surface of the fabric was abraded.

CHAPTER II

REVIEW OF LITERATURE

Review of the Problem of Surface Distortion

The problem of surface distortion is best defined by Aly El-Shiekh "as a phenomenon that occurs when a number of filaments in the yarn or even a whole yarn are pulled away and stand away from the surface of the knit fabric."[2] Several theories have been suggested in regard to the problem of distortion in polyester double knits. The surface distortion problem is influenced by many variables, namely; fiber, yarn construction, knit construction, finishes, effect of laundering and test procedures. Since each of these factors influence surface distortion each must therefore be discussed separately.

Theories of Causes of Surface Distortion

Snagging, picking and pulled yarns are weaknesses in polyester fabrics caused largely by the inherent strength of the fiber. Polyester is a fiber with tenacious strength which, when pulled requires excessive strain to break it loose from the fabric. Often the pulled fiber needs to be cut because strain on the fiber will cause the entire to be pulled out of the fabric construction. This is in oppostion to the pulling of

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[2]Aly El-Shiekh, "The Snag Behavior of Knitted Fabrics," First Annual Report to the National Science Foundation (Grant GK 32012), January, 1972 - January, 1973, 1.

a weaker fiber, such as wool, which would break and fall from the surface of the fabric.

Most polyester fibers that are manufactured are smooth and cylindrical in shape. As Brunnschweiler stated "smooth cylindrical fibres are apt to work their way to the fabric surface."[3] Once on the surface the fiber can easily become caught, causing an unsightly snag.

Polyester double knit are composed mostly of filament yarns. Therefore, when a filament is pulled it causes tight threads or "shiners"[4] as Peter Lennox-Kerr states in his research. James Blore suggested at a Textile and Apparel Seminar that this problem would be eliminated if polyester double knits were made with spun yarns instead of filament yarns.[5] The reason being that the yarn would break before a shiner could be formed.

Other theories stated by Aly El-Shiekh are that "snagging potential decreases as yarn twist decreases and as yarn rigidity (denier /fil) increases."[6] To combine all three theories about yarn construction the best possible yarn for polyester double knits would be a bulkier, spun, low-twist yarn.

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[3]E. Brunnschweiler, "Pilling - Causes, Methods of Control, and Testing." Ciba Review, XI (September, 1958), 34-36.

[4]Peter Lennox-Kerr, "Snag Tester For Double Knits," Textile Industries, CXXXIV, No. 10 (October, 1974),125-126.

[5]James H. Blore, "Snagging of Textured Polyester Double Knits," Modern Knitting Management, L (May, 1972), 34-35.

[6]El-Shiekh, op. cit., pp. 152-153.

The knit construction is an important variable in the problem of surface distortion with polyester double knit fabrics. Peter Knickerbocker,[7] R.E.Read,[8] and Charles Reichman[9] reported in their separate articles that knit construction alone will stop the problem of snagging. It has been suggested that a fabric with alternating high ridges and low indentions allows for protruding areas to exist. These areas can easily be caught on rough surfaces. The problem becomes more noticeable on a multi-color design because the broken fibers may over lap another color. It was reported by Saul Helfgott that the loose stitch knit patterns are the designs that are snag potential.[10] The most hazardous construction is the "Plain Jersey face stitches"[11] according to James Blore. It could therefore be established that the surface distortion of polyester double knits could be reduced with the use of better knit constructions being utilized.

Polyester double knit fabrics were in large scale production when the problem of surface distortion appeared as a consumer complaint,

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[7]Peter Knickerbocker, "Outlook For Knits 1973 - 1974," Knitting Industry, XCIII (January, 1973), 46, 85.

[8]R.E. Read, "A New Snag Tester," Sources and Resources, VI, No. 3 (1973), 37.

[9]Charles Reichman, "Men's Wear Cutters Surmount Initial Fabrication Obstacles," Knitting Times, XLI (March 13, 1972), 44-45, 80.

[10]Saul Helgott, "Anti-Snag Finishes For Polyester Knits." American Dyestuff Reporter, LXI (July, 1972), 27-30.

[11]James K. Blore, "How To Stop Snagging Of Textured Polyester Double Knit Fabrics," Knitting Times, XL (August 9, 1971), 50-51.

as reported by Tony Shaw.[12] Therefore, manufacturers with large inventories of distortion prone polyester fabric began to look to researchers to find a finish to reduce the distortion quality of the fabric. Many researchers such as Aly El-Shiekh,[13] J.A. Finnigan,[14] and R.E. Read[15] have described the problems of surface distortion and proclaimed a need for a finish to be quickly devised which would save the polyester double knit industry. H.E. Bille more readily defined what kind of finish was needed, this finish "was to improve the cohesion of the individual fibers in the yarn in such a manner that the fibers were locked in place against each other without affecting the handle of the goods."[16] Saul Helfgott reported on the MaceGard Finish that would "eliminate the snagging potential of knit goods, be durable to repeated washings and drycleanings, have a minimum effect on the esthetic properties of the polyester, and be easy to use."[17] This finish seemed to be what the textile industry was seeking.

When a finish is marketed that does eliminate surface distortion, the finish will have to be able to withstand laundering cycles. As Saul

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12Tony Shaw, "Meeting: Committee RA84 Knit Fabrics, Chairman's Report," Sources and Resources, VI, No. 3 (1973), 36.

13El-Shiekh, op. cit., pp. 152-153.

14J.A. Finnigan, "Laboratory Prediction Of the Tendency Of a Fabric To Snag During Wear." Textile Institute and Industry, X (June, 1972), 164-167.

15Read, Loc. cit.

16H.E. Bille, W. Thonig, and G. Schmidt, "Comparing Chemical Finishing Of Knit and Woven Goods," American Dyestuff Reporter, LXI (October, 1972), 56, 66

17Helfgott, Loc. cit.

Helfgott stated in his article "some fabrics with little snag-potential initially had a great snag-potential after being washed or drycleaned several times."[18] It seems that polyester fibers lose the cohesive quality with the agitation of the laundering process which makes the fabric more surface distortion prone.

Test Methods For Surface Distortion

Many of the articles written by textile research personnel concerning polyester double knit fabrics concluded their articles by expressing a need for standardized test instruments and procedures. Presently there are three types of surface distortion devices on the market. The first device is the Mace Tester. This device tests only for snagging propensity and not picking. The Mace tester has been considered to be too severe for correlation with wear-tested garments. The second instrument is the J.C. Penney Tester. This device seems most valuable in testing the picking characteristics of a fabric. This instrument is considered too mild to show a real wear-test correlation. The third device is the DuPont Snag Tester. This instrument has been on the market a short time, therefore, little information has be reported as to its effectiveness in use. All three types of devices can test one fabric direction at a time. Since abrasion of garments occurs in lengthwise, crosswise and diagonal directions simultaneously, it seems that an instrument which would indicate distortion of this type would be of value in

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[18]Saul Helfgott, "Finishes For Polyester Knits," Knitting Industry, XCIII (July, 1972), 26-27, 64.

fabric evaluation. Michael Feltser,[19] R.E. Read,[20] and Otto S. Young[21] protested that there is still no test procedure that can effectively duplicate expensive wear testing. Ally El-Shikh stated "the first requirement to solve this problem is to establish a rapid laboratory method of snag testing which can be correlated to wear test results."[22] James Alexander believes "that the variability in results is most likely due to differences in the evaluation of ratings, rather than differences in testing conditions, although either can be a valid reason for the differences."[23] Therefore, it is essential that an adequate test method be established before the problem of surface distortion of polyester double knits can be solved.

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[19]Michael Feltser, "Testing For Quality and Performance," Modern Knitting Management, L (May, 1972), 64.

[20]Read, Loc. cit.

[21]Otto S. Young, "Time To Check Your Knit-ventory," Knitting Times, XLI (March 13, 1972), 57.

[22]El-Shiekh, op. cit., p.11.

[23]James Alexander, "Task Group, Snagging Of Knit Fabrics," Sources and Resources, V, No. 9 (1972), 8-9.

CHAPTER III

PROCEDURE

This study was planned to develop a procedure to predict surface distortion propensity in polyester double knit fabrics by adapting the Taber Abraser Model E-4010. In order to test the effiveness of the instrument, the distortion propensity of different surface designs were investigated. Testing included investigation of the effect of laundering temperatures and techniques on the surface distortion of the experimental fabrics.

Description of the Fabrics

The fabrics used in this study were purchased at a retail cloth store as a consumer would usually purchase fabric. Therefore, the manufacturers and special finishes or treatments that may have been applied to the fabrics, were not known. All fabrics were white in color and one hundred percent polyester weft double knits.

The fabrics were marked off in thirty-six, six and one half inch squares, then marked with a number from one to thirty-six in indelible ink. The samples squares were chosen for each of four groups by a table of random numbers.

Description of Laundering Techniques

The fabrics for this study were laundered by two different techniques. Both machine washing and hand washing procedures were similar to cleaning procedures which would be used by consumers.

1. The machine washed samples were washed in a General Electric Filter Flo 14 washing machine at 140±5 degrees F (60±3 degrees C) temperature. The fabrics were washed on the Permanent Press cycle with a wash cycle of twelve minutes, a spin sysle of four minutes, a rinse cycle of five minutes, with a final spin cycle of four minutes. They were dried in a General Electric dryer with an exhaust temperature ranging between 140 and 160 degrees F (60 and 71 degrees C) for one half hour.

2. The hand washed samples were washed at 105± 5 degrees F (41±3 degrees C) with mild hand agitation for one half hour, and dried at room temperature.

The laundered samples in each procedure were washed with ninety grams of a commercial detergent. After the first and fifth wash, fabric was added to provide weight equal to the original load level.

Description of the Surface Distortion Device

The surface distortion device adapted for this study was a Taber Abraser Model E-4010. The decision to adapt the Taber Abraser Model E-4010 was based on the premise that the machine could test fabric in all directions of grain simultaneously.

Description of Test Procedure

The test procedure for this experiment was as follows:

1. The fabrics were marked off in 36, six and one half inch squares, then marked with a number from one to 36 in indelible ink. The sample squares were chosen for each of four test groups by a table of random numbers. A test group was composed by the number of launderings

the fabric sample was to receive. Each fabric in Group 1 (the control or unlaundered group,) was tested for surface distortion characteristics. The fabrics in Group 2 were laundered once; Group 3 were laundered five times; Group 4 were laundered ten times prior to testing surface distortion characteristics. There were three replications within each Group of samples.

2. All 72 samples (24 of each fabric) were tested in random order on the surface distortion device.

3. Each test specimen received ten complete revolutions on the surface distortion device.

4. After the testing was complete, the samples were evaluated randomly.

Description of the
Evaluation Method

The evaluation method for this study was conducted by random selection of the samples. The samples were judged by a panel of graduate students in textiles who were unaware of the hypotheses or testing procedures. Each sample was placed individually on a gray peg board viewing apparatus with an over head florescent light as the only light source. The samples were evaluated on a rating scale of five to one. This rating scale was based on five separate samples of a plain white double knit fabric, that had been distorted to different degrees. A five rating indicated no surface distortion while a rating of one indicated extreme surface distortion. Therefore, each sample had a possibility of one of five scores.

Treatment of the Data

Analysis of variance was used to determine significant differences at the .001 percent level of confidence to confirm or reject the hypotheses stated in the introduction.

A 3 x 2 x 4 factorial design was used to determine significant differences within the fabrics, the laundering techniques, the four laundering groups, and interactions of these major variables.

CHAPTER IV

RESULTS OF EXPERIMENTATION

The purpose of this study was to develop a test procedure to predict surface distortion propensity of double knit fabrics. The distortion propensity of different surface designs were investigated, in order to determine the effectiveness of the test procedure. Testing also included the effect of laundering temperatures and techniques on the surface distortion of the experimental fabrics.

DEVELOPMENT OF THE TESTING DEVICE

Rotary motion was considered likely to produce surface distortion effects more closely resembling types of surface damage encountered in consumer use than instruments currectly used to evaluate fabric damage. A Taber Abraser Model E-4010 was considered as an instrument which might provide such rotary motion.

Adapting the instrument to this purpose srquired experimentation with various abrasives. The Calibrase and Calibrade wheel usually used with the instrument were sufficiently abrasive to distort the surface of the fabric but failed to produce the characteristic snags, picks, or shiners. Sandpaper of courser grain than the abrasive wheels was considered. Difficulty was encountered in attaching the sandpaper to the wheels with the permanence necessary for the abrading of the fabrics. A nylon tape fastener used for apparel plackets and closures of various was another abrasive considered. The barbed side of the tape would have produced the desired types of distortion except that this abrasive also was difficult to attach to the surface of the wheel with the permanence necessary for the number of cycles needed for abrasion. The abrasive action which proved to be adaptable and functional was the substitution of wire sanding wheels for the Calibrase or Calibrade wheels. These wire wheels were the same diameter as the Calibrase wheels and were fitted to the machine with brass collars. The instrument equipped with the wire wheels is shown as Figure 1.

Preliminary experimentation indicated that the normal speed of the Abraser was too rapid and the individual wires could not penetrate below the surface of the fabric. A Variac rheostat usually used with the vacuum attachment was connected to the instrument to reduce the speed from approximately 69 to 49 revolutions per minute. Ten cycles likely to produce the desired surface distortion effects.

LABORATORY ANALYSIS OF EXPERIMENTAL FABRICS

Fabrics with three different surface constructions were selected for this study. Fabric A had a crepe effect. Fabric B was of a weft rib surface construction and Fabric C had a waffle effect. A laboratory analysis of the three fabrics is shown in Table I.

The fabrics were similar in wales per inch, denier, and filament count but differed in courses per inch, needle gauge and weight per square yard. All fabrics were white so that neither color nor applied surface design would affect the visual evaluation.

Figure 1
Taber Abraser Model E-4010
With Wire Wheels

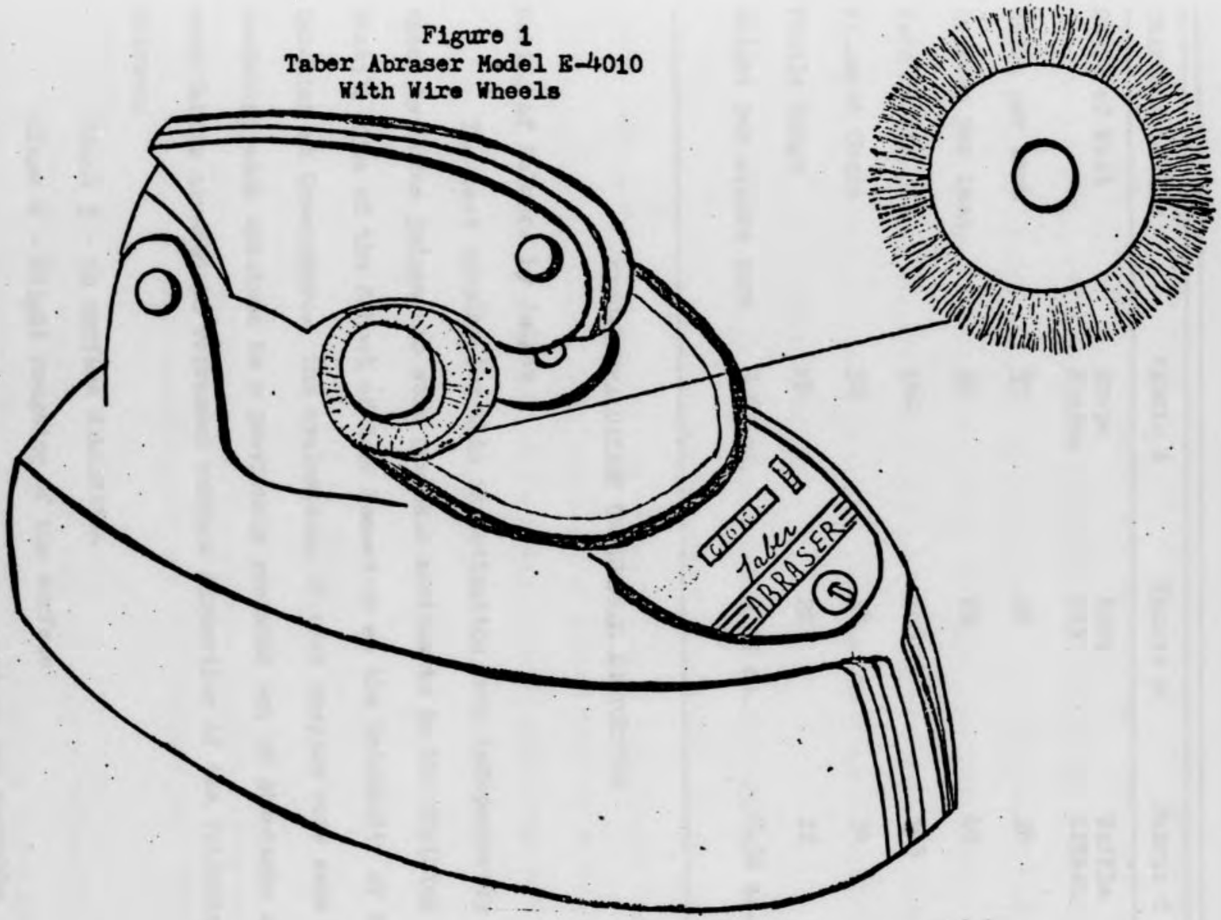

Table 1

Fabric Construction Comparison

Characteristics	Fabric A	Fabric B	Fabric C
Style of Knit	Crepe Finish	Weft Rib	Waffle Effect
Wales per inch	33	28	28
Courses per inch	50	28	48
Yarn Denier	160	166	163
Filament Count	30	34	34
Needle Gauge	28	22	22
Weight per square yard	8.85 oz.	9.59 oz.	8.32 oz.

VISUAL EVALUATION OF SURFACE DISTORTION

Rating of Fabrics by Judges

The test samples for this investigation were independently evaluated by three judges who were graduate assistants in the Clothing and Textile Area of the School of Home Economics at the University of North Carolina at Greensboro. The evaluations of test samples were made by comparing each specimen to a previously prepared set of standards of each fabric abraded to represent surface distortion of the following classes:

Class 5 - No surface distortion

Class 4 - Slight roughing of the surface

Class 3 - Noticeable roughing of the surface but wearable

Class 2 - Objectionable distortion (snagging and picking and shiners evident - wearability affected)

Class 1 - Extreme surface distortion (garment no longer wearable)

The judges differed in their opinions of the surface distortion, as can be seen in Table 2. Judge 1 was less critical than Judge 2 and 3, awarding a total of 29 Class 4 ratings as compared to the 7 and 4 Class 4 ratings given by Judges 2 and 3, respectively. Judge 3 was the most critical of surface appearance, noting the specimens with extreme distortion (Class 1) as compared with 12 and 17 specimens placed in this category by Judges 1 and 2 respectively. None of the judges considered the fabric worthy of a Class 5 rating.

The mean ratings of the three judges over all hand and machine launderings at each interval are presented in Table 3. It can be seen from these mean ratings of the three replicates of each fabric that ratings given by Judge 1 were consistently higher than those of the other two judges. The mean of all (72) ratings given by each judge are compared in Figure 2. These mean ratings of 2.9 for Judge 1; 2.5 for Judge 2; and 2.4 for Judge 3 indicate the differences.

DIFFERENCES IN FABRICS FOLLOWING SURFACE DISTORTION

There were differences in the surface distortion effects of the three fabrics prior to laundering and overall intervals and laundering methods.

The surface distortion of the fabrics prior to laundering was less evident on Fabrics A and B (mean ratings of 3.6 and 3.5 respectively than on Fabric C, the waffle construction. The surface rating on this

Table 2

Ratings Of Three Judges

	JUDGES	HAND LAUNDERINGS					MACHINE LAUNDERINGS				
		0	1	5	10	M	0	1	5	10	M
Fabric A	1	4.0	4.0	3.3	3.0	3.8	4.0	3.7	3.7	3.3	3.9
	2	3.3	3.0	2.7	3.0	3.0	3.7	3.0	2.7	2.3	2.9
	3	3.3	3.0	3.0	2.7	3.0	3.3	3.0	2.3	2.3	2.6
Fabric B	1	4.0	3.7	3.7	3.3	3.7	4.0	3.7	3.3	3.3	3.7
	2	3.3	3.2	3.0	2.0	2.8	3.3	3.7	2.7	1.7	2.9
	3	3.3	2.7	2.7	1.3	2.5	3.3	2.3	2.0	1.3	2.2
Fabric C	1	1.7	1.7	2.0	1.0	1.8	2.0	1.7	1.0	1.0	1.4
	2	2.0	1.7	1.3	1.0	1.5	2.0	1.3	1.0	1.0	1.3
	3	1.3	1.7	1.0	1.0	1.2	1.3	1.0	1.0	1.0	1.3

Table 3

Ratings Of Surface Distortion Of Fabrics

Before and After Laundering

		Ratings of Judges							
		Hand Laundered				Machine Laundered			
		1	2	3	Mean	1	2	3	Mean
Fabric A		4	3	3	3.3	4	4	3	3.6
		4	4	3	3.6	4	4	3	3.6
Interval	0	4	3	4	3.6	4	3	4	3.6
		4	3	3	3.3	4	3	3	3.3
		4	3	3	3.3	4	3	3	3.3
	1	4	3	3	3.3	3	3	3	3.0
		4	3	3	3.3	4	2	2	2.6
		3	3	3	3.0	4	3	2	3.0
	5	3	2	3	2.6	3	3	3	3.0
		3	3	2	2.6	4	2	2	2.6
		3	3	3	3.0	3	3	2	2.6
	10	3	3	3	3.0	3	2	2	2.3
Fabric B		4	3	3	3.3	4	3	4	3.6
		4	4	3	3.6	4	4	3	3.6
	0	4	3	4	3.6	4	3	3	3.3
		4	4	2	3.3	4	3	2	3.0
		4	3	3	3.3	3	3	2	2.6
	1	3	3	3	3.0	3	4	3	3.3
		4	3	2	3.0	4	3	2	3.0
		4	3	3	3.3	3	3	2	2.6
	5	3	3	3	3.0	3	2	2	2.3
		4	2	1	2.3	4	1	1	2.0
		3	2	2	2.3	3	2	1	2.0
	10	3	2	1	2.0	3	2	2	2.3

Table 3 (continued)

Ratings Of Surface Distortion Of Fabrics

Before and After Laundering

	Ratings of Judges							
	Hand Laundered				Machine Laundered			
	1	2	3	Mean	1	2	3	Mean
Fabric C	2	2	1	1.6	2	2	1	1.6
	2	2	1	1.6	2	2	1	1.6
Interval 0	1	2	2	1.6	2	2	2	2.0
	2	2	1	1.6	2	2	1	1.6
	2	1	2	1.6	2	1	1	1.3
1	1	2	2	1.6	1	1	1	1.0
	2	1	1	1.3	1	1	1	1.0
	2	1	1	1.3	1	1	1	1.0
5	2	2	1	1.6	1	1	1	1.0
	1	1	2	1.3	1	1	1	1.0
	1	1	1	1.0	1	1	1	1.0
10	1	1	1	1.0	1	1	1	1.0

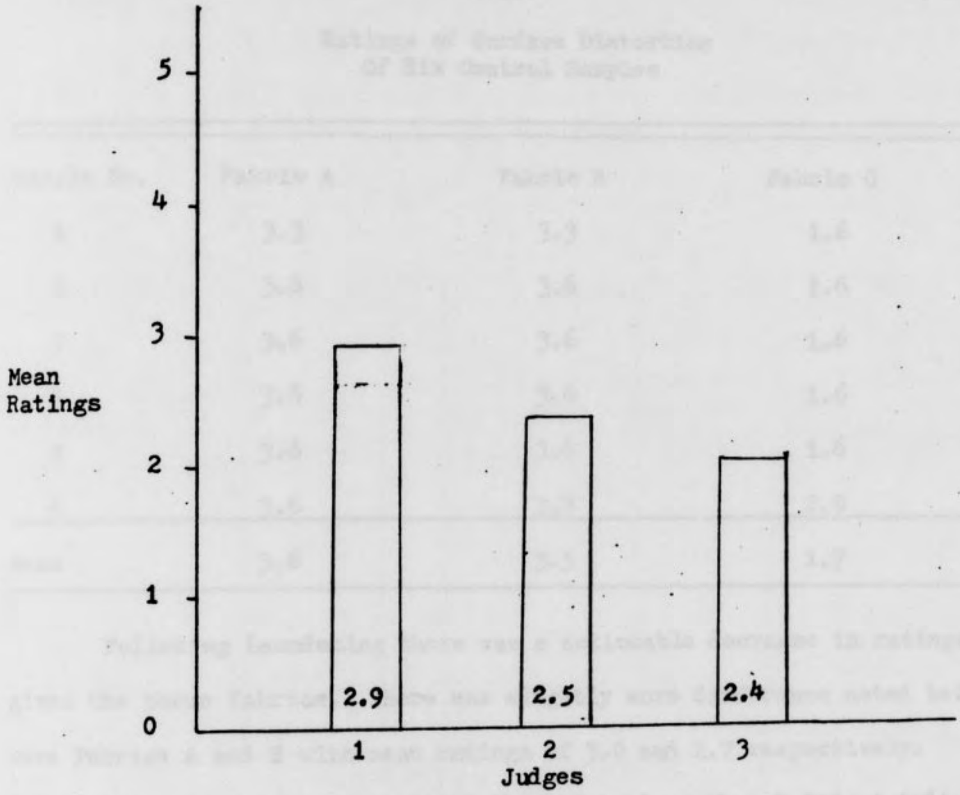

Figure 2

Comparison of Mean Ratings of Judges
(Overall Laundering Treatments and Intervals)

fabric was 1.7. The evaluation of surface distortion of control (unlaundered) samples is recorded in Table 4 and Figure 3.

Table 4

Ratings of Surface Distortion
Of Six Control Samples

Sample No.	Fabric A	Fabric B	Fabric C
1	3.3	3.3	1.6
2	3.6	3.6	1.6
3	3.6	3.6	1.6
4	3.6	3.6	1.6
5	3.6	3.6	1.6
6	3.6	3.3	2.0
Mean	3.6	3.5	1.7

Following Laundering there was a noticeable decrease in ratings given the three fabrics. There was slightly more difference noted between Fabrics A and B with mean ratings of 3.0 and 2.7 respectively. Fabric C received more Class 2 and Class 1 ratings than Fabric A indicating noticeable surface distortion differences not evidenced in the mean scores. Fabric C, again, showed objectionable surface distortion with a mean rating of 1.3. No Class 4 or 3 ratings were given to this fabric at any laundering interval.

EFFECT OF LAUNDERING ON SURFACE DISTORTION

One objective of this study was to investigate the effects of laundering methods on surface distortion propensity. The two laundering

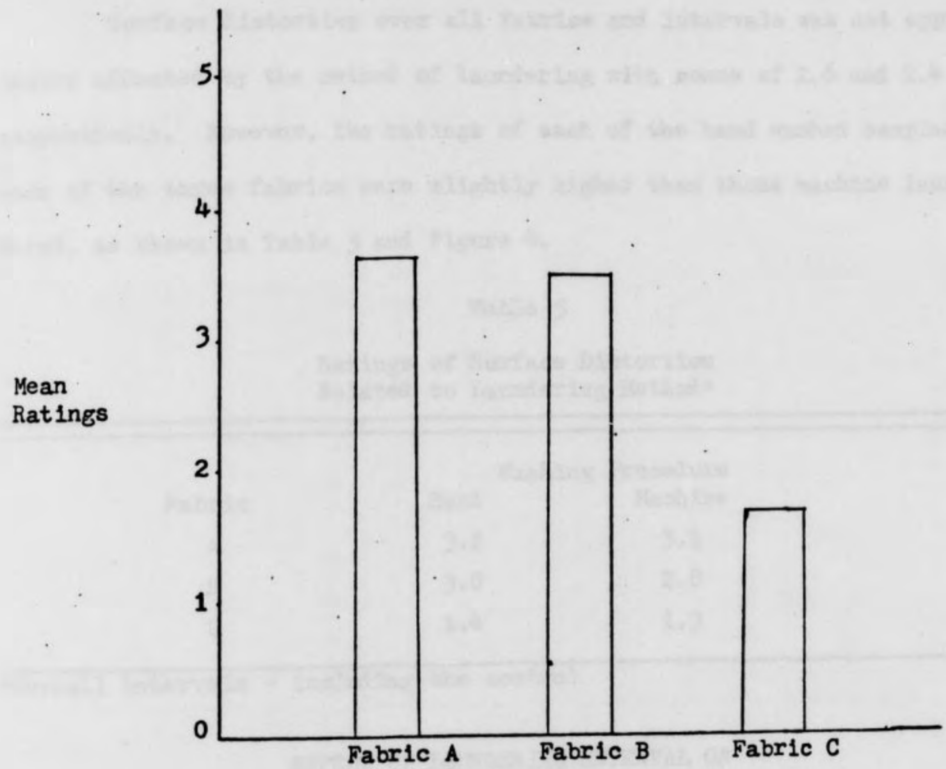

Figure 3

Comparison of Surface Distortion
of Control Samples

methods observed were machine washing with a temperature range of 140 to 160 degrees F (60 to 71 degrees C) and hand washing with a temperature range of 105 $\pm$ 5 degrees F (41 $\pm$ 3 degrees C).

Surface distortion over all fabrics and intervals was not appreciably affected by the method of laundering with means of 2.6 and 2.4 respectively. However, the ratings of each of the hand washed samples of each of the three fabrics were slightly higher than those machine laundered, as shown in Table 5 and Figure 4.

Table 5

Ratings of Surface Distortion
Related to Laundering Method*

Fabric	Washing Procedure Hand	 Machine
A	3.2	3.1
B	3.0	2.8
C	1.4	1.3

*Overall intervals - including the control

EFFECT OF LAUNDERING INTERVAL ON SURFACE DISTORTION

Four different laundering intervals were investigated in this study. The intervals were 0(control), 1, 5, and 10 launderings. Test data shows that progressive laundering did influence the surface distortion propensity of the polyester double knits.

As would be expected, surface distortion over all fabrics and launderings methods was more evident as launderings and cycles of abrasion were increased. Mean ratings decreased from approximately 2.6 at the first laundering to 2.0 at the tenth interval. The results of the

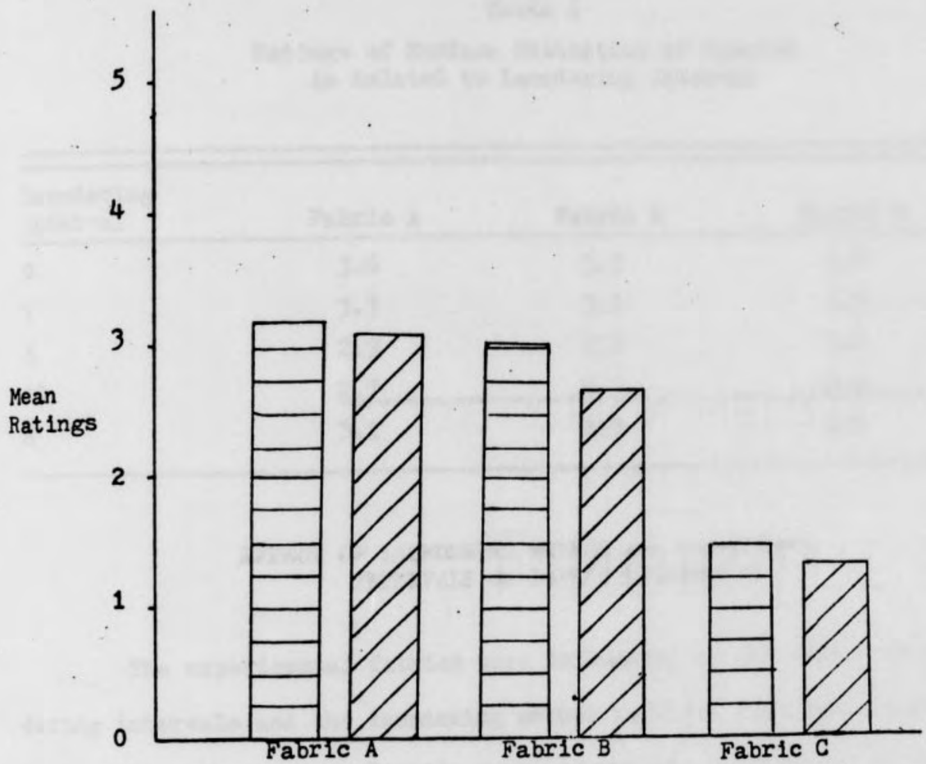

Figure 4
Comparison of Surface Distortion
Related to Laundry Method

Key
Hand Laundered
Machine Laundered

judges ratings related to laundering intervals is shown in Table 6 and Figure 5.

Table 6

Ratings of Surface Distortion of Fabrics As Related to Laundering Interval

Laundering Interval	Fabric A	Fabric B	Fabric C	$\bar{M}$
0	3.6	3.5	1.7	3.0
1	3.3	3.1	1.5	2.6
5	2.9	2.9	1.2	2.2
10	2.7	2.2	1.1	2.0
$\bar{M}$	3.1	2.9	1.4	

EFFECT OF LAUNDERING METHOD AND LAUNDERING INTERVALS ON FABRIC DISTORTION

The experimental fabrics were influenced by the number of laundering intervals and the laundering method to which they were subjected. Each of the fabrics was slightly more susceptible to abrasion if machine washed than if hand washed. Also, increased number of launderings resulted in lower visual evaluation ratings. All the fabrics received higher ratings if subjected to hand washings and a minimum number of launderings. The mean ratings comparing surface distortion related to fabric, laundering method, and laundering interval is shown in Table 7 and Figure 6.

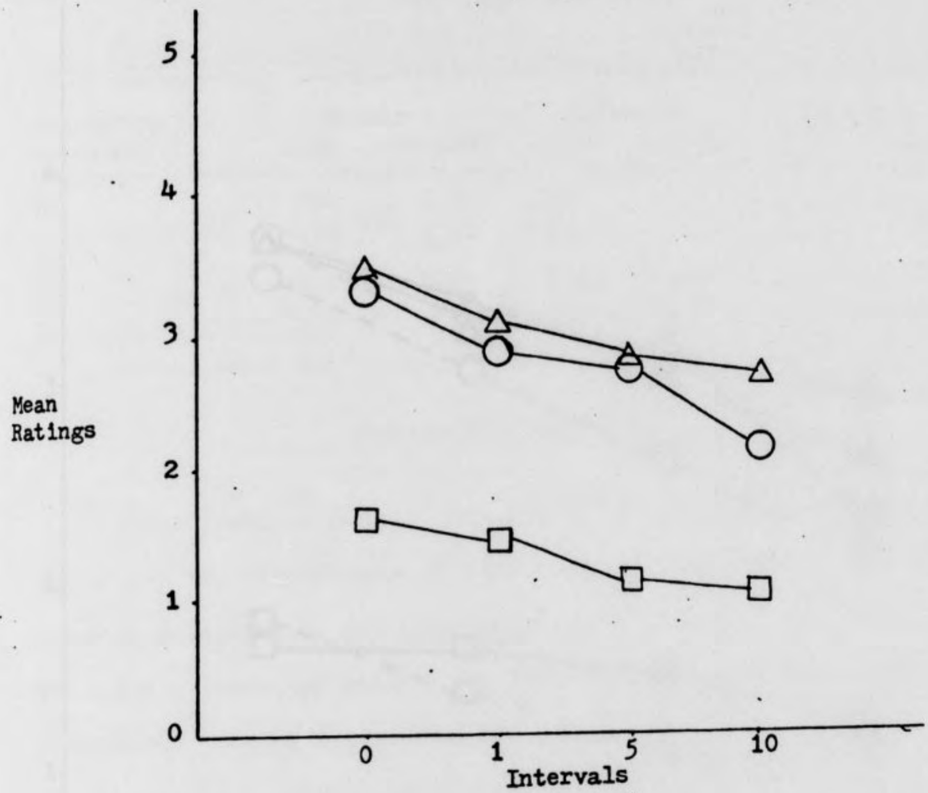

Figure 5
Comparison of Surface Distortion
Related to Laundry Intervals

Key
Fabric A △
Fabric B ○
Fabric C □

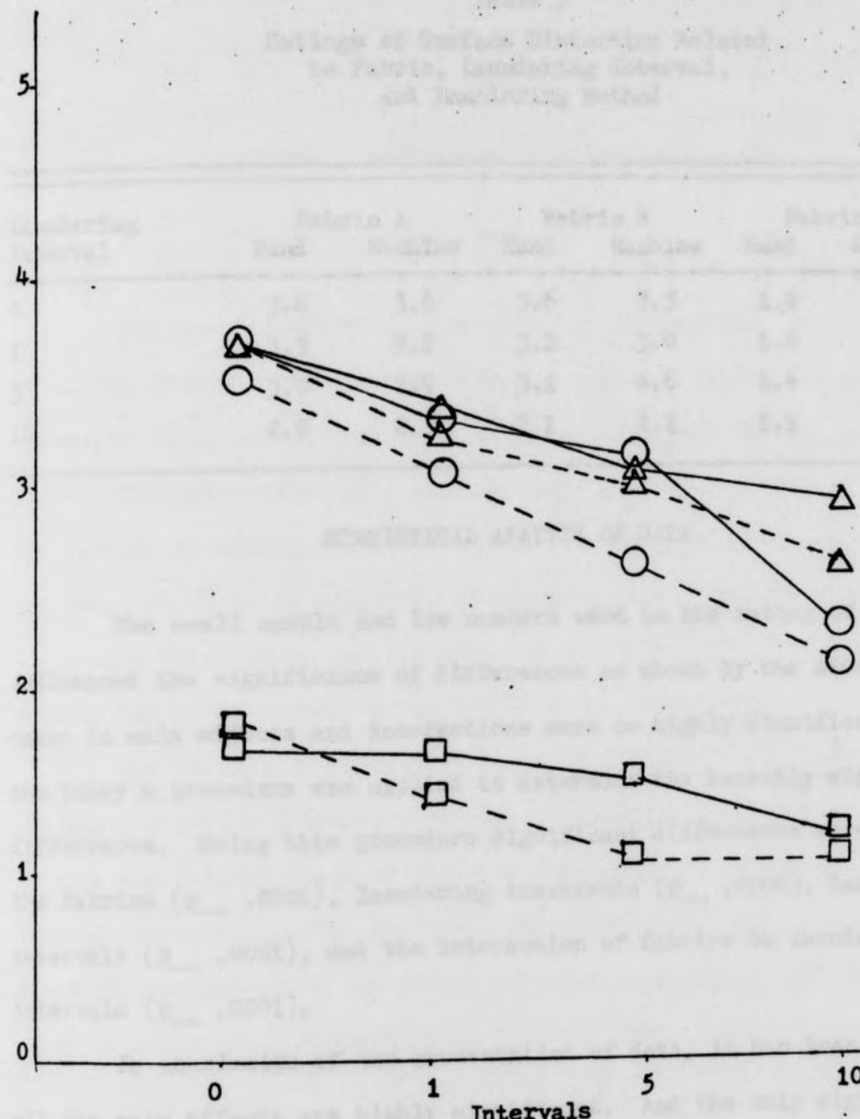

Figure 6

Comparison of Surface Distortion Related To Fabric, Laundry Interval, And Laundry Method.

Key
Fabric A △
Fabric B ○
Fabric C □
Hand ————
Machine – – – –

Table 7

Ratings of Surface Distortion Related to Fabric, Laundering Interval, and Laundering Method

Laundering Interval	Fabric A Hand	Fabric A Machine	Fabric B Hand	Fabric B Machine	Fabric C Hand	Fabric C Machine
0	3.6	3.6	3.6	3.5	1.6	1.7
1	3.3	3.2	3.2	3.0	1.6	1.3
5	3.0	2.9	3.1	2.6	1.4	1.0
10	2.9	2.5	2.2	2.1	1.1	1.0

STATISTICAL ANAYSIS OF DATA

The small sample and low numbers used in the rating of fabrics influenced the significance of differences as shown by the ANOV. Differences in main effects and interactions were so highly significant that the Tukey w procedure was applied to determine the honestly significant differences. Using this procedure significant differences were found in the fabrics (p__ .0001), laundering treatments (p__ .0006), laundering intervals (p__ .0001), and the interaction of fabrics to laundering intervals (p__ .0001).

In conclusion of the presentation of data, it has been shown that all the main effects are highly significant. And the only significant interaction was that between the fabrics and the laundering intervals.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

SUMMARY

Surface distortion of knit fabrics has received considerable attention from research personnel due to consumer complaints concerning excessive snagging and picking problems associated with the fabric. One reason for this problem of distortion of the surface of knit fabrics is the lack of an adequate test method to measure distortion propensity of a fabric before it is marketed. A second proposed reason is the effect of laundry temperature and technique on the polyester fiber structure. Another suggested reason is the effect of surface design.

The purpose of this study was to develop a test procedure to pre- surface distortion propensity in polyester double knit fabrics. In order to test the effectiveness of the test procedure, the distortion propensity of different surface designs were investigated. Testing also included investigation of the effect of laundering temperature and technique on the surface distortion of the experimental fabrics.

Description of the Surface Distortion Apparatus

The surface distortion apparatus developed for this study was a Taber Abraser Model E-4010 adapted with wire brush wheels instead of Calibrase or Calibrade wheels. A Variac rheostat was used to slow the revolutions per minute from 69 down to 49 revolutions per minute.

The results of experimentation indicated that a rotary abraser of this type could be developed for the abrading of fabrics. Further experimentation might indicate that the number of cycles might be reduced to prevent immediate destruction of the fabrics.

Description of the Test Method

All samples were randomly tested on the surface distortion device. Each specimen received ten complete revolutions on the surface distortion device. There were three replications for each Group of samples. After the samples were randomly evaluation. The evaluation method for this study was conducted by random selection of the samples. Each sample was placed individually on a grey peg board viewing apparatus with an over-head florescent light as the only light source and evaluated on a rating scale of five to one. This rating scale was composed of five separate samples of a plain white double knit fabric, that had been distorted to different degrees. A Class 5 indicated no surface distortion and a Class 1 indicated extreme surface distortion. So that each sample had a possibility of one to five scores. The samples were judged by research personnel unaware of the hypotheses or testing procedure. Since the surface distortion evaluation was judged by research personnel there was a human element in the experiment. The degree to which the researcher judged the fabric depended on her opinion of the extent of the distortion. In several instances the rating of a single fabric sample differed according to the judges decision. A fabric with a rough surface style effect was by one judge "hiding" the snags or picks, thereby receiving a number four rating. But by another judge the fact that the snags or picks were there qualified it for a number one rating. Perhaps this problem would be eliminated if the person evaluating the fabric sample stood three feet away from the sample.

Description of Fabrics, Treatments, and Intervals

All test fabrics were one hundred percent polyester, white, weft knits. The basic differences in the three fabrics were the surface design, which proved to be significant to surface distortion propensity to the .0001 level of confidence. Fabric A was a crepe design surface which showed a gradual distortion from the control interval of a 4.0 rating to a 2.3 rating after the tenth laundering. Fabric B showed a somewhat greater evidence of damage in the control interval with a 3.6 rating, but after the tenth laundering it was 2.3; which shows a more gradual deterioration after repeated laundering than Fabric A. Fabric C started with a very poor rating of 1.6 with the control interval, therefore the evaluation after repeated launderings did not have far to fall to hit the bottom rating of 1.0. All three fabrics established an individual rate of distortion, therefore, it can be summarized that fabric surface does influence its distortion propensity.

The experimental fabrics in this study were subjected to two different laundering techniques. The machine washed samples were washed in a General Electric Filter Flo 14 washing machine at 140± 5 degrees F (60± 3 degrees C) temperature. The fabrics were washed in the Permanent Press Cycle with a wash cycle of twelve minutes, a spin cycle of four minutes, a rinse cycle of five minutes, with a final spin cycle of four minutes. They were dried in a General Electric Dryer with exhaust temperature ranging between 140 and 160 degrees F (60 and 71 degrees C) for one half hour.

The hand washed samples were washed at 105$\pm$ 5 degrees F (41$\pm$ 3 degrees C) with mild hand agitation for one half hour, and dried at room temperature.

The laundered samples were washed with 90 grams of a commercial detergent. After the first and fifth wash, fabric was added to provide weight equal to the original load level.

The difference in the effect of laundering techniques on evaluations of surface distortion were slightly significant at the .0006 level of confidence. It was observed that machine washed samples deteriorated slightly more than the hand washed samples. It can therefore be concluded that laundering technique did influence surface distortion behavior to a small degree.

The experimental fabrics in this study were subjected to four different laundry intervales, 0 (control), 1, 5, and 10 launderings. The fabrics were marked of in thirty-six, six and one half inch squares, then marked with a number from one to thirty-six in indelible ink. The samples squares were chosen for each test group by a table of random numbers. Each fabric in Group 1 was tested for surface distortion characteristics. The fabrics in Group 2 were laundered once; Group 3 were laundered five times; and Group 4 were laundered ten times prior to testing surface to testing surface distortion characteristics. All fabrics without exception showed signs of graduated distortion as launderings were increased. The difference in laundry intervals proved to be significant to the .0001 level of confidence. It can therefore be theorized that the more times a polyester double knit fabric is laundered, the more the surface will be distorted.

CONCLUSIONS

The results of this study indicate the following conclusions:

1. There were highly significant differences in surface distortion among the three fabrics. Therefore, Hypothesis 1 stating that there was no significant difference at the .001 level of confidence in surface distortion among the three fabrics was rejected.

2. There were highly significant differences in the surface distortion of the fabrics subjected to the treatments. Hypothesis 2 was also rejected.

3. There was a significant difference of interactions between fabrics and treatments. Hypothesis 3 was rejected.

4. The surface distortion apparatus developed for this study was an effective test apparatus for measuring distortion propensity of polyester double knit fabrics.

RECOMMENDATIONS

The area of surface distortion of polyester double knit fabrics is a broad field of study and has many topics that need to be developed. Among these are:

1. Determination of a surface structure that would best prevent surface distortion.

2. Determination of the effect of a double knit fabric composed of spun yarns (as opposed to filament yarns) propensity of surface distortion.

3. Determination of a chemical finish that could prevent surface distortion in polyester double knits.

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