

THE EFFECTS OF EXPOSURE IN THE FADE-OMETER ON THE SERVICE
QUALITIES OF ORLON, NYLON, DACRON, AND ACETATE FIBERS
IN CURTAIN MARQUISSETTES

by

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INTRODUCTION

Fabrics used as glass curtains and draperies generally are expected to look well and wear well for a period of years. They must possess certain properties of texture as well as draping qualities, and must be suitable and of decorative value for the room. Curtains may be used to give privacy yet let in sunlight and air, and to improve the appearance of windows by softening window lines. While the consumer wants curtains which will serve these purposes she also wants as durable and serviceable a product as her budget allows. To be durable a curtain fabric must withstand exposure to sunlight, atmospheric conditions, and laundering. To look well while in service a fabric must hold its color, resist wilting, and not shrink or stretch. The time and energy required to care for curtains is another important factor to consider.

Durability and attractiveness were mentioned about the same number of times by city and small town women of Missouri when they were asked what qualities they considered important (Petzel, 11). However, durability was considered the most important quality by the majority of the women. Colorfastness, ease of laundering, and preshrinking were considered essential by many. Shrinkage and fading had been sources of difficulty to the great majority.

The results of various studies show that the rate at which

curtains deteriorate when exposed to heat and light varies with fiber content. The rate of deterioration of textile fibers is of major importance to homemakers who wish to buy serviceable curtains. "Information gathered about one fiber from a specific fiber group can be applied in general to all fabrics of the same fiber content." (Fletcher, 8).

Today, with the introduction of many new man-made fibers the consumer finds choosing curtain fabrics even more difficult than before. This study was an effort to determine the effects of light, by means of Fade-Ometer exposure, on the serviceability of curtain fabrics made of Chromspun cellulose acetate, nylon, Orlon, and Dacron fibers. The findings of this study will contribute to a larger study of a group of curtain fabrics to determine their serviceability by means of Fade-Ometer exposure as compared with exposure to natural light rays.

REVIEW OF LITERATURE

The nature and present status of the fibers studied, the action of light on these fibers as well as the effects of light on curtain fabrics were reviewed.

Fibers

In 1951, the Federal Trade Commission set up Trade Practice Rules for rayon and acetate. Acetate was taken out of the rayon classification since it is not a regenerated cellulose but a

cellulose derivative, and it must be labeled as acetate. Chromspun acetate is a recent improvement which has been important in bringing acetate to the fore. Yarn is dope dyed, and properties claimed for this fiber are as follows: colorfastness to sunlight, resistance to soiling, cleanability, quick drying, excellent draping qualities, and elimination of gas fading. A wide variety of colors are now possible in both filament and staple form. Chromspun is the registered trade name of Tennessee Eastman for this fiber. Celanese Corporation of America makes the same type of yarn under the trade name Celaperm (Boyo, 1).

With the introduction of nylon, the man-made fibers industry took its longest step forward since its birth in the era of acetate and rayon. Nylon is the generic term for any long chain synthetic polymeric amide, and was developed as a result of a study of polymers beginning in 1928 by the Du Pont Company under the direction of Dr. Carothers. The name, "Polymer 66", was applied to the fiber in 1935, but it was not announced until 1938. The fiber is a polymer of diamine and adipic acid, with (NH₂NH) amide linkage. Entering 1954, nylon assumes a brand new aspect as, for the first time, the specter of competition is faced by Du Pont who was the only producer of the fiber for so many years. Four other companies, plus European variations of the fiber, will increase nylon output and there will be a great deal more spice in merchandising (Boyo, 1).

Orlon, the first polyacrylonitrile fiber to appear in United States research became a reality in 1941, but was not produced commercially until 1950. It is produced by polymerizing

acrylonitrile and extruding it through a spinneret. Orlon is the trade mark selected by Du Pont for its acrylic fiber, and hereafter is will be referred to as Orlon. The distinctive properties of Orlon are: high bulk and coverage; warm with desirable hand; easy wetting; resistance to pilling; and resistance to cigarette ashes. In resilience, Orlon is not as lively in springing out from creased positions as Dacron and wool, but is, nevertheless, good in this respect. The longer time recovery from creasing is excellent. Resistance to abrasive surface is good, varying with the fiber construction and tests used, but it is not in the nylon category in this respect, ranking with cotton and wool. The filament has higher resistance to degradation by sunlight than the staple. New acid colors have outstanding light fastness for use on Orlon, and they were introduced by Du Pont (Holmes, 10).

Dacron is the Du Pont trade mark name for its polyester fiber made from ethylene glycol and terephthalic acid. The polyester fiber will be referred to as Dacron in the following discussion. The groundwork for the development of Dacron was laid by Dr. Carothers, but he devoted his main efforts to developing the polyamides. Meanwhile, an English firm, using Carothers' work as their basis, developed "Tereylene." Carothers completed the development of Dacron in the United States, and it was patented in 1946 under the title of Fiber V. Many people support the opinion that it is the most successful of the new textile fibers. Du Pont faces no immediate important competition here, and the market for Dacron is rapidly expanding.

During the past year the dyeing problem has been overcome to an extent where all basic shades needed in men's suitings are possible (Boyo, 1). Dacron's distinctive functional properties are: high wet and dry resistance, dimensional stability under wet or dry conditions, high stretch resistance coupled with high strength, high bleach and heat resistance (3).

Nylon, Orlon, and Dacron do have a number of characteristics in common, but they are not identical and each contributes certain outstanding properties in addition to those held by all three. In varying degree, each of the three has good dimensional stability, good wrinkle recovery, press and shape retention, easy launderability, high durability, and resistance to all sorts of degrading influences (Holmes, 10).

Light, Sunlight and Fade-Ometer

Light has been analyzed into a spectrum of colors with unseen ultra-violet rays and infra-red heat rays on opposite sides of the spectrum. Light rays act upon a fabric by chemical action and by raising the temperature of the fabric causing the extreme of burning the cloth or causing it to reach the melting point of the fiber to lesser extremes where some other kind of degradation takes place. This happens in the absence of dyes, pigments and finishing chemicals, and the presence of these products may aid, detract, or be neutral in the action of light on a textile.

Sunlight varies and changes with seasons of the year having

marked geographic differences between Texas and Maine, and varying from the moist humid days of New York in August and the dry atmosphere of Denver. The action of light on a fabric may be direct or reflected, prolonged or short periods of exposure, filtered by glass or unfiltered. But the action of light alone is not the only factor affecting the condition of a fabric. Exposure to air, variations of temperature, particular conditions of wear and abrasion, washing and dry cleaning as well as the construction of the fabric, type of textile fiber, type of dye used, color, and even type of processing of the manufacture of the textile may introduce variable factors, and all of these act together. These variables of daylight are difficult to reproduce in the laboratory, for conditions in the Fade-Ometer are less variable (Teplitz, 14). In the Fade-Ometer the temperature increases too much and the relative humidity drops to a very low value. This causes discrepancies for those dyes whose fading is highly moisture susceptible. Too often the temperature around the immediate vicinity of the specimen is 30°-40° F. higher than that of the surrounding air (van der Heuve, 15). Therefore, light fastness measurements made on Fade-Ometer are generally more severe than those made in natural sunlight. Exposure often browns the color while natural sunlight bleaches it (Fields, 7).

In 1951, a Dutch firm made modifications on the Fade-Ometer involving an apparatus to maintain conditions in the testing chamber corresponding sufficiently with normal conditions. The apparatus can be fitted on any machine easily. A screen is used

instead of cotton wicks and air currents are forced to pass in front of samples with a humidity more than 65 per cent to attain the relative humidity of 65 per cent. When it was tested the results were identical with exposure to daylight with but few cases showing deviations (van der Heuve, 15).

The American Association of Textile Chemists and Colorists Committee on Colorfastness made a comparative sunlight and Fade-Ometer test on 75 dyed, synthetic fiber samples. The fibers included were cellulose acetate, Acrilan, Dacron, dynel, nylon, and Orlon. They were exposed, in two steps under glass in sunlight by the South Florida Testing Service during February, March, and April of 1952. Twenty-two of these samples were exposed in four steps in FDA-R Fade-Ometers by ten different laboratories. During exposure the black panel temperature, mercury bulb temperature, room temperature, and relative humidity in the Fade-Ometer were taken. The extent of difference between sunlight and Fade-Ometer exposure was studied, and how much under varying conditions the various Fade-Ometer exposures differed. The results showed that the character of fading, loss of strength as well as color change, is similar between sunlight and Fade-Ometer exposure. Samples exposed in Fade-Ometers with black panel temperatures consistently over 175° F. showed a considerably faster rate of fading with a tendency to be scorched or burned than did those exposed in Fade-Ometers with black panel temperatures below 175° F. (12).

A paper presented at the convention of the AATCC in Chicago reported a comparative Fade-Ometer and sunlight test on two

groups of synthetic fibers. It was pointed out that as the newer synthetic fibers have become more widely used many instances of variation in fastness ratings between Fade-Ometer and sunlight exposure have been reported. Previous work has noted great differences in ratings on many dyes brought about by changes in relative humidity and temperature in the atmosphere surrounding the test sample. Fibers were divided into two groups. Synthetic fibers in Group I were those that could be dyed with acetate or disperse colors and included acetate, Dacron, Dynel, nylon, and Orlon. Group II were those that could be dyed with acid colors and included wool, Acrilan, nylon, and Vicara. Yarn of each group was dyed a light and a dark shade to about the same depth for each fiber, but not necessarily with the same amount of dyestuff. Yarns were exposed in a wide variety of conditions in a special research Model Fade-Ometer as well as the commercially used Model FDA-R Fade-Ometer. The three relative humidity ranges selected for this study were 35 per cent, 50 per cent, and 65 per cent. Two sets of daylight exposures were made out of doors. In general, with all fibers an increase in temperature had more effect on both fibers and dyestuffs than did an increase in relative humidity. Also, it was noted that there were many more definite patterns by fiber grouping than by dyestuff grouping. No abnormal hue change or character of fading was observed between the spring and summer outdoor tests, and between the various Fade-Ometer tests when the black panel temperature did not exceed 175° F. (6).

The results of another study of the effects of sunlight

exposure on nylon (4) also showed that nylon yarn is subject to degradation on exposure to light. Prolonged exposure caused a loss of strength and elongation, and affected other properties of the yarn, but did not cause discoloration of the nylon. The degradation was primarily due to the effect of light in the visible violet and blue range of wave lengths. Data indicated that bright nylon yarns have essentially the same sunlight durability as cotton, linen, and bright rayon yarns of the same denier, greater sunlight durability than silk and dull rayon yarns, and less than Orlon. Bright nylon was considered more resistant to degradation than semi-dull nylon. The rate of deterioration could be appreciably increased or decreased by the presence of dyes, finishes, and other agents in or on the fiber. Yarns had slightly better resistance to sunlight when exposed behind window glass than when exposed outdoors, and deterioration was more rapid at certain locations than at others. At most, but not all, locations in the United States the rate of deterioration was much more rapid in summer than in winter.

Curtain Fabrics

Relatively few studies have been made on curtain fabrics using Fade-Ometer exposure as the means for determining the effects of light on curtain fabrics. This is especially true of fabrics made of the newer fibers such as nylon, Orlon and Dacron.

The Bureau of Human Nutrition and Home Economics made a study (Fletcher, 8) of the effects of Fade-Ometer and heat ex-

posure on the breaking strength and light reflection of undyed fabrics and plastic materials used for curtains. Marquisette, gauze, crash, and taffeta fabrics made of the following fibers: cotton, nylon, linen, silk, wool, acetate, rayon, and glass were included in the study, as well as five colored plastics.

Results showed that Fade-Ometer exposure decreased the breaking strength of all the fabrics, except glass; the silk and nylon fabrics lost the most strength, and the cotton and acetate fabrics lost the least strength. Exposure to heat affected the color of the undyed fabrics, indicated by a decrease in reflection. Fabrics showed less change in reflection after Fade-Ometer exposure than they did after heat exposure. From the results of the study it was concluded that curtains, hanging over heat radiators and getting direct sunlight, made of acetate or glass fibers would be the most serviceable. Fabrics made of linen and nylon fibers would be the least serviceable under similar conditions. The plastics have great strength, but become stiff on exposure.

Taylor (13) used fabrics made of polyester Dacron, polyamide nylon, acrylic Orlon, and cellulose acetate fibers in a study to compare these four thermoplastic fibers when used for curtain fabrics. A portion of each fabric was exposed to sunlight for six consecutive months beginning in February; another portion of each fabric was exposed in the Fade-Ometer for 90 hours which was used for color comparison tests only.

The results of this study showed the polyester fiber had

excellent dimensional stability, maximum color colorfastness, both to natural light and Fade-Ometer exposure, great strength and maximum resistance to degradation by sunlight and atmosphere, excellent soil resistance, and remarkable ability to shed small amounts of soil. It was considered, therefore, the best suited of the four fibers for curtain fabric. The acrylic Orlon fabric was very satisfactory, too, possessing the same characteristics as the polyester fiber, but not to as marked a degree. Fabrics made of polyamide and cellulose acetate fibers were not considered satisfactory because of degradation of the fiber upon exposure to natural light, lack of dimensional stability, lack of soil resistance, and change of color partially due to stain from soil. The four fabrics showed little change in the physical properties after six months of normal exposure with cellulose acetate fabric showing the greatest change, polyamide fabric showing some change, and the polyester and acrylic fabrics showing negligible change.

Erwin (5) studied the general construction, physical properties, shrinkage, and colorfastness of nylon marquisette curtain fabric. The breaking strength and elongation of the fabric were noted after each of the following: exposure to sunlight at windows for eight months; Fade-Ometer exposure for 100, 200, and 300 hours; ageing in dry and moist heat; and exposure to atmospheric gases for 16 hours. Curtains were hung at north and east windows in a home for the eight months of sunlight exposure, and the results showed a decrease of breaking strength with a statistically significant greater loss of strength for those exposed

at north windows. Exposure in the Fade-Ometer for 100, 200, and 300 hours caused a greater loss of strength than did the exposure at the windows for eight months. Fabrics became slightly darker in color during natural light exposure, but the exposure in the Fade-Ometer for 300 hours and to dry heat for 100 hours caused a greater change in color than that caused by natural light rays. The Fade-Ometer exposure caused the color to become lighter as the period of exposure increased, while ageing in dry and moist heat caused the color to become darker as the period of exposure increased. In general, laboratory exposures were more severe than exposure under conditions of normal use. Fabrics shrank very little under all conditions. Resistance to slippage, warp on filling was low, and resistance to abrasion was good. From the results of the study it was concluded that nylon curtains are most serviceable in a moderate atmosphere where they are not exposed to direct sunlight for long periods.

Hess (9) reported a study of the effects of 40, 80, and 120 hours of Fade-Ometer exposure on the breaking strength of rayon, a low and high quality cotton, and nylon marquisette fabrics. After 120 hours of exposure, the nylon fabric was dark brown in color; the better grade of cotton and the nylon fabrics resisted deterioration to about the same extent; and the rayon fabric showed more than three times as much deterioration as these other two fabrics. Nylon and the better grade of cotton shrank less than two per cent; rayon and the low quality cotton fabric shrank more than two per cent, and were considered unsatisfactory.

METHOD OF PROCEDURE

All the tests conducted in this study were done according to standards set up by the American Society for Testing Materials (A. S. T. M.) Committee D-13, (2). The artificial light exposure of the selected fabrics was done in a FDA-R Model Fade-Ometer.

Selection of Fabrics

Four marquisette fabrics, one each of Chromspun cellulose acetate, nylon, Orlon, and Dacron fibers were purchased in retail stores, as curtain panels. All of the fabrics were white or ivory white in color, Plate I. The prices and sizes of the panels were as follows:

Table 1. The prices and sizes of curtain panels.

Fibers of fabrics	Size in inches	Price per panel
Acetate	42 x 81	\$1.29
Nylon	42 x 90	2.29
Orlon	41 x 81	2.69
Dacron	42 x 81	3.48

For convenience, fabrics will be referred to as fabrics A, B, C, and D, each representing one of the selected fibers as follows: A-Chromspun cellulose acetate, B-nylon, C-Orlon, D-Dacron.

Exposure in the Fade-Ometer

The FDA-R Fade-Ometer is a carbon arc fading lamp manufactured by the Atlas Electric Devices Company, Chicago, Illinois (2). It is a mechanical reproduction of daylight or sunlight, but less variable than daylight. Specimens of fabrics A, B, C, and D were exposed to the Fade-Ometer for each of the following time periods: 50, 100, 150, 200, 250, and 300 hours. The specimens were revolved about the carbon arc to unify the exposure. The air about the specimens was humidified by means of cotton wicks, and the black panel temperature was set at 80° F.

Laundry Procedure

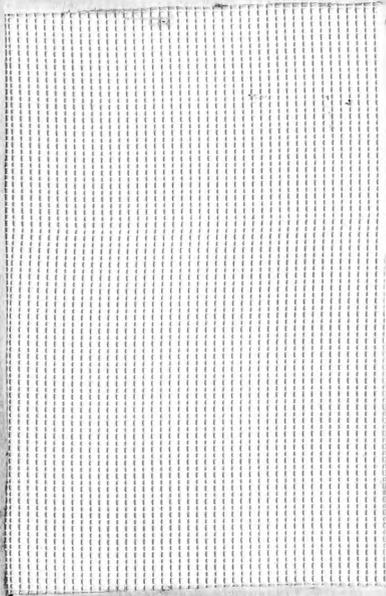
After each 50 hour period of exposure the specimens were washed for five minutes in a portable electric washing machine with enough neutral soap to maintain two or more inches of standing suds throughout the washing period. They were rinsed three times, two minutes each. A water temperature of 100 (±) 2° F. was used for the washing and rinsing. Specimens were smoothed out and pressed between towels to remove excessive moisture, then pressed with a steam iron.

EXPLANATION OF PLATE I

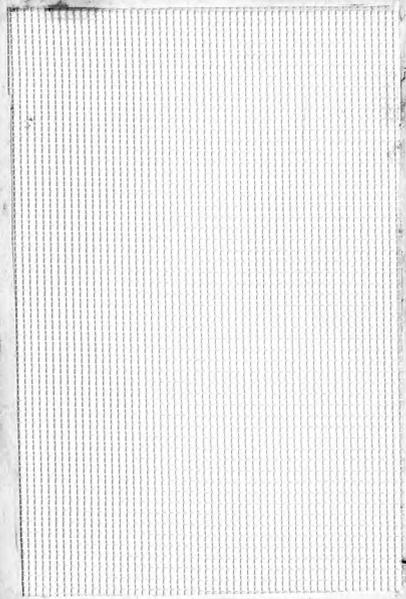
Samples of Fabrics Used

- A. Chromspun cellulose acetate
- B. Nylon
- C. Orlon
- D. Dacron

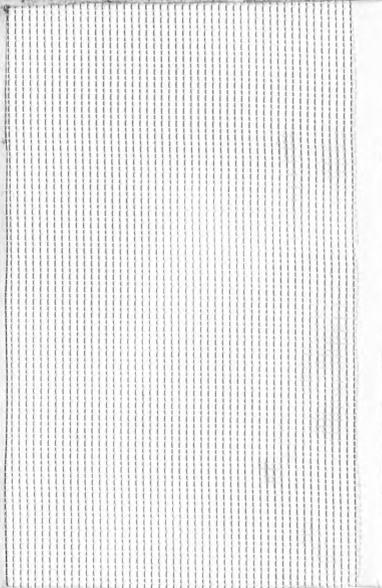
PLATE I



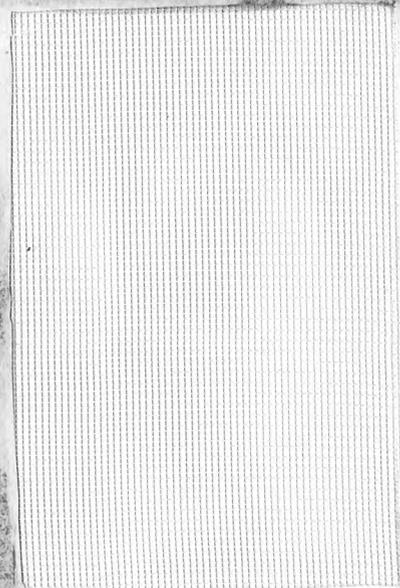
A



B



C



D

Analyses of Fabrics

For testing purposes, specimens of each of the fabrics A, B, C, and D were cut according to the Plate II. The fabrics, as purchased, were analyzed for amount of twist, thread count, wet and dry breaking strength (ravel strip), elongation, dimensional change, and weight per square yard. Specimens of each of the four fabrics were exposed in the Fade-Ometer for each time period to determine color change. These specimens were not washed at any time.

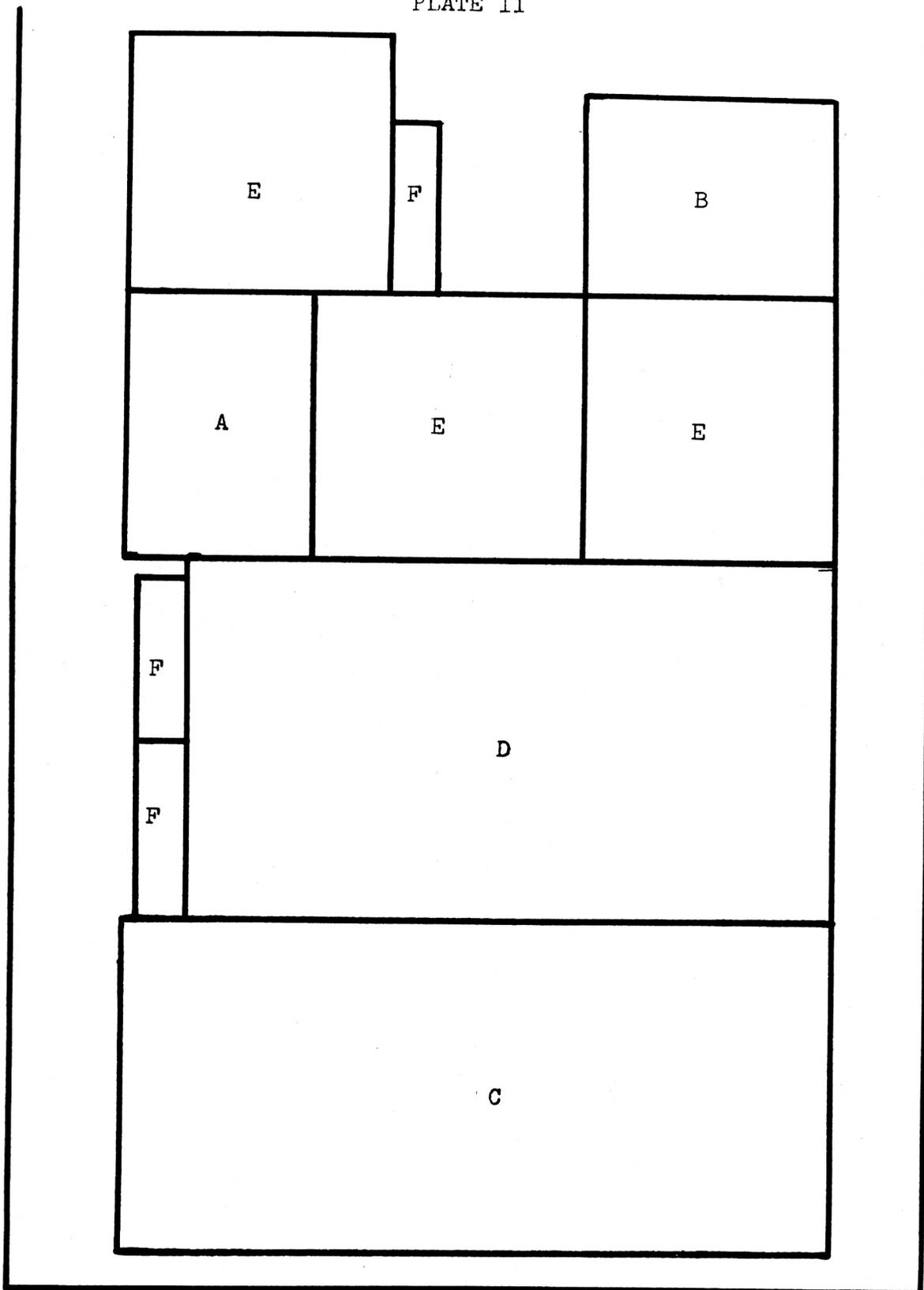
After specimens were exposed in the Fade-Ometer for the specified time periods and laundered they were tested for wet breaking strength and elongation. For the discussion of findings the periods of exposure and launderings will be referred to as follows: one, 50 hours of exposure, one laundering; two, 100 hours of exposure, two launderings; three, 150 hours of exposure, three launderings; four, 200 hours of exposure, four launderings; five, 250 hours of exposure, five launderings; and six, 300 hours of exposure, six launderings. Change of color also, was determined.

EXPLANATION OF PLATE II

Cutting Chart for Fabrics

- A. Breaking strength, warp
- B. Breaking strength, filling
- C. Fade-Ometer breaking strength, warp
- D. Fade-Ometer breaking strength, filling
- E. Dimensional change
- F. Color change

PLATE II



DISCUSSION OF FINDINGS

Fabrics as Purchased

The fabrics were all marquisettes of gauze weave. The analyses of the fabric as purchased (Table 2) showed that fabric D had the highest warp and filling thread count of the four fabrics with 60 warp and 38 filling yarns per inch; fabric B had 56 warp and 36 filling yarns per inch; fabric C had 54 warp and 31 filling yarns per inch; and fabric A had the lowest thread count with 44 warp and 30 filling yarns per inch. Fabrics A, B, and D had approximately one-half again as many warp yarns as filling yarns, but fabric C had more than two-thirds again as many as filling yarns.

The yarns, warp and filling of the four fabrics had only a small amount of twist. The warp and filling yarns in fabrics A, B, and D had the same amount of twist; the twist in the filling yarns of fabric C was slightly more than in the warp yarns. The yarns of fabrics A and D had S-twist for both warp and filling, and in fabrics B and C the yarns had Z-twist for both warp and filling. The yarns in fabric A showed the least twist; fabric D showed the highest; and fabric C had a slightly greater filling twist than did the yarns in fabric B.

Fabric A was the heaviest of the four fabrics and weighed 1.5 ounces per square yard; fabric D weighed 1.1 ounces; fabrics

Table 2. Analyses of fabrics A, B, C, and D as purchased.*

Tests performed	A		B		C		D	
	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling
Dry breaking strength, lbs.	13.9	8.8	38.2	28.4	31.0	15.2	38.1	30.3
Wet breaking strength, lbs.	9.3	6.6	34.8	24.0	30.4	15.2	41.7	30.2
Percentage elongation, dry	22.1	24.2	35.3	32.7	19.5	18.1	31.9	32.3
Percentage elongation, wet	41.0	42.9	36.5	34.3	18.9	18.9	31.3	32.1
Percentage dimensional change	7.0	6.0	2.2	2.2	1.2	0.3	0.1	0.1
Threads per inch	44	30	56	36	54	31	60	38
Twist in yarns per inch	19	19	20	20	20	21	22	22

*Weight per sq. yd. in ounces

A 1.5 C 0.9

B 0.9 D 1.1

B and C each weighed 0.9 ounces per square yard.

The dry breaking strength of fabric A was greater than the wet breaking strength, with 13.9 pounds dry and 9.3 pounds wet warp, and 8.8 pounds dry and 6.6 pounds wet filling strength. Fabric B also showed a higher dry than wet breaking strength with 38.2 pounds dry and 34.8 pounds wet warp, and 28.4 pounds dry and 24.0 pounds wet filling strength. Fabric C showed no significant difference between the dry and wet filling. Fabric D showed a slightly higher wet warp than dry warp breaking strength. Fabric D showed the highest breaking strength of the four fabrics as purchased, both warpwise and fillingwise, and for wet as well as dry tests; fabric A showed the lowest. Fabric B showed a higher breaking strength, warp and filling, for both dry and wet tests than did fabric C.

Fabric A showed a high percentage of elongation for wet breaking strength, both warpwise and fillingwise, 41.0 per cent warp and 42.9 per cent filling elongation. The fabric showed a much lower percentage of dry elongation, 22.1 per cent warp and 24.2 per cent filling. The warp and filling of each of the fabrics B, C, and D showed little variation between the results of the dry and wet elongation tests. The four fabrics, in order of highest to lowest percentage of wet warp and filling elongation, were: A, B, D, and C. The fabrics, in order of highest to lowest percentage of dry warp and filling elongation were: B, D, A, and C.

Fabric A showed the greatest dimensional change of the four fabrics with seven per cent warpwise shrinkage and six per cent

fillingwise. Fabric B showed two per cent shrinkage in both the warp and filling; fabric C, one per cent warp shrinkage and no significant change in the filling; and fabric D, no significant changes warpwise or fillingwise. The dimensional change of fabric A was great enough to make it unsatisfactory as a curtain fabric, but fabrics B, C, and D would be satisfactory.

Color Change

The four fabrics were judged by five people as having no apparent change of color after each series of exposure and laundering, or after each series of exposure and no laundering.

Thread Count

The warp and filling thread counts of fabrics A, B, C, and D after each series of laundering are given in Table 3. The warp and filling threads of fabric A increased four yarns per inch after the first three series of launderings, and then remained constant. Fabrics B and C showed an increase of two yarns per inch, warpwise and fillingwise after the series of laundering; and fabric D showed an increase of two yarns per inch warpwise, but remained constant fillingwise.

The increase of yarns per inch of fabric A as compared to the other fabrics corresponds with the results of test for dimensional change which showed a greater change for fabric A than for the other fabrics. The increase of yarns per inch of fabric

D as compared to the other fabrics also corresponds to the results of dimensional change which showed fabric D with the least change of the four fabrics.

Table 3. Number of yarns per inch for fabrics A, B, C, and D after each series of Fade-Ometer exposure and laundering.

Series	A		B		C		D	
	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling
1	46	31	58	37	54	32	62	38
2	46	32	58	37	54	32	62	38
3	48	33	58	38	54	32	62	38
4	48	33	58	38	56	32	60	38
5	48	34	58	38	54	32	62	38
6	48	34	58	38	56	33	62	38

Breaking Strength

Curtain fabrics undergo the treatest amount of handling and strain during laundering. The following discussion concerns the results of wet breaking strength tests which were conducted after each series of exposure and laundering. The results given in Table 4 show the breaking strength in pounds and the percentage of the change in the fabric as purchased. Figures 1 and 2 compare the warp and filling breaking strength of each fabric after each series of exposure and laundering.

In general, each of the fabrics showed a corresponding loss of warp and filling breaking strength throughout the series of exposure and laundering. The breaking strength of fabric A de-

Table 4. Wet breaking strength of fabrics A, B, C, and D after each series of Fade-Ometer exposure and laundering and the percentage change of the original breaking strength.*

Series	A				B				C				D			
	Warp		Filling		Warp		Filling		Warp		Filling		Warp		Filling	
	lbs.:	%	lbs.:	%	lbs.:	%	lbs.:	%	lbs.:	%	lbs.:	%	lbs.:	%	lbs.:	%
1	9.1	97.8	6.0	89.4	29.8	85.6	19.7	82.1	27.6	90.8	15.7	103.3	37.1	89.0	29.4	97.3
2	9.1	97.8	5.5	83.3	25.0	71.8	16.9	70.4	26.9	88.5	15.4	101.3	37.1	89.0	29.5	97.7
3	8.5	91.4	5.8	87.9	14.6	42.0	9.8	40.8	27.2	89.5	15.2	100.0	36.5	87.5	28.1	93.0
4	8.2	88.2	5.1	77.3	14.5	41.7	10.1	42.1	28.5	93.8	14.5	95.4	36.9	88.5	29.3	97.0
5	8.1	86.1	5.3	78.8	12.9	37.1	8.3	34.6	28.8	94.7	14.7	96.7	36.6	87.8	27.6	91.4
6	7.9	84.9	4.7	71.2	11.0	31.6	6.9	28.8	26.6	87.5	15.5	102.0	36.7	88.0	27.8	92.1

*In pounds

Warp A 9.3; B 34.8; C 30.4; D 41.7

Filling A 6.6; B 24.0; C 15.2; D 30.2

creased from an original warp strength of 9.3 pounds to 7.9 pounds and from an original filling of 6.6 pounds to 4.7 pounds after the sixth series. This showed a loss of 15 per cent in the warp and 28.8 per cent in the filling. Fabric A showed less difference between the number of pounds of warp and filling breaking strength than did the other fabrics. Fabric B showed a decrease from 34.8 pounds to 11 pounds in the warp, and 24 pounds to 7 pounds in filling strength after the sixth series. This was a 68.4 per cent loss of warp and a 71.2 per cent loss of filling breaking strength. Fabric B showed the greatest decrease of strength, warp and filling, after each of the first three periods of exposure and laundering, with the greatest single loss after the third period. The results indicate that the warp yarns in the fabric lost more strength than the filling yarns throughout the series of tests. The pounds of warp and filling breaking strength of fabric C varied throughout the series of exposure and laundering. The warp showed the least loss of strength after the fifth period 28.8 pounds, a 5.3 per cent loss, and the greatest after the sixth period 26.2 pounds, a 11.5 per cent loss. The filling showed a greater strength after the first period with 15.7 pounds, 3.3 per cent higher than the original strength, and the greatest loss of strength after the fourth period, 14.5 pounds, a 4.6 per cent loss. In general, the warp showed a loss and the filling remained essentially the same after the six periods of exposure and laundering. Fabric C showed the greatest difference in the number of pounds of warp and filling breaking strength of the four fabrics. Fabric D showed a decrease

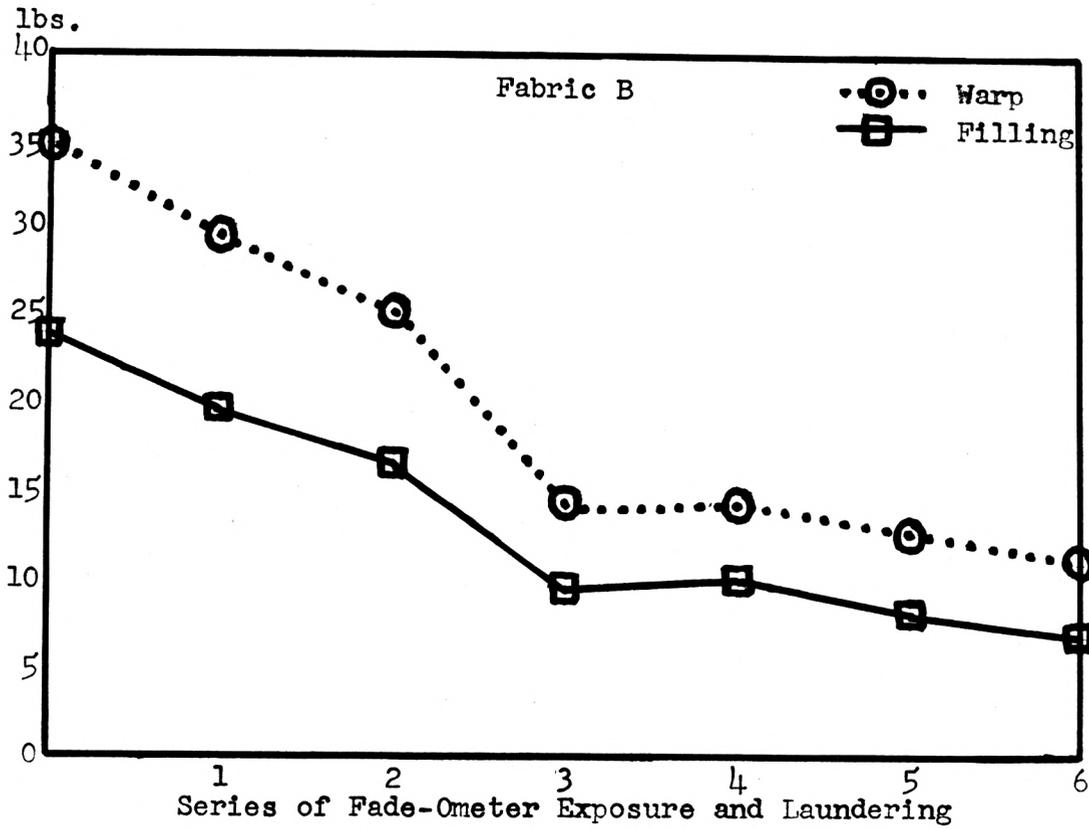
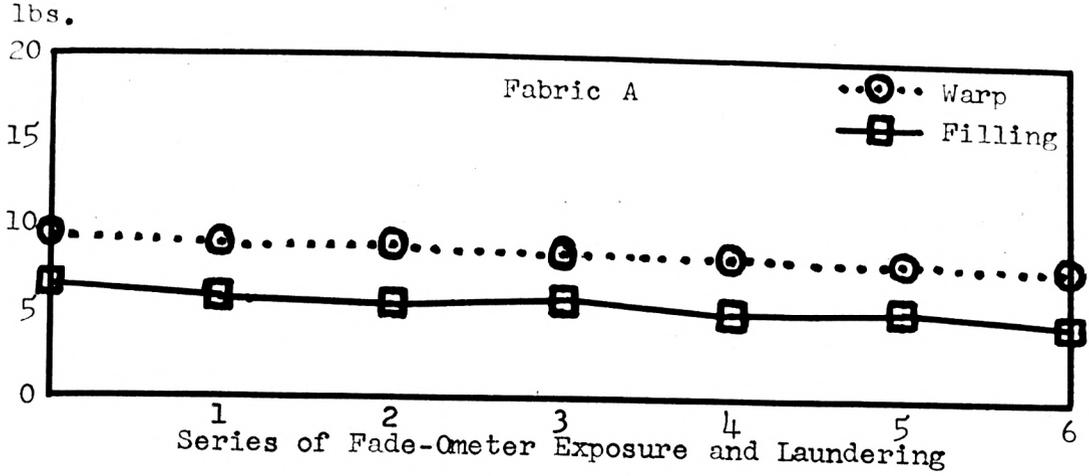


Fig. 1. Wet breaking strength, warp and filling, of fabrics A and B after each series of Fade-Ometer exposure and laundering.

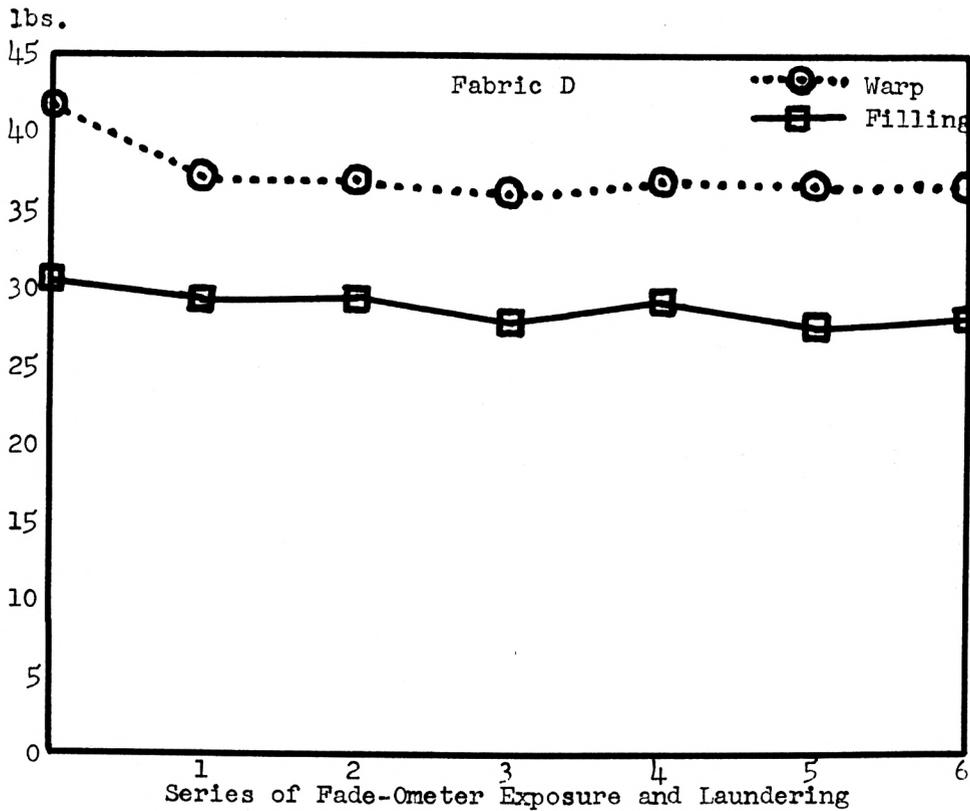
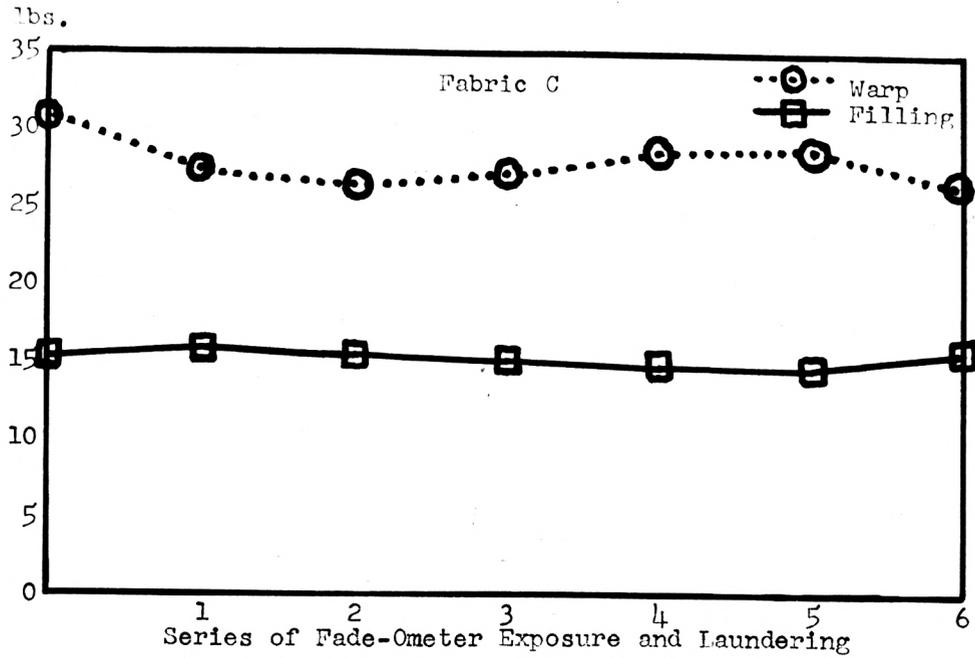


Fig. 2. Wet breaking strength, warp and filling, of fabrics C and D after each series of Fade-Ometer exposure and laundering.

from 41.7 pounds to 36.7 pounds in warp breaking strength after the six periods which was a 12 per cent loss of strength. The filling breaking strength varied throughout the series and showed the least loss after the second period, 29.5 pounds, a 2.3 per cent loss, and the greatest loss after the fifth period 27.6 pounds, an 8.6 per cent loss. Fabric D showed a greater loss of strength, warpwise than fillingwise, throughout the series of tests.

Figure 3 compares the warp and filling breaking strength of fabrics A, B, C, and D after each series of Fade-Ometer exposure and laundering. Fabric B showed the greatest warp and filling loss of breaking strength of the four fabrics, both in number of pounds lost as well as percentage change in breaking strength of the fabric as purchased. Fabric D showed a slightly greater loss of warp and filling strength, both in pounds and percentage change than did fabric C. Fabric A lost approximately the same number of pounds after each series of exposure and laundering as did Fabrics C and D, but lost a greater percentage of the original breaking strength. After the sixth period, 300 hours of exposure and six launderings, the order of greatest to the least number of pounds of breaking strength, warp and filling, of the four fabrics was as follows: D, C, B, and A. According to the results of tests, fabrics A and B would not be serviceable curtain fabrics; C and D would be very serviceable.

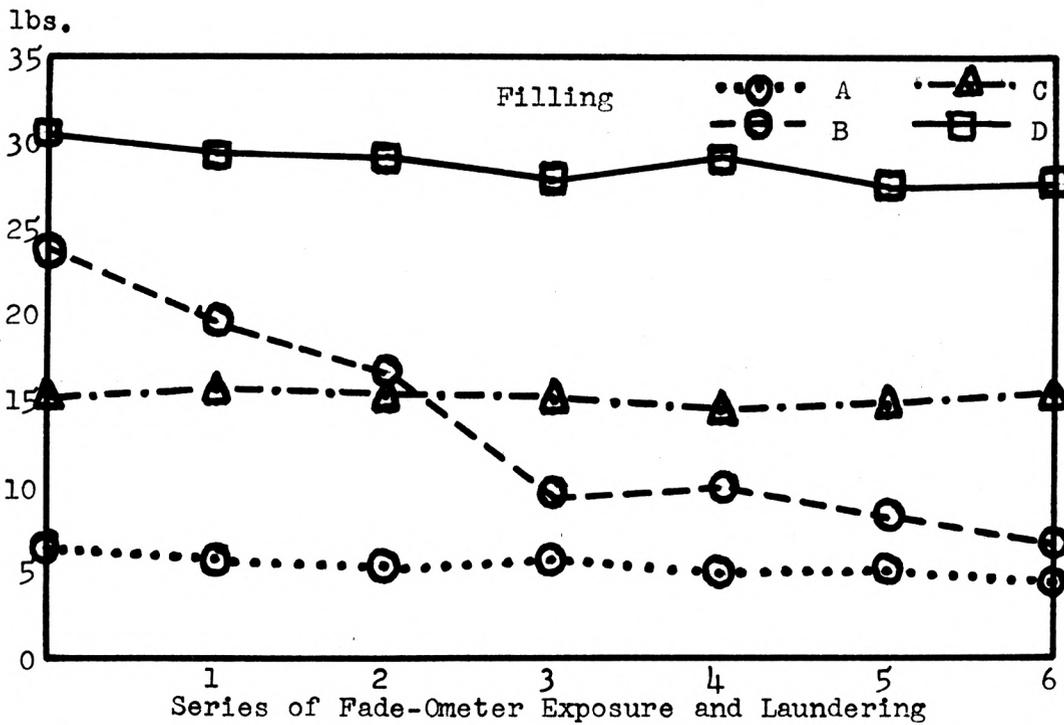
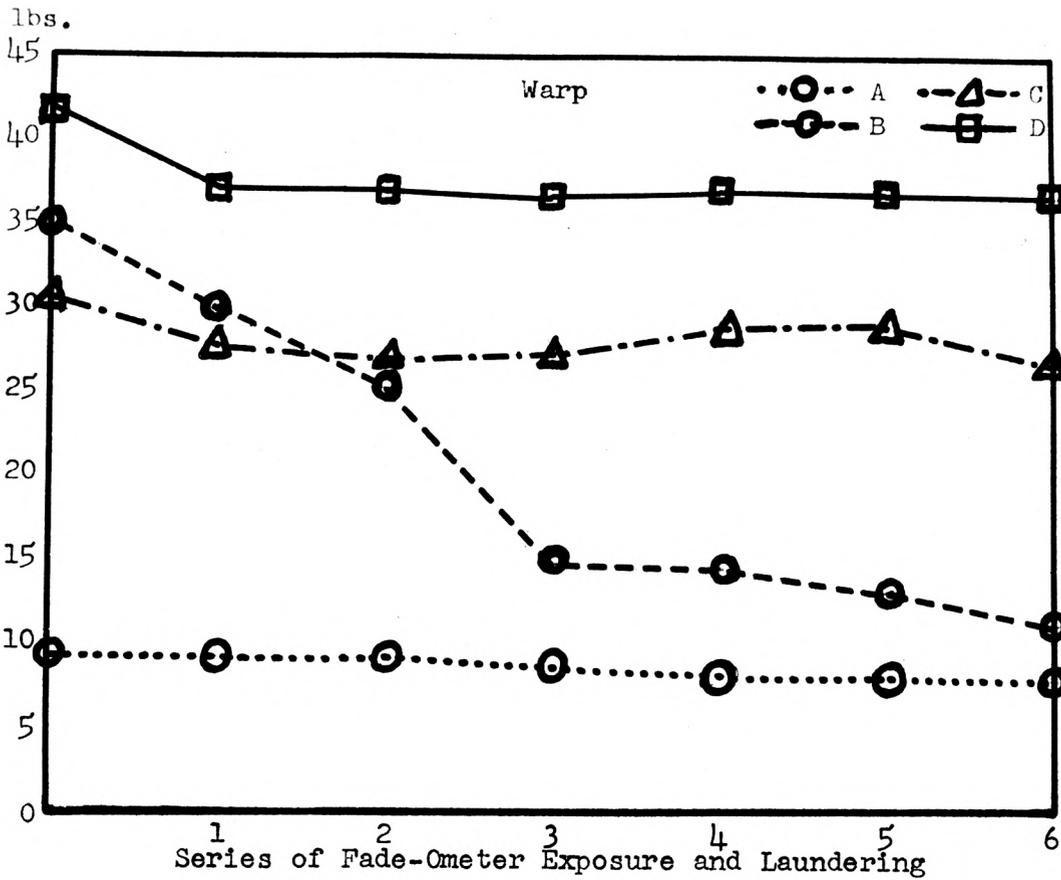


Fig. 3. Wet breaking strength of fabrics A, B, C, and D after each series of Fade-Ometer exposure and laundering.

Elongation

The results of the elongation tests are given in Table 5. The following discussion concerns only the wet elongation of fabrics A, B, C, and D for the series of exposure and laundering.

Table 5. Percentage of elongation of fabrics A, B, C, and D after each series of Fade-Ometer exposure and laundering.

Series	A		B		C		D	
	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling
1	43.2	43.5	35.8	32.1	20.4	19.6	34.6	30.5
2	44.3	40.8	29.8	27.3	19.7	19.3	34.0	31.9
3	45.9	44.9	22.2	20.9	19.7	19.1	31.5	30.5
4	44.1	40.5	21.7	19.3	18.5	17.5	29.9	29.5
5	43.2	41.5	19.8	18.2	18.8	18.0	29.5	28.7
6	42.8	37.9	19.3	16.3	21.4	18.9	32.4	29.4

In general, the warp and filling elongation of each of the four fabrics followed a corresponding pattern of increase or decrease throughout the series of exposure and laundering. Fabric A showed a high percentage of warp and filling elongation throughout the series. Both the warp and filling showed the highest percentage of elongation after the third period with a 45.9 elongation per cent for the warp and 44.9 per cent for the filling. The warp elongation gradually increased until after the third period, then gradually decreased; the results indicate a slight increase after the six periods. The filling varied

throughout the series, but results indicate a slight decrease of elongation as compared with the fabric as purchased. The elongation of fabric A did not hold to a definite relationship with the breaking strength for the series of exposure and laundering. Fabric B decreased from an original warp elongation of 36.5 per cent to 19.3 per cent and from an original filling of 34.3 to 16.3 per cent after the sixth period. The elongation showed a warp and filling decrease corresponding with the warp and filling decrease in breaking strength, and also showed the greatest decrease of elongation after each of the first three periods. The warp and filling elongation of fabric C fluctuated: an increase after the first period, then a gradual decrease until the sixth period, and a definite increase after that. The warp showed a greater degree of variation than the filling. The highest elongation for the warp was 21.4 per cent after the sixth period, and 19.6 per cent for the filling after the first period. Both the warp and the filling showed the lowest elongation after the fourth period with 18.5 per cent for the warp and 17.5 per cent for the filling. After the series of exposure and laundering the warp showed a slight increase and the filling showed no significant change in elongation. The pattern of increase and decrease in elongation for fabric C showed an inverse relationship to the breaking strength of the fabric. Fabric D showed the same general pattern of warp and filling elongation as fabric C for the series. The highest percentage elongation for the warp was 34.6, after the first period, and 31.9 for the filling after the second period. The lowest percentage elongation

was 29.5 after the fifth period for warp and 28.7 for filling. The results indicate a small increase of warp and filling elongation after the sixth series as compared to the fabric as purchased. Fabric D also showed an inverse relationship between the elongation and breaking strength.

Fabric A showed the highest percentage of elongation, warp and filling, of the four fabrics throughout the series of exposure and laundering; fabric B, the lowest warp and filling elongation after the series of tests. Fabric D showed a greater warp and filling elongation than did fabric C throughout the series.

The results of these findings indicate that fabric A would be unsatisfactory because of high percentage of elongation and low breaking strength. The high percentage of elongation and high breaking strength of fabrics C and D throughout the series of exposure and laundering indicate that they would be serviceable curtain fabrics. Fabric B also showed a high breaking strength and high elongation for the fabric as purchased, but the great decrease of both elongation and breaking strength after the series of exposure and laundering make it unsatisfactory as a curtain fabric.

SUMMARY AND CONCLUSIONS

The purpose of the study was to determine the effect of light, by means of Fade-Ometer exposure, on the serviceability of curtain fabrics made of Chromspun cellulose acetate, nylon, Orlon, and Dacron fibers, fabrics A, B, C, and D respectively. The results indicate that:

1. The initial price per panel for each of the fabrics made of a different fiber, in order of lowest to highest, was as follows: Chromspun cellulose acetate, nylon, Orlon, and Dacron.

2. Amount of twist, weight per square yard, and the number of yarns per inch were not important factors in determining the serviceability of the fabrics.

3. The effect of Fade-Ometer exposure upon each of the fabrics was dependent upon the fiber content. Nylon showed the greatest deterioration, Orlon and Dacron showed the least, and Chromspun cellulose acetate showed appreciable deterioration.

4. Chromspun cellulose acetate probably would not be a serviceable fiber for curtain fabric because of low strength and high elongation, appreciable shrinkage, and extensive deterioration after the series of exposure and laundering.

5. Nylon probably would not be a serviceable fiber for curtain fabric because of the loss of more than two-thirds of the original strength and approximately one-half the original elongation after the series of exposure and laundering. The fabric showed little dimensional change.

6. The fabrics made of the Orlon and Dacron fibers probably would be very serviceable for curtain fabrics. They showed high strength and elongation, only a small percentage of loss after 300 hours of exposure and six launderings, and no significant dimensional change.

7. Since there was no apparent change of color in any of the four fabrics, either after Fade-Ometer exposure and laundering or exposure and no laundering, after each of the six periods, this was not a factor in determining serviceability of the fabrics.

From the results it was concluded that even though fabrics made of the Orlon and Dacron fibers had a higher initial cost they possessed the desired service qualities to a much greater degree throughout the series of tests than did the fabrics made of the nylon and Chromspun cellulose acetate fibers.

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THE EFFECTS OF EXPOSURE IN THE FADE-OMETER ON THE SERVICE
QUALITIES OF ORLON, NYLON, DACRON, AND ACETATE FIBERS
IN CURTAIN MARQUISETTES

by

HAZEL GRABER

B. S., Bethel College, 1948

AN ABSTRACT OF A THESIS

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An increasing number of curtain fabrics made of the newer fibers are found on the market. The purpose of this study was to determine the effect of light, by means of Fade-Ometer exposure, on the serviceability of curtain fabrics made of Chromspun cellulose acetate, nylon, Orlon acrylic, and Dacron polyester fibers.

MATERIALS AND PROCEDURE

Four marquisette fabrics, one each of Chromspun cellulose acetate, nylon, Orlon, and Dacron fibers, purchased as curtain panels were used for this study. All of the fabrics were of gauze construction and white or ivory white in color.

Standards set up by the American Society for Testing Materials, Committee D 13 were used for testing. Fabrics as purchased, were analyzed for amount of twist, thread count, wet and dry breaking strength (ravel strip), elongation, dimensional change, and weight per square yard.

Fabrics were exposed in a FDA-R Fade-Ometer for each of the following time periods: 50, 100, 150, 200, 250, and 300 hours. After each 50 hours of exposure, portions of the fabrics were washed in a portable electric washing machine with enough neutral soap to maintain two or more inches of standing suds throughout the washing period. They were then rinsed three times, for two minutes each, excessive moisture removed, dried, and pressed with a steam iron. After each series of exposure and laundering

the fabrics were tested for wet breaking strength and elongation. Change of color was determined on exposed and laundered portions as well as exposed portions not laundered.

SUMMARY AND CONCLUSIONS

The analyses of the fabrics as purchased showed that the amount of twist, weight per square yard, and yarns per inch were not important factors in determining the serviceability of the fabrics. The results of the study indicated that the fibers used in the curtain fabrics were the determining factor of the effect of Fade-Ometer exposure on the serviceability. Nylon showed the greatest deterioration after 300 hours of Fade-Ometer exposure, Chromspun cellulose acetate showed appreciable deterioration, and Orlon and Dacron showed the least.

Fabrics made of the acetate fibers had the lowest initial cost, fabric of the Dacron fiber the highest, and fabric of Orlon fibers had a little higher initial cost than that of nylon.

According to the tests Chromspun cellulose acetate would not be a serviceable fiber for curtain fabric because of low strength and high elongation, appreciable shrinkage, and extensive deterioration after the series of exposure and laundering. The fabric did not show any change of color due to exposure.

Nylon would not be a serviceable fiber for curtain fabric because of the loss of more than two-thirds of the original strength and approximately one-half the original elongation after the series of exposure and laundering. The fabric showed little

dimensional change, and no change of color.

The fabrics made of the Orlon and Dacron fibers would be very serviceable for curtains. Although the initial cost was higher these two fabrics possessed the desired service qualities to a greater degree throughout the series of tests. They showed high strength and elongation, only a small percentage of loss after 300 hours of exposure and six launderings; no significant dimensional change, and no apparent change of color.