THE RESISTANCE OF WOOL AND POLYACRYLIC BLANKETS TO ABRASION

by

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THE RESISTANCE OF WOOL AND POLYACRYLIC BLANKETS TO ABRASION

CHAPTER I

INTRODUCTION

With the advent of man-made fibers, it has become increasingly difficult for the consumer to identify and judge the performance of fabrics manufactured for use in everyday living. These new fibers have been used either in combinations with natural fibers or alone to produce fabrics with a wide range of qualities.

New fabrics found on the market today are being used in all kinds of clothing, blankets, carpets, draperies, and upholstery, to name a few. J. H. Ball (4, p. 750) points out that it is necessary for the consumer of today to rely upon the seller, manufacturer, commercial testing laboratories, government bureaus, etc. for data concerning the performance of new fabrics. It is important to the consumer to know the use-value or potential wearability of articles made from these fabrics.

D. L. C. Jackson (14, p. 803) lists the following main factors which probably constitute wear; (1) plane abrasion, (2) flex abrasion, (3) edge abrasion, (4) force abrasion (tearing), (5) snagging, and (6) impact forces. Various ways of evaluating these wear changes have been suggested such as (a) tensile strength, (b) thickness,

(c) weight, (d) surface luster, (e) air permeability, (f) color, and (g) appearance.

Recently a pilot study on wool, Orlon, and Acrilan blankets was conducted at Oregon State College (5). It seemed expedient, therefore, that the present investigation be conducted to explore further the field of the resistance of wool and polyacrylic blankets to abrasion.

This investigation was limited to abrasion by means of the Accelerotor. The effects of abrasion were evaluated through weight, thickness measurements, and visual changes before laundering, after one laundering, after five launderings, and after ten launderings.

CHAPTER II

REVIEW OF LITERATURE

Walter J. Hamburger (12, p. 169) explains that textiles are seldom designed to withstand an application of great single stress, but that ordinary fabrics, over the long period of their lifetime, are subjected to a series of repeated applications of stress. These repeated stresses may be in the form of bending, compressing, twisting, or tensioning. Abrasion of everyday fabrics involves a pattern of repeated stresses; however these stresses are of a much lower order of force than the stresses used in laboratory tests.

Abrasion has been cited as the most important single factor in wear (32, p. 625; 30, p. 171; 21, p. 589; 28, p. 210; 7, p. 449). Actual use tests involve much time and many human differences; therefore in trying to reproduce all of these differences a great number of abrasion machines has been designed for laboratory use. Margaret Zook (32, p. 626) reported that fifty such machines have been made and tested in an effort to duplicate the most important causes of wear, and also to correlate the laboratory testing by means of these machines with service wear tests. However, in a much later report Stiegler et al (26, p. 700) reported sixty-four abrasion instruments in service.

In 1945 Herbert J. Ball (4, p. 750) worked with eleven of these instruments, endeavoring to classify each. At this time, he said that there was no universal instrument to test every type of wear on every kind of fabric that would meet all conditions found in the life of a material. However, he and several others have shown that results obtained by means of the abrasion machine need not necessarily reproduce service wear action as such, but that the wear patterns produced by laboratory abrasion should be comparable to those obtained in corresponding service wear (8, p. 588; 24, p. 59; 27, p. 410; 28, p. 227). R. G. Stoll (27, p. 412) found micro-wear patterns to be identical with the surface appearance of damages, plane abrasion, projected abrasion, flex abrasion or abrasion of folded, or stitched edges. Stoll further states that the micro-pattern can be described as the type of break-up of individual fibers which are affected by the alternative action of snagging, tearing, and unraveling effect upon yarns such as is produced by gradual wearing down by everyday friction.

In reports of early investigations into the field of abrasion the terms "abrasion" and "wear" were used interchangeably. It soon became evident that a distinction must be made between the two terms (4, p. 750; 27, p. 394; 32, p. 625). The authorities for the preceding statement agree that the differences should be as follows: abrasion,

derived from the verb "to abrade", distinctly suggests a "rubbing off". As the word "abrasion" is an adjective, it can properly be applied to all machines or tests in which rubbing is the only or at least the major characteristic.

The term "wear" is believed to be associated with all of the conditions surrounding everyday use and service, thus, combining the effects of several factors, of which abrasion or rubbing is only one. "Wear" now takes on a broader scope than "abrasion", and is used to apply whenever other important actions, with or without abrasion, are present or intentionally introduced by the machine or test method.

Stanley Backer and J. H. Skinkle (2, p. 453; 25, p. 113) gave a slightly different slant by using the terms "serviceability" and "abrasion-resistance". The investigators refer to the former as a term that should relate to the over-all durability of the fabric under conditions of intended use. The latter term should be restricted in meaning to the ability of the fabric to withstand direct abrasion (rubbing) under conditions of intended use.

A study by Fletcher and Gilliam (9, p. 39) explains that resistance to abrasion is known to be an important factor in the serviceability of most fabrics. To date the military studies (16, p. 502) have been the most extensive in comparing laboratory and actual use tests. These tests

have shown that laboratory studies can be reasonably accurate, predict the serviceability of fabric, and be made in less time, with far less fabric and less effort than the use tests.

One of the problems of abrasion tests is the election of the type of abradant to be used. In various studies the investigator will find mineral abrasives (carborundom or emery), canvas, the same cloth as that being abraded, flat metal surfaces, steel spring blades, and even wire gauze (2, p. 453; 14, p. 803; 27, p. 394; 30, p. 171; 22, p. 181; 33, p. 661). The use of emery seems to be the most serviceable and wears cloth to the point of fracture more rapidly (15, p. 413).

The major wear actions are: (1) plane or flat abrasion, (2) edge abrasion, (3) flex abrasion or binding, (4) force abrasion (tearing), and impact force (2, p. 543; 27, p. 394). In other words rubbing, continuous folding and bending, stretching and sudden hitting forces are the everyday abrasive actions. These wear actions may occur in any sequence.

Stoll (27, p. 394) gives the three basic cohesive factors determining abrasion; cohesion or molecular attraction between the abrasive and the fiber, the cohesion between the contiguous fiber, and the cohesion between structural parts of the fibers themselves. J. H. Skinkle (25, p. 113) divides this wear quality as follows: 50 per

cent friction, 26 per cent folding, 22 per cent stretching, and says that chemical action (oxidation) accounts for 8 per cent. Jackson (14, p. 803) disagrees with these percentages and places them thusly: plane abrasion 30 per cent, edge abrasion 20 per cent, flex abrasion 20 per cent, tear abrasion 20 per cent, and all other action 10 per cent. They do agree, however, that these percentages will vary for different materials and for different uses.

Pierce (22, p. 181) thinks that the behavior of objects or fabrics can be accurately indicated if the environment is kept simple, constant, and known. From the known facts or characteristics, the behavior of the fabric in any environment may be deduced, in so far as pertinent facts and relative conditions are known.

It becomes important then that the method of evaluating the results of abrasion be consistent within studies. After many studies the following bases of evaluation seem to be generally used: (1) visual changes which include loss of luster, changes of surfaces, color changes and the appearance of broken yarns (one or more), (2) thickness changes, (3) weight changes, (4) tensile strength changes, and (5) air permeability changes (32, p. 625; 12, p. 169; 30, p. 171; 11, p. 169; 25, p. 113; 15, p. 413; 2, p. 453; 4, p. 750). Of these five methods of evaluation, this investigation will be concerned with three, weight, thickness, and visual changes.

In studies by Backer, Rogers and Ball (3, p. 625; 23, p. 318; 4, p. 750) it was found that the area of contact between the fabric and the abradant surfaces determined the magnitude of local pressures occurring under a given load. This local pressure influenced the depth of penetration into the fabric structure; this in turn, controlled the amount of cutting and snagging damage. The total abrasion-resistance, or wear life of the fabric, is related to the thickness or diameter of the textile structure which is exposed to the rubbing or abraded surface. There are, however, some limitations; for example, it was found in these studies that some fabrics first increased in thickness with abrasion, and then decreased in thickness with increased abrasion. Ball (4, p. 750) explains that this effect results from the cutting and breaking of the fibers and the working of the fibers out of the yarns, resulting in a rough, fuzzy surface of greater thickness than the original when measured under conditions of pressure. Finally, with further abrasion, a point is reached when these fibers become detached from the surface, and thickness begins to decrease. He also points out that some fabrics have such yarn or fabric structures that they load with particles of abradant and their own detritus. The results are an increase in weight in the early stages of a test, followed later by the anticipated decrease as the abrading action continues.

Lester (17, p. 207) feels that the tendency of some fabrics is to develop a flannelette-like surface during testing and during wear, that this "raised" surface undoubtly affords some protection against further wear. This is a defect to which wool-containing fabrics are subject, in that they become covered with tufts or "noils" of fiber more or less rigidly attached to the surface.

From his investigations Cirlic (6, p. 469) stated that this surface wearing (abrasion) takes place in three steps: (1) a fuzziness up to the first breaking of a yarn at the point of interlacing, (2) destruction of all yarns at these interlacing points, and (3) wearing of a hole. He believes that it is during step one that abrasion tests agree with actual wear. He also feels that blends of fibers resist abrasion better than pure fibers, particularly pure wool.

Matthew, Backer, and Clegg (20, p. 497; 3, p. 365; 7, p. 449) all found that a structural change in textile fabric often took place as the result of laundering, dry-cleaning, etc. Shrinkage served to increase the number of yarns per inch and thus reduced the wear rate in further abrasion. They also agreed that increased thickness of a fabric was an indication of greater wear life of that fabric. Backer stated that increased fabric thickness and larger yarn diameter were generally related, thus,

providing a marked improvement in the abrasion-resistance of the fabric structure.

Tait (30, p. 171) made a study in which he observed over eleven hundred samples of lining fabrics after abrasion. He stated that the most noticeable point upon examination of these abraded samples was that no matter what the weave, the yarn size, the relationship between warp and filling yarns, the warp yarns always wore out first. He further stated that this fact was confirmed upon the examination of actual worn garments.

Cirlic (6, p. A469) made a study of the abrasion of woolen, and worsted men's suiting, and ladies' dress fabrics containing wool and viscose rayon fibers in various percentages. He compared the results of this study with the results of the same fabrics after actual wear tests. He concluded that blends had a greater resistance to abrasion, while woolens revealed a greater loss than worsteds. He examined the abraded particles microscopically; this examination disclosed that the particles consisted of almost undamaged fibers that had been pulled from the fabric, and that the dust of the larger particles consisted of short damaged fibers.

Hamburger and Lee (13, p. 61) stated that the most common type of severing occurred when one complete float was worn away, but another and not uncommon type was for two adjacent floats to be worn away, leaving a free hook.

They reported that an unusual type of severing took place where abrasion effected only a limited point, and that the number of broken ends remaining in the yarn was a measure of the primary breaks in the fabric. They further stated that fabrics which had a low average measure of elasticity and good elastic properties resisted abrasion better than those which had a high measure of elasticity.

An investigation by Rogers et al (23, p. 318) of worn and unworn wool blankets reported a gradual change in the appearance of fiber ends. Following this study Macormac (18, p. 149) made a study using the Accelerotor (here no samples were held by tension, pressure, or filling and all were free to move) to correlate the number of fibers per yarn cross section, the number of fiber ends per fiber per inch, and the character of the fiber ends after abrasion for various periods of time. Worsted whipcord was the fabric tested. He averaged all results and reported an increase in weight in all-wool fabrics which he stated may be due to the greater tendency of wool to felt and mat together, and to take up more extraneous material and moisture.

Some of the conditions that affect abrasion as stated by Stoll, and Skinkle were (27, p. 394; 25, p. 113): (1) general conditions, such as dry abrasion, wet abrasion, or abrasion under other specific functional condition, (2) type of abradant, (3) pressure and tension on the sample,

(4) direction and speed of the motion, and (5) removal of lint and other detritus. Variations in these conditions can easily cause a larger deviation in the test response than that caused by differences among the samples, consequently, invalidating the results of inadequately conducted tests. These men concur that the problems of abrasion must be carefully standardized in each study in so far as such differences can be controlled.

Normally, the standard control of 70°F ± 10°, and 65 ± 2 per cent relative humidity should be maintained unless special functional requirements make other temperatures and humidity necessary.

Different investigators referred to visual changes in different ways, but a summary of these referred to the same type of changes (4, p. 750; 17, p. 207; 18, p. 149; 7, p. T449; 25, p. 113; 22, p. 181; 32, p. 625). They agree that the checking of visual changes includes: (1) loss of luster, which can occur after wet or dry abrasion, laundering, dry-cleaning, etc.; (2) changes of surface texture, such as felting, matting, tufts or general roughness or fuzziness; (3) appearance of first broken thread, two or three threads, forming pin holes; and (5) the appearance of a break large enough to be called a hole.

Pierce (22, p. 181) stated that many garments were discarded without evidence of wear because visual changes caused them to be unsuitable for their intended purposes.

It seems appropriate that this review of literature should contain a short description found concerning the Accelerotor which was written by H. W. Stiegler *et al* (26, p. 685) in 1956. The Accelerotor is a relatively new instrument with new principles, that has been developed for rapid abrasion testing and mechanical manipulation of textile and flexible materials (1, p. 3). Mr. Steigler *et al* pointed out that there was a need for a small, compact instrument that would include many functions in one machine. The desire was to develop a machine that would (1) present a single specimen to register colorfastness to abrasion (both wear and laundering), (2) give all the effects of flexing, frictional abrasion of surface, internal yarns and even fiber against fiber, and (3) the effect of sharp cutting abrasion with grit. The Accelerotor was designed to meet these requirements as well as other textile applications.

The Accelerotor consists primarily of a chamber within which rotors, or impellers of special design, revolve at controlled high speed. The various types of abrasion and flexing achieved produce results within a few minutes which bear close and realistic relationship to the effects of (1) much larger, slower moving machinery found in wear-testing equipment, (2) laundering, or (3) dry-cleaning textiles over a long period of time.

Two teams of investigators, Macormac and Richardson (18, p. 149) and Weisheit and Padgett (31, p. 368) have completed successful studies with the Accelerotor. The latter group showed that ten minutes in the Accelerotor at 2500 revolutions per minute using 100 milliliters of a 0.2 per cent neutral soap solution heated to 160°F and 2 milliliters of a bleach containing 5.25 per cent available chlorine was comparable to one hundred commercial launderings. These tests demonstrate the time saving property of the Accelerotor.

CHAPTER III

METHOD AND PROCEDURE

Selection of Blankets

This investigation continued where the pilot study stopped (5); four lines (or brands) of blankets of each fiber content, Acrilan, Orlon (the polyacrylic fibers), and wool were obtained. The blankets were chosen to correspond as nearly as possible on the basis of weight, thickness, weave, and yarn structure.

Throughout this investigation the blankets will be referred to by numbers used for the purpose of identification. Acrilan blankets were numbered from 1 through 4, Orlon blankets 5 through 8, and wool blankets 9 through 12.

Laundering Procedure

Blankets were first cut into fourths, and a fourth from four different blankets of the same fiber composition were sewed together, making a full sized blanket to be laundered. Each fourth of the reassembled blanket was marked on twill tape with marking ink with the number given to the blanket for identification, and the number of times it was to be washed. These blankets of randomized fourths were set up for one laundering, five launderings, and ten launderings, with one fourth of each blanket being held for unlaundered tests.

A Norge washer with water at 100°F ± 4°F to a depth of 8-1/4 inches (9 gallons) was used. A detergent, Dreft, was added to the water, the percentage of mixture was 4.57 grams of detergent per gallon or 41.13 grams per nine gallons. The detergent was dissolved and allowed to agitate for one minute, the blanket was then submerged and soaked for twelve minutes, during which time the blanket was turned by hand; then followed a further soaking of eight minutes, making a total soaking of twenty minutes in all. At this point the water was measured with a ruler to find the exact depth. By manual control the dial of the washer was set to extract the water for two minutes or until no water came out of the pipe. The blanket was left in the washer, and the first rinse, at 100°F, was added until the same level was reached as had been checked at the end of the soaking. For the first rinse the blanket was soaked for three minutes, turned by hand, and then allowed to soak for another two minutes. The water level was again checked and the water spun off as before. The tub was then refilled with the second rinse at 100°F. This second rinse proceeded in the same manner as the first rinse. During the last part of this rinse step, five large bath towels were placed in a dryer (Norge) with the running time set for five minutes at medium temperature. Following the second rinse the water was again removed, and the blanket was folded with three of the heated towels within

its folds. The blanket was then placed in the dryer with the two remaining towels; with the dial set for "blanket" heat the blanket was partially dried (approximately ten minutes). The blanket was then removed from the dryer, placed over two lines (to allow air circulation), in a room of ordinary temperature to complete drying. Care was taken that the blanket was hung straight, a fan was turned on, and the blanket left overnight.

Abrasion

The Accelerotor, recently developed by the American Association of Textile Chemists and Colorists, was used for determining the effects of abrasion. This instrument consists primarily of a chamber within which rotors, or impellers, of special design, revolve at controlled high speeds to produce results within a few minutes which bear close relationship to the effects of use. High velocity and random motion combine to flex, rub, and stretch the fabric. The instrument is designed to be used for a variety of purposes, such as the determination of the effects of laundering, and of wet and dry abrasion. Since this is a relatively new instrument, standard test methods have not been used, and each laboratory has developed its own procedure (1).

For this investigation the methods developed in the pilot study were followed (5, p. 32). The 4-1/4 inch

pitched blade rotor was used with a collar fitted with a fine abrasive (number 250). After each laundering period, each specimen from each blanket was treated in the Accelerotor for two minutes at a speed of 3500 revolutions per minute.

As each specimen was removed from the chamber of the Accelerotor, it was shaken free of detritus and conditioned for at least twenty-four hours before further tests were continued. The chamber was carefully cleaned, and the liner of abrasive was replaced with a new one after abrading five specimens.

The effects of abrasion were then evaluated on the basis of thickness, weight, and visual changes.

Preparation of Specimens and Sequence of Work

Five specimens were cut at random from each blanket after each period of laundering. These specimens were 4-1/4 inches square and so cut that each was from a different part of the blanket. Each specimen was stitched by machine 1/4 inch from the edge, using fifteen stitches to the inch, with six-cord unmercerized white cotton thread. The edges were then raveled as close to the stitching as possible. Next a thin ribbon of adhesive (Ubabond) was applied to the edges. The specimens were allowed to dry over night and then placed in a room where standard conditions were controlled at $70^{\circ} \pm 2^{\circ}$F and 65 ± 2 per cent

relative humidity. After at least twenty-four hours in this room the fabrics were (1) measured for thickness, (2) then subjected to abrasion, (3) measured for thickness following abrasion, (4) then one two-inch square was cut from each specimen, and (5) the two-inch squares were then weighed. Corresponding two-inch squares had also been weighed before abrasion.

Thickness

A Compressometer was used to measure the thickness of each specimen before and after abrasion. The specimen was centered upon the base under the pressure foot smoothly but without tension. The pressure foot was then lowered on the fabric slowly and without impact. This downward motion was continued until the upper dial reading indicated that a pressure of 0.01 pound per square inch had been applied. A timer was started, and after ten seconds the pressure was read and recorded to the nearest 0.001 inch. One thickness reading was made on each specimen both before and after abrasion. Readings on each specimen were paired. Results were used to calculate the percentage of increase or decrease in thickness.

Weight

After each set of launderings before abrasion two-inch squares were weighed individually on an analytical balance.

Similarily squares were cut from the abraded fabric and weighed. The percentages of increases or decreases in weight as a result of abrasion were then calculated.

Visual Changes

Visual changes were noted from the standpoint of (1) any change in luster, (2) such changes as were noticeable in the surface texture, (3) any color change, (4) the appearance of pin holes (one, two, or three broken threads), and (5) the appearance of any breakage large anough to be a hole.

CHAPTER IV

DISCUSSION OF DATA

Effects of Abrasion on Thickness

Acrilan Blankets

The Acrilan blankets usually gained appreciably in thickness after abrasion when unlaundered or following one, five, or ten launderings (Table I, Figures 1 and 2). Of the Acrilan blankets, number 1 had by far the greatest percentage gain in thickness after abrasion at each laundering period.

In the unlaundered condition blanket 1 gained approximately 69 per cent in thickness; blankets 3 and 4 made about the same amount of gain, 12 per cent and 13 per cent respectively; and blanket 2 decreased in thickness by more than 6 per cent after abrasion.

The percentage gain in thickness after abrasion of blankets 1 and 4, which had been laundered one time, was less than for the corresponding unlaundered blankets. Blanket 2 had a greater percentage increase in thickness after abrasion following one laundering than when unlaundered, and blanket 3 increased slightly in percentage gain in thickness after abrasion following one laundering. The percentage increase in thickness of blanket 2 rose to approximately 3 per cent while that of blanket 3 rose to 13 per cent.

TABLE I

PERCENTAGE CHANGES IN THICKNESS AFTER ABRASION

Fiber Composition and Blankets		Number of Launderings			
		0	1	5	10
Acrilan					
	1	68.8	61.3	58.8	59.5
	2	- 6.4	3.1	11.9	3.2
	3	12.1	13.0	18.3	11.4
	4	13.4	9.2	11.2	3.1
Mean		19.5	19.1	25.0	19.3
Orlon					
	5	36.3	27.3	31.4	29.5
	6	21.1	24.5	22.8	20.3
	7	22.4	22.1	21.0	19.7
	8	22.6	16.8	20.1	17.7
Mean		25.6	22.6	23.8	21.8
Wool					
	9	- 6.9	- 3.4	- .2	- 1.8
	10	-12.8	-11.8	- 5.4	- 7.6
	11	2.3	- .8	- .5	- 2.3
	12	- 7.0	- 6.8	- 6.8	- 8.5
Mean		- 6.1	- 5.7	- 3.1	- 5.0

After five launderings, blanket 1 continued to have a smaller gain in thickness while blankets 2, 3, and 4 had a greater percentage increase in thickness as a result of abrasion than following one laundering. The increases were greater for blankets 2 and 3 than for blanket 4.

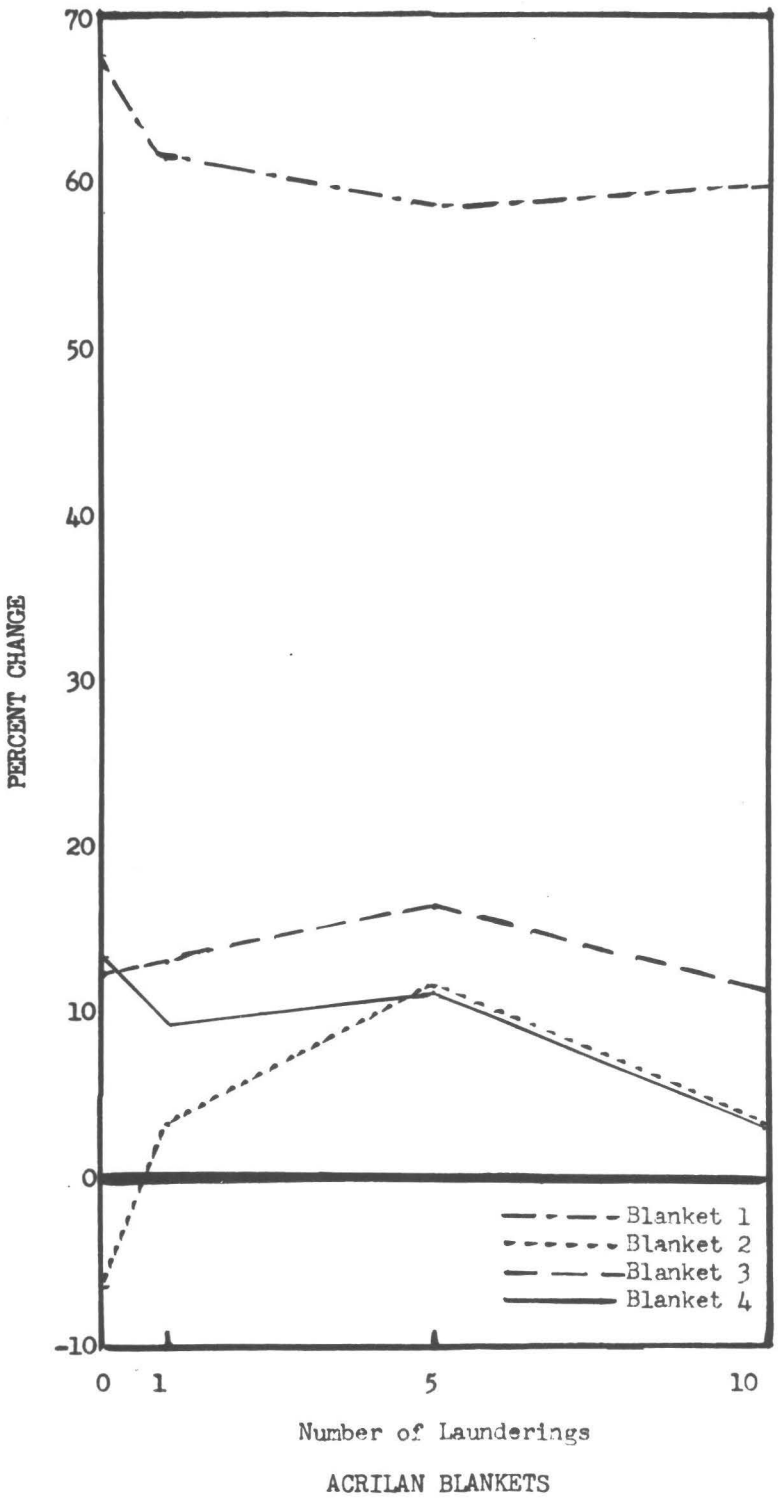

Figure 1. PERCENTAGE CHANGE IN THICKNESS AFTER ABRASION

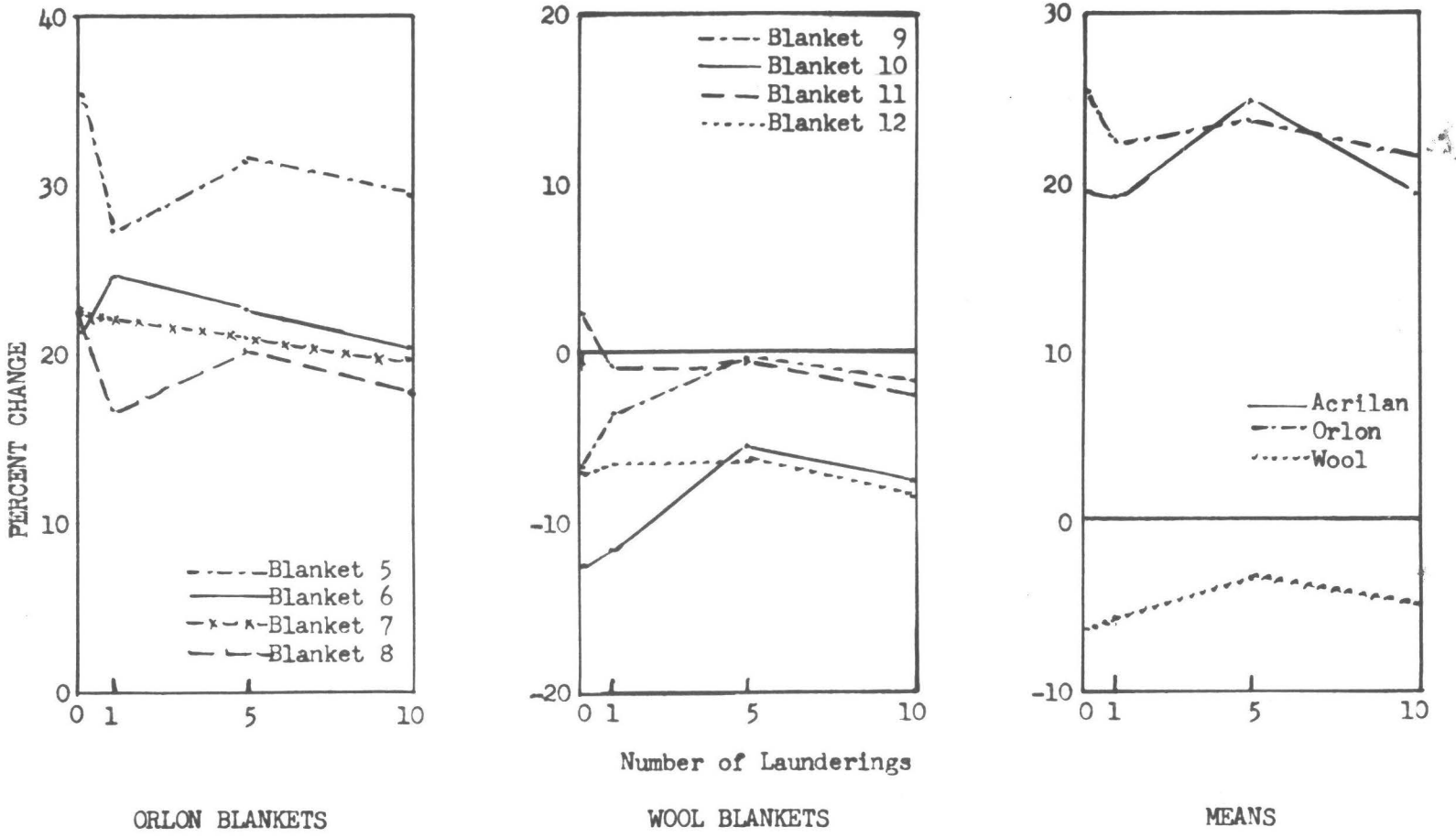

Figure 2. PERCENTAGE CHANGE IN THICKNESS AFTER ABRASION

When abraded after ten launderings, blanket 1 made a slightly greater percentage gain in thickness than following five launderings; however blankets 2, 3, and 4 made smaller percentage gains in thickness after abrasion following ten launderings than five launderings.

Orlon Blankets

All four unlaundered Orlon blankets gained in thickness after abrasion. Orlon blanket 5 had by far the greatest percentage gain in thickness after abrasion at each laundering period than the other Orlon blankets (Table I, Figure 1).

The gains in thickness of unlaundered blankets 6, 7, and 8 after abrasion differed little. The range of percentage gains in thickness of unlaundered Orlon as the result of abrasion was from 21.1 per cent to 36.3 per cent.

The gain in thickness of blanket 6 after abrasion following one laundering was greater than when unlaundered. The increase in thickness of blankets 5, 7, and 8 after abrasion following one laundering was less than when unlaundered, the difference for blanket 7 being very slight.

After abrasion following five launderings Orlon blankets 8 and 5 had a greater percentage increase in thickness than following one laundering, while blankets 6 and 7 showed a slightly smaller percentage increase than after one laundering.

All Orlon blankets increased slightly less in thickness after abrasion following ten launderings than after five launderings.

Wool Blankets

With the exception of unlaundered blanket 11, wool blankets decreased in thickness after abrasion at every period of laundering.

Blanket 11 gained slightly in thickness after abrasion when unlaundered. Unlaundered blankets 9, 10, and 12 decreased in thickness after abrasion, with blanket 10 decreasing 12.8 per cent.

After abrasion following one laundering, wool blankets 9, 10, and 12 decreased less in thickness than when unlaundered, but blanket 11 decreased in thickness as compared with the increase in the unlaundered condition.

After abrasion following five launderings, blanket 10 showed a smaller percentage decrease in thickness than after one laundering, but blankets 9, 11, and 12 changed little in thickness.

All four wool blankets decreased slightly more in thickness after abrasion following ten launderings as compared with five launderings.

Effects of Abrasion on Weight

Acrilan Blankets

One of the Acrilan blankets increased slightly in weight after abrasion at each laundering period, but the other three Acrilan blankets decreased in weight after abrasion at each laundering period (Table II, Figures 3 and 4).

Blanket 1 showed a slight 1.6 percentage increase in weight after abrasion when unlaundered. Blanket 4 had a slight percentage decrease in weight, while blankets 2 and 3 showed a percentage decrease of approximately 9 per cent after abrasion when unlaundered.

Blanket 1 made a slight percentage increase in weight after abrasion following one laundering, while blankets 2 and 3 had a smaller decrease in weight after one laundering than when unlaundered. Blanket 4 decreased more in weight after abrasion following one laundering than when unlaundered.

After abrasion following five launderings, blankets 2, 3, and 4 decreased slightly less in weight as compared with one laundering.

After abrasion following ten launderings two of the Acrilan blankets, 3 and 4 decreased slightly less in weight than after five launderings, but blanket 2 decreased more in weight after abrasion following ten launderings as compared with five launderings.

TABLE II

PERCENTAGE CHANGES IN WEIGHT AFTER ABRASION

Fiber Composition and Blankets		Number of Launderings			
		0	1	5	10
Acrilan					
	1	1.6	2.5	3.1	3.2
	2	- 9.2	- 6.4	- 3.7	- 5.3
	3	- 8.9	- 6.4	- 2.8	- 1.3
	4	- 1.3	- 3.8	- 3.0	- 1.8
Mean		- 4.4	- 3.5	- 1.6	- 2.9
Orlon					
	5	- .5	- .3	1.6	3.6
	6	- 7.1	- 4.8	- 4.0	- 3.1
	7	-10.9	- 6.2	- 1.8	- 2.0
	8	- 3.8	- 2.2	- .2	- 1.2
Mean		- 5.5	- 3.3	- 1.1	- 1.7
Wool					
	9	- 8.8	- 9.5	-13.7	-10.4
	10	-10.0	- 9.0	- 9.2	-10.8
	11	- 3.3	- 5.0	- 7.0	- 7.8
	12	- 7.1	- 7.5	- 8.3	- 8.2
Mean		- 7.3	- 7.7	- 9.5	- 9.3

Orlon Blankets

All Orlon blankets except blanket 5 decreased in weight after abrasion following all laundering periods. Blanket 5 decreased in weight after abrasion when unlaundered or laundered once, but after that it gradually increased in weight.

The Orlon blankets decreased in weight after abrasion when unlaundered.

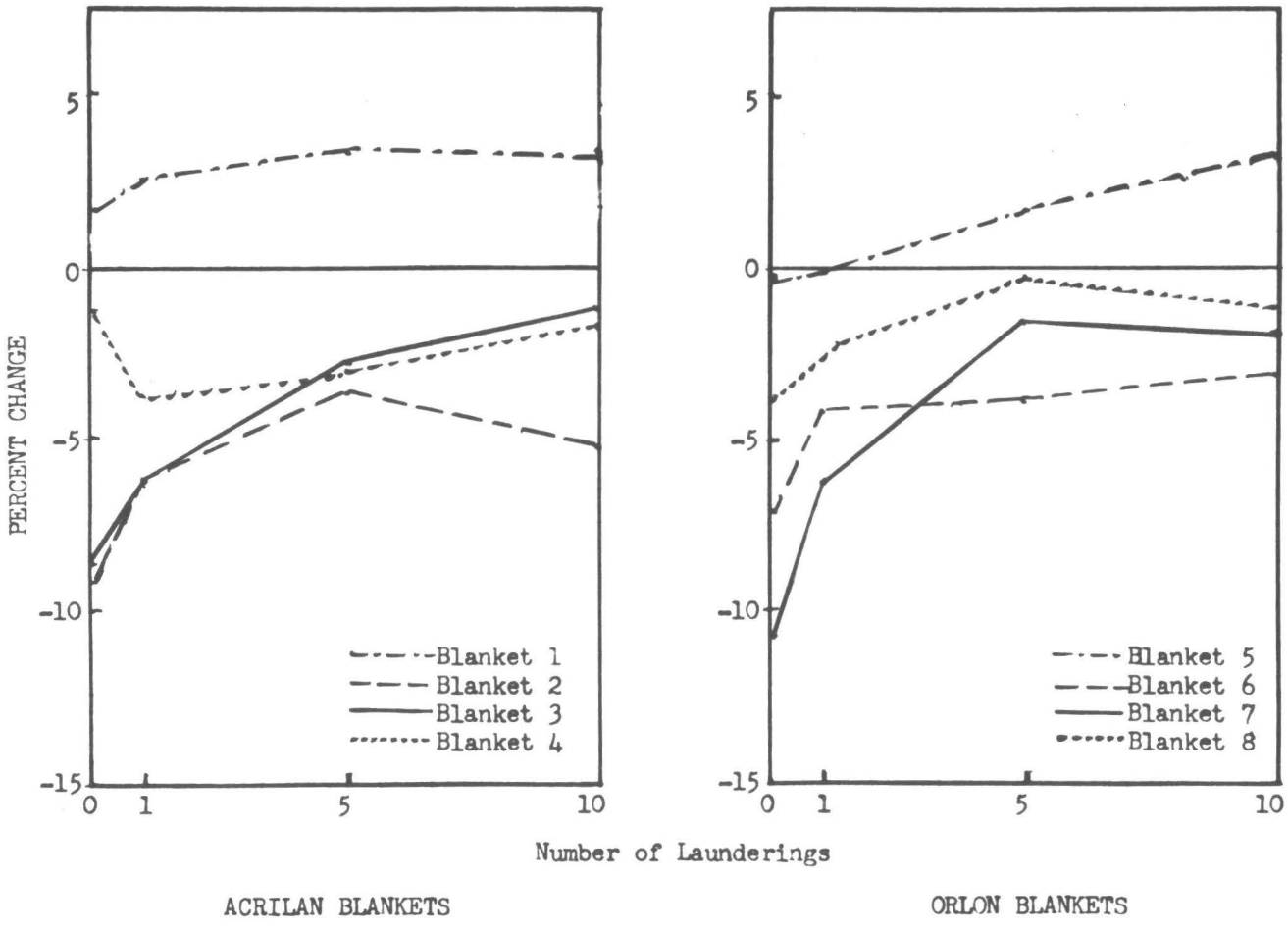

Figure 3. PERCENTAGE CHANGE IN WEIGHT AFTER ABRASION

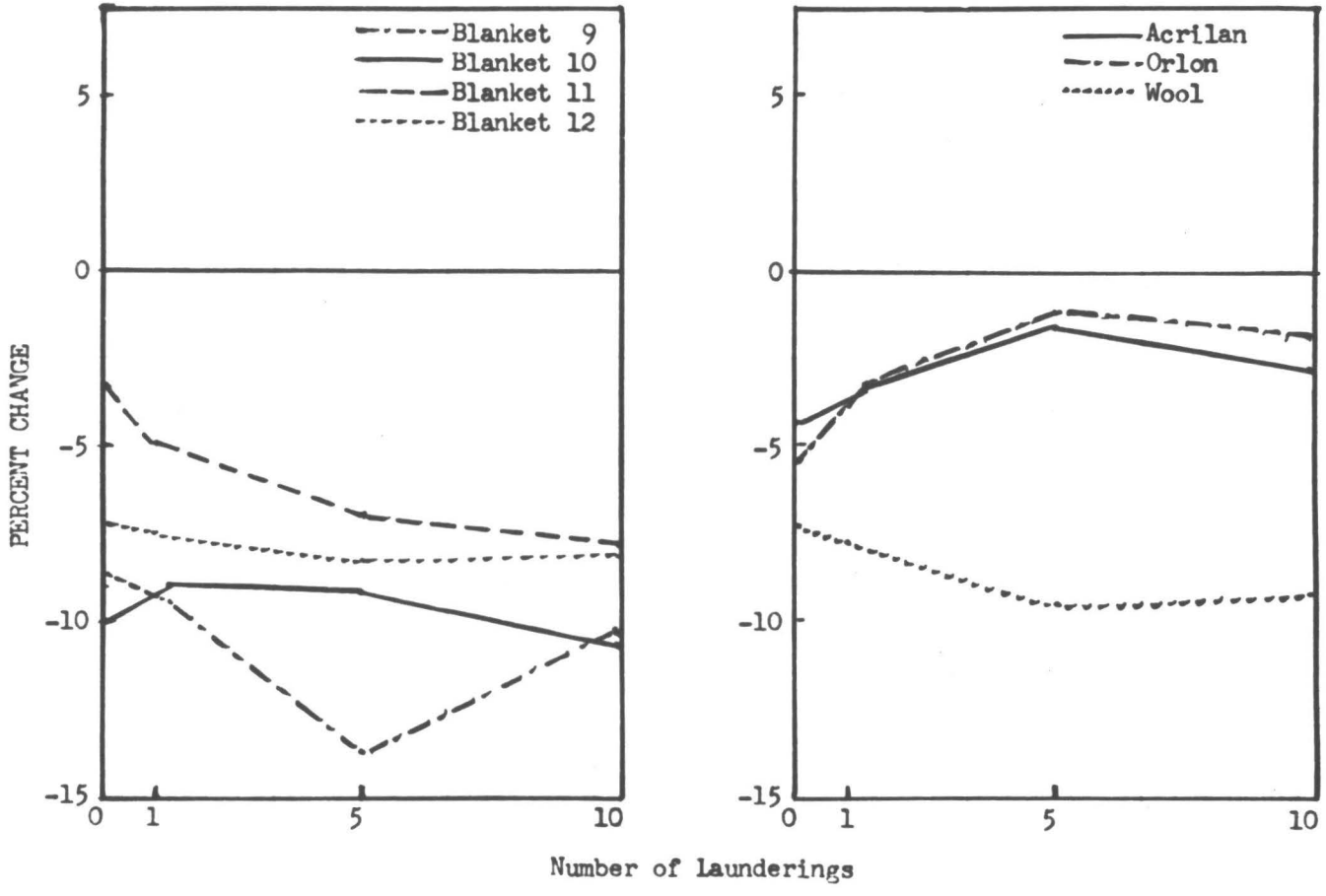

Figure 4. PERCENTAGE CHANGE IN WEIGHT AFTER ABRASION

After abrasion following one laundering all four Orlon blankets decreased less in weight than when unlaundered.

Blankets 6, 7, and 8 continued a slightly smaller percentage decrease in weight after abrasion following five launderings than one laundering, although the decrease was very slight for blanket 6.

Orlon blankets 7 and 8 had a slightly greater percentage decrease in weight after abrasion, and blanket 6 decreased in weight slightly less after abrasion following ten launderings than after five launderings.

Wool Blankets

All wool blankets decreased in weight after abrasion following all laundering periods.

After abrasion all four unlaundered wool blankets decreased in weight.

After abrasion following one laundering three wool blankets continued to decrease slightly in weight; however blanket 10 decreased slightly less in percentage loss in weight as compared with the unlaundered fabric.

After abrasion following five launderings all of the wool blankets decreased in weight as compared with one laundering, the largest decrease being found in blanket 9.

After abrasion following ten launderings wool blankets 10 and 11 decreased slightly more in weight than following

five launderings. The percentage decrease in weight for blankets 9 and 12 after abrasion following ten launderings was slightly less than after five launderings.

Visual Changes

Plate I readily depicts the change in texture obtained by abrading an unlaundered Acrilan blanket. The fibers have become drawn out, matted and tangled. During the abrasion process some fibers have been pulled or broken from the body of the sample and have attached themselves to other fibers in the manner of spinning yarns from short staple fibers. As some of these projecting fibers were fairly long, they gave a rough, fuzzy surface that increased the thickness. Enough of these fibers were out and lost to cause a percentage decrease in weight; however the matted condition resulted in an increase in thickness throughout the several steps of abrasion. After abrasion one of these Acrilan blankets had the appearance of fur cloth.

Plate II depicts an Orlon blanket fabric with the same type of increase in thickness as in Acrilan due to the matting and attaching of loose fibers to the surface during abrasion. Although this change occurs in Orlon in much the same manner as it does in Acrilan, the Orlon does not seem to become as fuzzy. When compared with Acrilan

and wool, the Orlon blankets could be said to be intermediate in apparent thickness after abrasion.

Plate III pictures wool blankets before and after abrasion. The abraded wool blankets are matted and covered with tufts or pills rather than having fuzzy surfaces as did the Acrilan and Orlon blankets.

Ball and Lester (4, p. 750; 17, p. 209) stated that, in the first stages of abrasion, wool mats to give a flannelette-like surface, with tiny tufts or pills that are more or less rigidly attached to the surface. Lester further stated that he feels that this flannelette-like surface delays wear by abrasion to some extent.

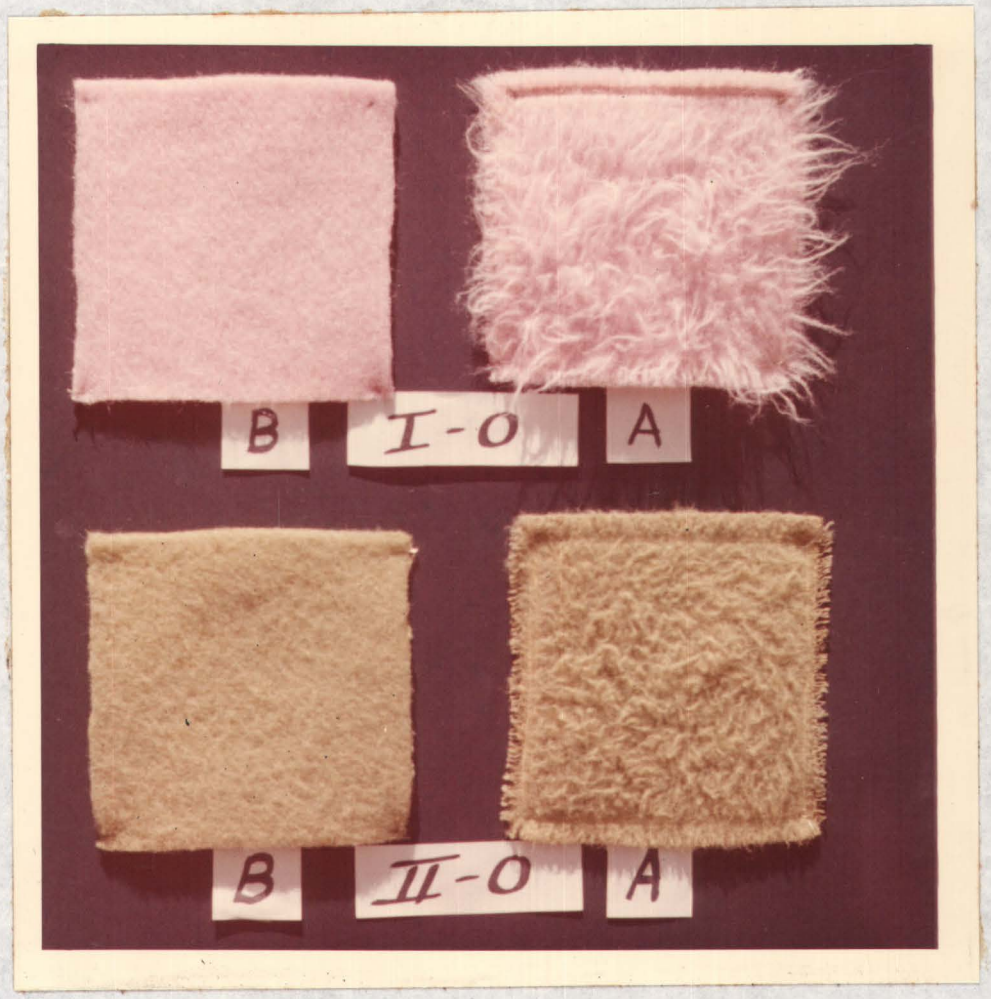

PLATE I. TEXTURE OF TWO ACRILAN BLANKETS
BEFORE (B) AND AFTER (A) ABRASION

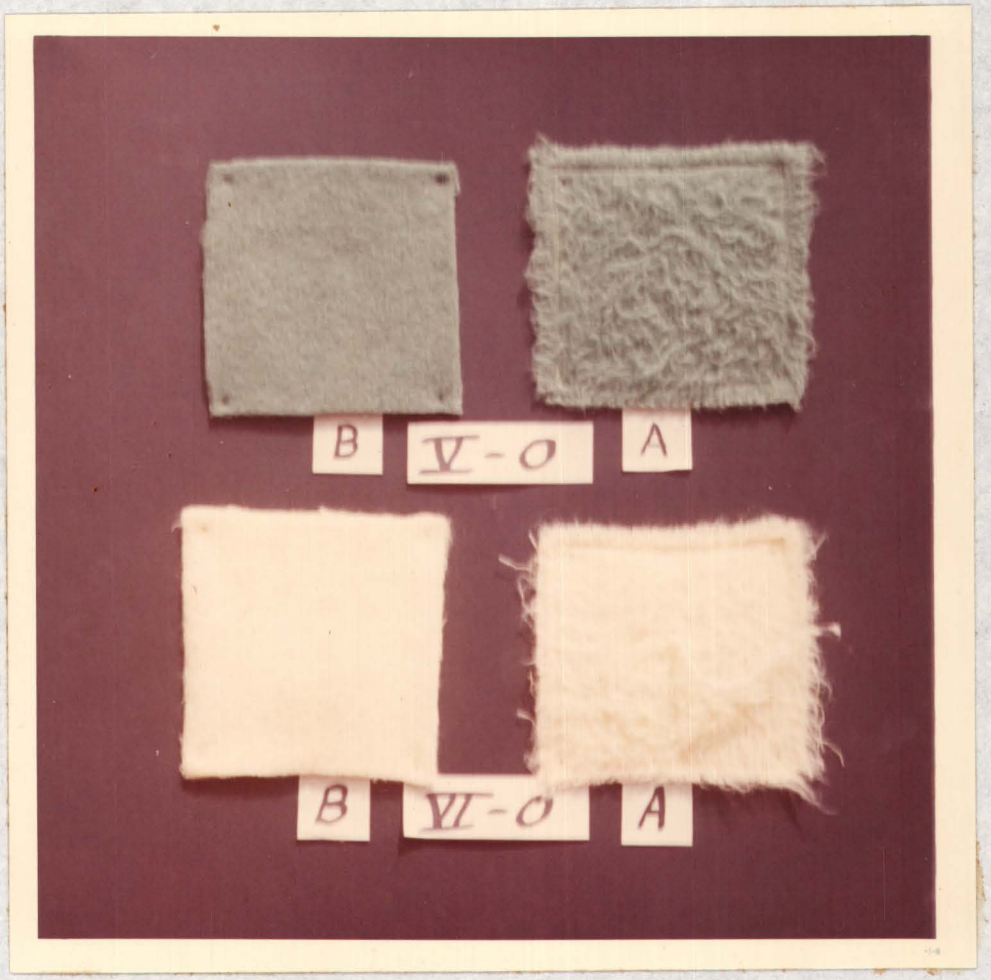

PLATE II. TEXTURES OF TWO ORLON BLANKETS BEFORE (B) AND AFTER (A) ABRASION

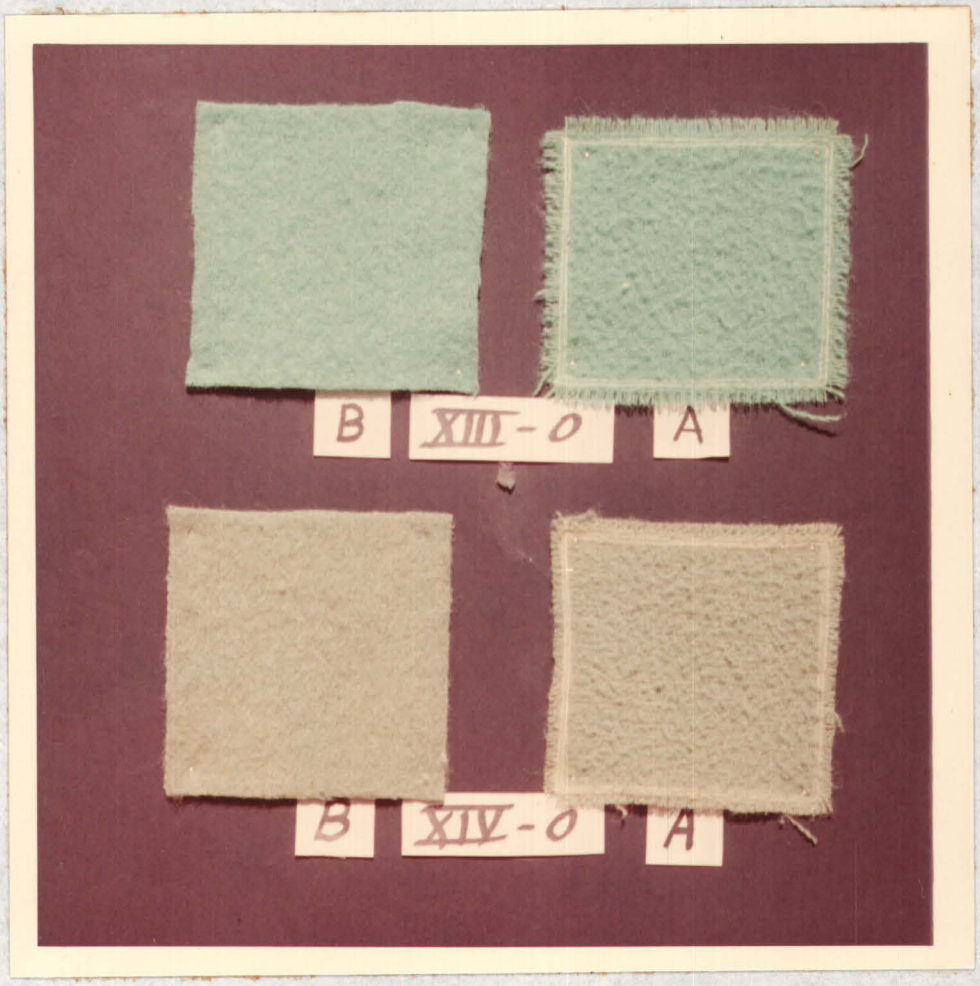

PLATE III. TEXTURES OF TWO WOOL BLANKETS
BEFORE (B) AND AFTER (A) ABRASION

CHAPTER V

SUMMARY

Blankets of both Acrilan and Orlon tended to gain in thickness after any abrasion with one exception, while the wool blankets tended to decrease in thickness after any abrasion with one exception. These exceptions probably resulted from the variations in characteristics among the individual blankets. Among all three fibers, the thickness tended to decrease after abrasion following ten launderings as compared with five launderings. Comparison indicates that in Acrilan and Orlon blankets the behavior of individual blankets differed more in thickness after abrasion when unlaundered or after onelaundering than after five or ten launderings.

With few exceptions blankets made of the three fibers decreased in weight after abrasion at all laundering periods; the percentage of decrease in weight of wool blankets tended to be somewhat greater than for Acrilan and Orlon. The percentage of weight decrease of Acrilan and Orlon blankets after abrasion following all laundering periods are about equal with two exceptions. These exceptions, one blanket each of Acrilan and Orlon, were probably the result of the variations among the properties of individual blankets.

Ball (4, p. 750) stated that such increases as are found in thickness and weight are due to the cutting and breakage of fibers that are teased from the outer edges of the samples and are then matted with the fibers on the surface of the specimen. He further stated that, as abrasion continues, the point is finally reached where the fibers fall out faster than they can be matted, and thus a decrease in weight and thickness occurs. He continued that some fabrics, as well as some yarns, have such a structure that they load with the particles of the abradant and their own detritus, causing an increase in weight and thickness in the early stages of abrasion. This same information is in accordance with findings of Lester and Macormac (17, p. 209; 18, 149).

The comparison of visual changes among the blankets of the three fibers revealed that the surface of the Acrilan and Orlon blankets tended to mat and become fuzzy after abrasion at all laundering periods; however Orlon did not seem to become as fuzzy as the Acrilan blankets. Wool blankets, unlike the blankets of the other two fibers, did not fuzz but pilled instead. The appearance of all three types of blankets was unattractive after abrasion.

On the basis of this study it appears that it would be a fallacy to select a blanket of any one of these fibers as the best of the group, for each fiber has points of strength and points of weakness. The differences in

appearance, after abrasion, could not alone be called a valid test by which one should select a blanket. Similar changes in thickness might be related to warmth of blankets, therefore further study of other characteristics of blankets of each fiber is necessary before any definite selection of any one blanket could be recommended with confidence.

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