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TEXTILE PROCESS

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This invention relates to textile fabrics and methods of producing the same and is directed, more particularly, to a novel method of creping fabrics containing yarn composed at least in part of organic hydrophobic fibers and the product produced thereby.

Fundamentally, the phenomenon of creping is primarily due to longitudinal contraction of yarn to which a high level of twist has been imparted, which yarn exhibits a great tendency to untwist when freed from restraint and, thus, may be said to possess a large amount of latent torsional energy. This tendency to untwist is a characteristic common to all yarns, regardless of their chemical nature or composition.

A second factor which contributes to the crepeability of particular yarns is the characteristic of swellability in water, particularly hot water. It should be apparent that if the yarn swells radially it possesses a much greater tendency to untwist than would be exhibited were the yarn nonswellable in water.

In woven fabrics, the individual strands of yarn are held under restraint both at the selvages and by the interlacing of warp and filling so that the yarns are not free to untwist or to form complete loops. They are free, however, to form partial or open loops which buckle or crinkle the yarns and produce the characteristic appearance at the surface of the fabric which is termed "crepe" or "pebble."

Generally, the prior art processes of creping are based upon the contraction in length of high twist yarn due to the tendency of hydrophylic yarns to swell on wetting. Since this factor increases the latent torsional energy of the high-twist crepe yarns which comprise the fabric, the amount of this energy available is sufficiently great to permit the fabric to be conveyed through the creping bath in open width, even though it is under a small amount of tension by reason thereof, and still undergo a satisfactory physical change. Thus, it is conventional to crepe fabrics composed of water swellable yarns, such as viscose rayon, silk, wool and, to some extent, acetate rayon, by treatment of the fabric in book fold form, in loop or reeled form on star frames, or by continuous treatment using the trough or lattice systems.

In the case, however, of yarns which are highly hydrophobic as, for example, nylon, Orlon acrylic fiber and Dacron polyester fiber which when immersed in hot water either do not swell or if they swell do so only a very slight amount and much less than the yarns mentioned in the preceding paragraph. The latent torsional energy of hydrophobic yarns is, therefore, not measurably increased by immersion in a creping bath, and the conventional creping treatments have proved completely ineffectual on fabrics comprising these yarns. We do not means to imply by the foregoing statement that there cannot be found in the patent and other technical literature various descriptions of suggested processes for preparing crepe-like fabrics with yarns of the above-mentioned type. Such suggested processes, however, involve

expensive techniques as, for example, introduction of excessive high twist into the yarn, usually by two-step process or by steaming during twisting; preparation of a composite yarn by plying together shrinkable and nonshrinkable yarns; treatment of the yarn with a chemical softening or swelling agent, which results in a fabric of relatively little strength; or by other means which yield a flat-faced fabric having little or none of the appearance of a true crepe.

It is, therefore, the object of this invention to provide a method of creping yarns of the highly hydrophobic type, which method does not involve the use of chemical agents, composite yarns or an excessive amount of twist in the yarn.

The highly hydrophobic yarns, being substantially nonswellable in water, do not possess a sufficient amount of latent torsional energy to crepe when the fabric is under a slight amount of tension, as when it is being conveyed through a creping bath in open width. On the other hand, we have observed that even when the fabric is handled in rope form, i.e., more or less randomly bunched together but not twisted, and, thus, is not under fillingwise tension, it is impossible to obtain a uniform crepe appearance. In this form, the fabric is, of course, heavily creased or bent and, as is the case when any member is bent, the convex side thereof is under tension while the concave side is under compression. In seeking to equalize these stresses, the yarns shift away from the locus of each crease, displacing the warp yarns laterally, spacing them apart in some places and grouping them together in others, with the production of thick and thin places. These thin places are, in effect, openings in the cloth which are known in the art as "cracks." It is also our belief that the thermoplastic nature of the highly hydrophobic yarns contributes to the formation of creases and/or cracks in that the yarns when introduced suddenly into a high temperature bath are heat set in a creased and cracked configuration.

As a result of extensive experimentation, we have discovered that true crepe fabric constructed, at least in part, of yarns of highly hydrophobic fibers can be produced by a process similar, in many respects, to the conventional process but differing therefrom in at least two essential steps or conditions. The first of these is that agitation of the fabric is essential for the production of satisfactorily creped fabrics of the above-mentioned class of yarns. One of the beneficial effects of agitation is that when the fabric is agitated the sites of the creases are constantly shifting so that there is no opportunity for the creases to become established at any point given in the cloth and, in addition, the yarns have no fixed locus from which to shift. More important than this, however, is the action of agitation in imparting additional energy to the fabric. The need for this additional energy has been conclusively proved. For example, if a swatch of fabric woven in a crepe construction from nonswellable yarns is suspended full width so that no cracks will be formed in a tank of water the temperature of which is then raised to the creping range, no crepe is formed. If, on the other hand, an identical swatch is given the same treatment but, in addition, is agitated while in the tank, an excellent crepe will be produced. The function of the energy of agitation is not fully understood; it is believed, however, that this added energy acts to trigger-off the release of the latent torsional energy in the yarn in a manner analogous to the ignition and burning of flammable material.

The second of these essential conditions is that the temperature of the creping bath into which the fabric is to be introduced must be maintained initially at room temperature or, at least, at a temperature below that of

any previous heat treatment to which the yarn may have been subjected, and then gradually or incrementally raised during the creping procedure to the full creping temperature. By virtue of this treatment, creping occurs gradually or progressively, rather than instantaneously, and the cracks are not given an occasion to develop at any given location, with the result that creping takes place uniformly throughout the full width and length of the fabric. It is to be understood that the agitation previously referred to is to be effected simultaneously with the incremental elevation of temperature of the creping bath, rather than in a separate operation. Unless these two conditions are observed, fabrics constructed of yarns of hydrophobic fibers either will not crepe at all or will crepe in such a nonuniform manner as to be virtually worthless.

The particular means for providing the agitation does not appear to be important, provided the agitation is quite violent in nature. The fabric may be mechanically agitated, or it may be subjected to the action of jets of steam, compressed air or to sonic or supersonic vibrations. As disclosed in our application Serial Number 210,088, filed February 8, 1951, now abandoned, of which the present application is a continuation-in-part, creping may be effected in batchwise or noncontinuous fashion by treatment of the whole of a length of cloth in a rotary wash wheel. Since the filing of that application, we have discovered that the process of creping by the instant invention can be carried out continuously by the use of a rotary wash wheel of the horizontal cylinder type which is geared to oscillate through a limited angle of rotation, i.e., not more than about 140°, and is provided with suitable openings adjacent the two ends thereof to permit the continuous ingress and egress of a length of fabric in rope form. Where but a single such machine is available, continuous treatment may be carried out by joining the ends of the single piece together so that the piece forms a continuous length of cloth which can be repeatedly passed through the wash wheel, the temperature of the bath being elevated after each pass or any desired number of passes. Where a number of these machines can be utilized, they may be arranged end on end, a number of lengths of cloth being joined together and passed successively from machine to machine, the temperature of the liquor contained in each successive machine progressively increasing until the maximum creping temperature is attained in the last machine.

Irrespective of the means by which the fabric is agitated, provided the fabric structure is one suited for creping and is introduced into the bath liquor at low temperature and the agitation is commenced promptly at such low temperature, satisfactory creping occurs when the liquor is brought relatively slowly to or above the creping temperature. The optimum temperature for creping varies, to some extent, with the particular fiber of which the creped yarn is composed and, also, with the previous treatment of the yarn. For fabrics composed of pre-steamed crepe yarns, the best results to date have been obtained when the bath liquor has been raised from room temperature to a temperature of about 200° F. over a period of about twenty to thirty minutes, then held at that temperature for about twenty minutes. It is believed, however, that creping of such fabrics starts at a temperature well below 200° F., say 160° F., or lower, and is possibly complete before 200° F. is reached. In any event, the final temperature must exceed that of any heat treatment to which the yarn may have been subjected prior to creping. If the high twist yarn in the fabric is not heat treated prior to the weaving operation to reduce its liveliness, satisfactory creping can be effected at temperatures lower than those mentioned above.

Any fabric construction conventionally employed for creped fabrics may be followed in weaving the new fabric. For example, the warp may be low twist yarns of either hydrophobic or hydrophilic fibers and the filling of high twist yarn of hydrophobic fibers. If desired, the fabric may be embossed under pressure before the creping treatment. The benefits of our process are not confined to fabrics containing yarns of crepe twists; fabrics which contain yarns of intermediate twists can also be treated advantageously. Fabrics woven from hydrophobic yarns of voile twist passed through conventional crepe finishing without permanent surface deformation can be made to develop an interesting and pleasing surface appearance by the new process.

The following nonlimitative examples indicate specifically how the instant process may be applied to fabrics of different materials and of different constructions.

Example I

Eighty yards of nylon crepe fabric, comprising a warp of 156 ends per inch of 40 denier, 34 filament, 10 turn (Z twist) nylon yarn with a filling comprising 70 denier, 34 filament, 65 turn nylon yarn woven alternately 2 picks S twist and 2 picks Z twist, 90 picks per inch, the filling having been conditioned at 190° F. dry bulb and 185° F. wet bulb temperatures for one hour, is prepared for creping by embossing at 10 tons pressure, with a roll temperature of 320° F. and at a speed of 50 yards per minute using a roll in which a crepe pattern has been engraved. The fabric is then folded loosely and is entered into a rotary wash wheel of the horizontal cylinder type having inside dimensions of 54 inches in diameter by 60 inches in length. The wheel is equipped for the injection of steam into the bath liquor during operation and is driven at a constant speed of approximately ten revolutions per minute. After entering the fabric, water at room temperature is admitted to give a liquid level of approximately 10 inches inside the cylinder and the wheel is started in motion (rotation may be unidirectional or forward-and-reverse). Steam is injected to raise the temperature at such a rate that the contents of the wheel will attain a temperature of 200° F. in from twenty to thirty minutes and after attaining this temperature it is held constant for an additional ten-minute period. The water is then dumped from the wheel and the fabric is rinsed twice, after which it will be found to be completely and uniformly creped. The material may then be dried and heat set, dyed, and subjected to any other normal finishing operations which are used for nylon or crepe fabrics. The finished fabric has a uniform fine pebble and may be used for dresses and blouses.

Example II

Filling yarn of 150 denier, 41 filament, 62 turn bright acetate is steamed on quills for one-half hour at 140° F. dry bulb and 120° F. wet bulb temperatures and is then woven alternately 2 picks S twist and 2 picks Z twist, 63 picks per inch, into a warp of 114 ends per inch of 100 denier, 60 filament, 3 turns per inch viscose continuous filament yarn. The woven fabric in dry state in then packed loosely in an open mesh bag which is introduced into the rotary wash wheel of Example I. Cold water is then introduced into the cylinder and the wheel started in motion. Steam is injected to raise the temperature of the water to 180° F. in twenty to thirty minutes and, after attaining this temperature, it is held constant for about five minutes. After rinsing and drying the fabric is found to be completely and uniformly creped. The pebble of this fabric is somewhat coarser than that of Example I.

Example III

Seventy denier, 34 filament, 65 turns per inch Du Pont Dacron yarn is wick-sized during quilling to contain approximately 2 percent of a partially hydrolyzed, low viscosity polyvinyl alcohol. The wound quills are then steamed for two hours at 190° F. dry bulb and 180° F. wet bulb temperatures. The yarn is then woven alternately 2 picks S twist and 2 picks Z twist, 100 picks per inch, into the nylon warp of Example I. The fabric is

then given the treatment of Example I, resulting in a uniformly creped material ready for dyeing and finishing. The creped fabric has a fine pebble and is suitable for use in linings and lingerie.

Example IV

Two hundred denier, 80 filament, 44 turns per inch Du Pont Orlon yarn is quilled at 15 to 25 grams tension. The wound quills are steamed for two hours at 190° F. dry bulb and 180° F. wet bulb temperatures and the yarn then woven alternately 2 picks Z twist and 2 picks S twist, 63 picks per inch, into the viscose warp of Example II. The fabric is then given the treatment Example I, resulting in a crepe fabric having an appearance similar to tissue faille.

Example V

Filling yarn of 70 denier, 34 filament, 55 turn nylon is sized during quilling and then woven, without preliminary steaming, 2 picks S twist and 2 picks Z twist, 86 picks per inch, into a nylon warp comprising 70 denier, 34 filament, 55 turns per inch, 1 S twist and 1 Z twist, 140 ends per inch. The woven fabric is embossed cold under 10 tons pressure at 20 yards per minute and entered into the wash wheel of Example I. Water at 70° F. is admitted to the wheel and agitation started. The temperature of the bath is raised to 210° F. in twenty minutes, the liquor then dumped and the fabric rinsed twice in water at 140° F. The creped fabric is then dried, heat set and dyed. A crepe of relatively coarse pebble, suitable for blouses and dresses is produced.

Example VI

Filling yarn of 70 denier, 34 filament, 65 turns per inch nylon is steamed on quills at 190° F. dry bulb and 185° F. wet bulb temperatures for one hour and then woven 2 picks S twist and 2 picks Z twist, at 96 picks per inch, into a warp of 50's cotton yarn, 110 ends per inch. The woven fabric is embossed at 320° F. under 10 tons pressure at 50 yards per minute and then introduced into the wheel of Example I. Water at room temperature is entered into the wheel to a level of 10 inches. Agitation is begun and the temperature of the bath raised to 200° F. in twenty minutes and then held at that temperature for ten minutes, agitation being continued throughout both periods. The bath is then dumped, the fabric rinsed twice in cold water, then dried, heat set and dyed. The creped fabric has a novel appearance and is suitable for use in blouses and dresses.

Example VII

A crepon as distinguished from a true crepe is produced by the process of any one of the foregoing examples when the fabric is constructed with a warp of low twist yarns and a filling of high twist organic hydrophobic yarn woven all S twist or all Z twist.

Example VIII

A fabric, comprising a warp of 130 ends per inch of 40 denier, 34 filament, 26 turn nylon yarn, arranged with alternate ends of S and Z twist, and a filling comprising 70 denier, 34 filament, 7 turn (Z twist) nylon yarn woven at 70 picks per inch is treated in accordance with Example II. The finished fabric is not a crepe, but presents an unusual striated appearance due to the finishing treatment. The striations are approximately 1/16 inch to 1/8 inch long and run at right angles to one another and at 45° with respect to the warp and filling directions. When finished without agitation, the striations, which are apparently caused by slight displacements of warp and filling yarns, do not appear in the final fabric.

Example IX

Flling yarn of 70 denier, 34 filament, 65 turn nylon which has been steamed on quills for one hour at 155° F. dry bulb and 150° F. wet bulb temperatures is woven alternately 2 picks S twist and 2 picks Z twist, 94 picks per inch, into a warp of 180 ends per inch of 30 denier, 10 filament, 10 turns per inch nylon continuous filament yarn. Six yards of an 80-yard length of this fabric are then threaded into a rotary wash wheel of the horizontal cylinder type having inside dimensions of about 20 inches diameter by 36 inches in length, being equipped at its top adjacent the ends thereof with suitable openings through which the cloth can be fed into and withdrawn from the wash wheel. The leading end of the cloth is stitched to the trailing end thereof so that the cloth forms a continuous rope, a portion of which is inside the rotary wash wheel. Eight inches of water is then admitted into the wash wheel and the wheel started in motion at an oscillation rate of 38 per minute, each oscillation being approximately through a 116° arc. The cloth is fed continuously through the machine, being admitted at one end thereof and withdrawn from the other at the rate of about 6 yards per minute, 6 yards being continuously maintained within the wheel. The water initially admitted into the wash wheel is at room temperature and thereafter, following each complete pass of the entire length of cloth through the wheel, the temperature is progressively raised to 85°, 100°, 115°, 130°, 145°, 160°, 175°, 190° and 205° F. The fabric, removed from the wheel and rinsed, is found to have shrunk approximately 15 percent warpwise and 13 percent fillingwise. After drying, framing and heat setting in a manner conventional in the art, the shrinkage is approximately 8 percent warpwise and 9½ percent fillingwise. The finished material possesses a very uniform crepe appearance with a small pebble, having good draping qualities with a slightly crisp feel.

Example X

Woven fabric similar to that of Example IX, excepting that the filling was twisted to 55 turns per inch, is boiled-off in the manner specified in the foregoing example and is found to have a shrinkage of approximately 14 percent warpwise and 9 percent fillingwise. After finishing, the material was a very uniform "crepe-de-Chine" which draped well and possessed a slightly softer feel than the finished fabric of Example IX.

Example XI

For purposes of comparison, a sample of the fabric used in Example IX is suspended in open width on a rod in a tank of cold water. The temperature of the water is then increased to 200° F. over a period of ten to fifteen minutes without agitation, except such as might come from convection currents within the tank. The fabric does not crepe and is very flat except for a few cracks.

Example XII

A length of fabric comprising a filling of 100 denier, 40 filament, 50 turns per inch Orlon acrylic yarn woven 2 picks by 2 picks alternately S and Z twist at 62 picks per inch in a warp of 70 denier, 34 filament, 7 turns per inch nylon, 130 sley, was boiled-off as in Example IX. The shrinkage after the boil-off was 5 percent warpwise and 5½ percent fillingwise. The material after conventional finishing processes is found to be a very uniform crepe with a light pebble.

Example XIII

Filling yarn of 75 denier, 24 filament, 75 turns per inch bright acetate steamed on quills at 140° F. dry bulb and 120° F. wet bulb temperatures for thirty minutes is woven 2 picks by 2 picks alternating S and Z twist in a 135 ends per inch warp of 75 denier, 45 filament, 2 turns per inch bright acetate. The woven fabric is embossed in accordance with conventional embossing procedures. A 50-yard length of this fabric is then threaded into

a wash wheel similar to that of Example IX, with the exception that it has an inside diameter of 20 inches and an inside length of 94 inches, 8 inches of water at room temperature having previously been admitted to the wash wheel. The wash wheel is oscillated at a rate of 36 oscillations per minute through an arc of about 140 degrees. The ends of the lengths of cloth are joined together and the cloth fed through the washer at a speed of 18 yards per minute, 5 to 20 yards of the cloth being maintained within the wash wheel at all times. The temperature of the water within the wheel is raised in increments of 15° F. after each complete pass of the cloth through the wash wheel until a final temperature of 180° F. is obtained.

The finished material had shrunk 4 percent warpwise and 5½ percent fillingwise and was an excellent light crepe with a fine pebble, possessing a pleasing hand and good drapability.

Example XIV

Filling yarn of 75 denier, 24 filament, 65 turns per inch dull acetate is woven 2 picks by 2 picks, alternately **S** and **Z** twist, at 85 picks per inch into a 150 ends per inch warp of 75 denier, 45 filament, 2 turns per inch bright acetate, the filling having been steamed as in the preceding example. Without being embossed, the woven fabric is boiled-off in the wash wheel described in Example XIII, containing about 8½ inches of water, and oscillated at about 38 oscillations per minute through an arc of 120 degrees. The fabric is fed into and withdrawn from the wheel at a rate of 18 yards per minute, a 36 yard load being maintained within the wheel. The temperature of the water which was initially about 85° F. is raised in 15° increments to a final temperature of 175° F. After being dried and framed the fabric was found to have shrunk 5 percent in the direction of the warp and 4 percent in the direction of the filling and was a quite uniform "crepe-de-Chine" with good drape and a soft hand.

From the foregoing description and, particularly, from the specific examples illustrative of the new process, it will be apparent that the yarn treatment, fabric construction and treating temperatures all may be varied widely and, therefore, that limiting conditions applicable for different fabric constructions cannot readily be specified. The following conclusions or general directions can, however, be stated. If the high twist hydrophobic yarn is not subjected to a heat treatment prior to weaving, the woven fabric can be creped at a much lower temperature than would be necessary had the fabric undergone a heat treatment, provided, of course, that agitation in the fabric is continued during immersion of the fabric in the bath. If, in order to facilitate quilling and weaving, resort is had to preheating of the high twist yarn, the fabric must be introduced into the creping bath at a temperature below that at which the crepe yarn was conditioned and the temperature of the bath, to insure good creping, should be raised to a temperature above that at which the yarn was conditioned. It is believed that creping starts below the preheating temperature but is not completed until the high temperatures are reached. Agitation must be maintained throughout the period that the fabric is in the creping bath. A lower limit of the temperature range within which the creping occurs is probably between 30° and 50° F. below the temperature at which the creped yarn was heated.

The process of the present invention is believed applicable to all organic hydrophobic yarns and is not limited, therefore, to the creping of fabrics containing the particular yarns mentioned in specific examples or the particular fabric constructions of such examples. In addition, it is capable of minor variations in accordance with the knowledge of the art, as for example, soaps or detergents can be added to the creping baths or the process can be practiced concurrently with a dyeing operation.

Having thus described our invention, that which is claimed is:

1. A method of creping fabrics comprising yarns which are substantially nonswellable in a high temperature aqueous medium which method comprises introducing a fabric, formed at least in part from twisted yarns having sufficient latent torsional energy to cause said yarns to form into open loops upon efficient release of said energy, into an aqueous creping bath at room temperature, initiating agitation of the bath immediately thereafter, gradually elevating the temperature of said bath until a temperature of at least 140° F. is attained and creping is complete, agitation being maintained throughout the treatment, withdrawing said fabric from said bath, and drying the same.

2. The method of claim 1 wherein said fabric is continuous lengthwise, a portion of said fabric in excess of the length of said bath being introduced into said bath prior to initiation of said creping treatment, and thereafter during said treatment, said fabric being continuously fed into and withdrawn from said bath, the rate of feed being slightly in excess of that of withdrawal to permit said fabric to shrink.

3. The method which comprises subjecting a fabric composed, at least in part, of organic hydrophobic fibers having sufficient latent energy to cause said fibers to form into open loops upon efficient release of said energy, to the action of an aqueous bath, and progressively increasing the temperature of the thus wetted fabric from about room temperature to at least about 140° F., while simultaneously agitating the fabric, to thereby result in the release of at least a portion of said latent energy.

4. A method of creping fabrics containing yarns of hydrophobic fibers which comprises conveying a fabric formed at least in part from twisted yarns having sufficient latent torsional energy to cause said yarns to form into open loops upon efficient release of said energy, through a region, the temperature of which is gradually increased from about room temperature to, at least, about 140° F. while at the same time causing said fabric to be agitated.

5. The method of claim 4 wherein said creping region comprises a plurality of zones, the first of which is maintained at about room temperature, the temperature of each successive zone being maintained at progressively higher temperatures, that of the last zone being, at least, about 140° F. and said agitation is effected in all of said zones.

6. The method of claim 4 wherein said region comprises a single zone through which the fabric is repeatedly passed, the temperature of said zone being maintained initially at room temperature and progressively increased after predetermined numbers of passes of fabric until a temperature of at least about 140° F. is reached.

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