

[54] **METHOD FOR CRIMPING CELLULOSIC FIBERS AND CRIMPED CELLULOSIC FIBERS OBTAINED THEREBY**

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[57] **ABSTRACT**

A method for manufacturing crimped yarns comprising cellulosic fibers, which comprises imparting distortion for a crimping treatment to a yarn comprising cellulosic fibers, subjecting the yarn to a caustic alkali treatment and a resin finishing treatment for imparting wet crease resistance. The crimped cellulosic yarns obtained thereby, and knitted or woven fabrics made of these crimped yarns.

6 Claims, No Drawings

METHOD FOR CRIMPING CELLULOSIC FIBERS AND CRIMPED CELLULOSIC FIBERS OBTAINED THEREBY

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a method for manufacturing crimped cellulosic fibers so as to impart durable crimps and excellent crimp-recovery characteristics to such fibers. Also, the invention relates to crimped cellulosic yarns obtained by this crimping method, and knitted or woven fabrics made of said crimped yarns.

2. Description of the Prior Art

Crimped yarns have been widely used for various apparel uses because of their unique stretchability, bulkiness and feel, and various crimping methods have been proposed previously. For example, synthetic fibers are mechanically crimped, and then heat-set, by utilizing their thermoplasticity. Or a method is employed in which synthetic fibers composed of two components which are different in their stretching and shrinking behaviors are crimped by stretching or heat-shrinking them. These methods give comparatively good crimps to synthetic yarns by dint of the thermoplastic characteristics of the resins that constitute the fibers. These methods, however, are naturally inapplicable to cellulosic fibers which have quite different characteristics. Even if the cellulosic fibers are processed by such methods, the crimps obtained are only temporary.

With a view to solving this problem, there was proposed a method which comprises strongly twisting a cellulosic yarn, weaving or knitting the twisted yarn, and then treating the resulting woven or knitted fabric with hot water or caustic alkali. According to this method, however, the degree of crimp is limited by the number of twists, and good crimps cannot be obtained. Also, the crimp-recovery characteristics and crimp durability of the crimped cellulosic yarn is of extremely low degrees, and the crimps are liable to disappear even by slight tension. A further defect is that the resulting woven or knitted fabric exhibits non-uniformity owing to irregularities in crimps of the component yarns. Thus, no satisfactory method has yet been realized for crimping cellulosic fibers, and no commercially feasible crimped cellulosic fibers have ever been provided. We have assiduously worked for removing these defects, and completed the present invention.

An object of this invention is to provide a method for manufacturing crimped cellulosic fibers to impart durable superior crimps and crimp-recovery characteristics thereto without appreciably reducing their tenacity. It is a further object of this invention to provide crimped cellulosic yarns processed by said method, and also woven and knitted fabrics composed of said crimped cellulosic yarns.

SUMMARY OF THE INVENTION

This invention provides a method for manufacturing crimped yarns comprising cellulosic fibers, which comprises imparting distortion for crimping treatment to said yarns, subjecting the yarns to a caustic alkali treatment and a resin finishing treatment for imparting wet crease resistance, crimped cellulosic yarns obtained by said method; and knitted and woven fabrics composed of these crimped yarns. These crimped yarns and knitted and woven fabrics have the useful property of in-

stantaneously regaining their crimps upon passing water when the crimps are reduced.

DETAILED DESCRIPTION OF THE INVENTION

The yarns comprising cellulosic fibers as used in the present invention are those obtained by spinning cellulosic fibers alone such as cotton, flax or viscose fibers, mixtures thereof, or mixtures of these cellulosic fibers with other fibers. Examples of the other fibers are polyester, polyamide or cellulose acetate fibers. The mix-spun yarns of the cellulosic fibers and the other fibers contain at least 50% by weight of the cellulosic fibers. Even those mix-spun yarns which contain less than 50% by weight of the cellulosic fibers can be processed into good crimped yarns by properly combining the crimping method of this invention with the conventional mechanical crimping method. Twisting at the time of spinning may be of the same degree as is usually practised, and it is not particularly necessary to impart strong twisting. Depending upon the purpose intended, the twist is either loose or strong.

For imparting distortion, the expedients used for producing conventional crimped yarns are generally applicable. Means for imparting distortion by twisting the yarn and means for imparting distortion by knitting the yarn are especially preferred. The stuffer box method and the gear molding method by which to impart toothed configurations to the yarn by a heated gear can also be employed, but where these methods are employed, the distortion imparting step is carried out during the alkali treatment or resin finishing treatment. Twisting is effected by twisting two or more single yarns by using a conventional twister. The number of twists employed at this time is about 10 to 50 per inch. If the number of twists is less than 10, good crimps are not obtained, and if it exceeds 50, the yarns tend to break. Preferably, the number of twists is at least 20 per inch, more preferably 30 to 40 per inch.

Where distortion is imparted by knitting, the yarn may be knitted either into a weft knitted fabric or warp knitted fabric. However, since the warp knitted fabric is produced from a number of yarns that have been warped, it is somewhat difficult to deknit the long yarns continuously, and therefore, the weft knitted fabric is preferred in the present invention. The texture of the knitted fabric may be of a plain stitch, interlock stitch or tuck stitch. In order to obtain one continuous yarn, a knitted fabric of the plain stitch made of one yarn is advantageous.

In case of imparting distortion to the yarn by twisting or knitting, the resulting twisted yarn or knitted yarn is detwisted or deknitted after alkali treatment and resin finishing treatment.

The sequence of the alkali treatment and the resin finishing treatment is optional. From the viewpoint of crimpability, better results are obtained generally by performing the alkali treatment first. However, the sequence can be freely chosen, and it is also possible to perform the alkali treatment during the course of the resin finishing treatment.

The alkali treatment can be effected by applying an aqueous solution of an alkali hydroxide to a yarn which has been given distortion, for example, a twisted yarn or knitted fabric by spraying or padding, and if desired, subjecting it to tension. The concentration of the alkali hydroxide in the aqueous solution is 100 to 350 g/liter, preferably 200 to 300 g/liter. If the concentration is

lower than 100 g/liter, the degree of crimps is low, and when such a yarn is formed into a knitted fabric, the product is substantially the same as that knitted from an uncrimped yarn. Even when the resin finishing treatment is performed in combination, durable crimps cannot be obtained. On the other hand, if the concentration is in excess of 350 g/liter, no appreciable great improvement in the state of crimps, the durability of crimps and crimp-recovery characteristics is obtained, and the cost of processing becomes rather high. This therefore is disadvantageous in actual production. The alkali treatment is carried out at a temperature not higher than 50°C., usually at room temperature, and the time of contact of the yarn with the alkali is about 20 to 120 minutes. After the treatment, the alkali hydroxide adhering to the yarn is removed by washing with hot or cold water.

The resins that are used for the resin finishing treatment are the kind which imparts the fibers crease resistance in the wet state. Such a resin may, for example, be (1) compounds having in the molecule at least two groups selected from vinyl and epoxy groups, or compounds which are convertible to compounds having at least two epoxy groups during the resin finishing treatment, (2) compounds having in the molecule at least one vinyl or epoxy group and a methylol group, and (3) cloth finishing resins conventionally used for resin finishing in the wet state.

These compounds classified under (1) to (3) include compounds which have not so high molecular weights as can be named resins, but for convenience's sake, they are also referred to as resins in the present specification and claims.

Examples of the compounds (1) are divinyl sebacate, allyl acrylate, diglycidyl ether, epichlorohydrin, and ethylene oxide. Examples of the compounds (2) are monomethylol acrylamide, dimethylol acrylamide, monomethylol aminostyrene, and dimethylol aminostyrene. Examples of the compounds (3) include glyoxal resins, triazone resins, methylolated alkylene urea resins, and carbamate resins.

The amount of the resin used is 0.5 to 15%, preferably 3 to 10%, based on the weight of the yarn. If the amount is less than 0.5%, durable crimps cannot be obtained, and crimp recovery in the wet state is poor. On the other hand, if it is larger than 15% by weight, the tenacity of the yarn is reduced greatly, and the coefficient of friction of the yarn increases. Furthermore, in case where the distortion is imparted to the yarn by twisting or knitting, during detwisting or deknitting the resulting twisted yarn or knitted yarn, the breakage of the yarn occurs frequently to reduce the productivity extremely. This, in turn, causes difficulty of weaving or knitting of the resulting yarn, and is likely to render the quality of the product commercially infeasible.

The resin finishing treatment is performed by dissolving or dispersing the resin in a solvent, usually water, and applying the solution or dispersion to a yarn in the amount described above by spraying, padding, roller coating or other means, and if desired, heat-treating the yarn under conditions suitable for the resin used. This will be described in greater detail below.

In the case of using the resin under (1) above, such as divinyl sebacate, allyl acrylate or diglycidyl ether, the resin is dissolved or dispersed in water or a mixture of water and an alcohol or other organic solvents in a concentration of 0.5 to 25%, and the solution or disper-

sion obtained is applied to the yarn in the amount indicated above. The yarn is then dried, and then allowed to react in alkalinity. The reaction in alkalinity is performed, for example, by immersing the yarn in sodium hydroxide having a concentration of about 2 g/liter to 100 g/liter, preferably 20 to 70 g/liter, and if desired, squeezing the yarn to a pick-up of about 60 to 200% after immersion, and then allowing the yarn to stand in a high humidity atmosphere. In either case, the treating time is about 20 minutes to 2 hours, and the yarn is subsequently washed with cold or warm water, and dried at a temperature not higher than 100°C.

The amount of the resin to be applied to the yarn can be easily controlled by the concentration of the resin and the amount of the solution or dispersion to be applied. For example, in the case of the padding method, the amount to be applied of the resin can be adjusted to a pick-up of about 60 to 150 by squeezing the yarn with squeeze rolls, frequently used in the usual fabric processing. When the resins of this type are used, the alkali treatment may be carried out before or after the resin finishing treatment, or between the application of the resin and its reaction in alkalinity, for example, in either case, no appreciable difference is observed.

When epichlorohydrin is used as the compound convertible to a compound having at least two epoxy groups in its molecule during the resin finishing treatment, an alkali metal salt of an organic acid is conjointly made present during the resin finishing treatment to convert epichlorohydrin to diglycidyl ether. When ethylene oxide is used, it is converted to diglycidyl ether by adding an alkali hydroxide, iron chloride or tin chloride to the reaction system. Other treating conditions are the same as described above.

In the case of using the resins under item (2), for example, monomethylol acrylamide, dimethylol acrylamide, monomethylol aminostyrene or dimethylol aminostyrene, an aqueous solution of such a resin in a concentration of about 0.5 to 25% by weight is applied to the yarn in the amount indicated above together with a suitable amount of a catalyst as in the case of the resin (1) above, and the yarn is then pre-dried at about 60° to 100°C., after which the yarn is heat-treated for 1 to 15 minutes at 130 to 150°C by using a suitable heat source such as a heating oven or heating roll. The catalyst used for this purpose may, for example, be an acidic type, such as magnesium borofluoride, magnesium chloride or zinc nitrate, and the amount of the catalyst is about 20 to 50% by weight based on the weight of the resin. When a resin of this type is used, excellent durable crimps can be imparted to the yarn whether the alkali treatment is performed before or after the resin finishing treatment. In view of crimpability, somewhat better results are obtained by first performing the alkali treatment and then the resin finishing treatment, but for commercial production, it is advantageous to perform the alkali treatment after the resin finishing treatment because one washing step can be omitted.

In the case of the resin under classification (3), such as a glyoxal resin, triazone resin methylolated alkylene urea resins or carbamate resin, a mainly aqueous solution of the resin in a concentration of 0.5 to 25% by weight is applied to the yarn in the same way as in the case of the resins (1) and (2). At this time, the pH of the solution must be adjusted to 2-5 by adding an acid such as acetic acid, hydrochloric acid, or phosphoric

acid, or a salt composed of a strongly acidic weak base such as magnesium chloride or zinc nitrate. The amount of the solution is such that the pick-up is 100 to 200% based on the yarn, because the yarn must be processed in the wet state. In the case of these resins, too, the crimp properties of the resulting yarn do not differ whether the alkali treatment is performed before or after the resin finishing treatment. If, however, the alkali treatment is carried out first, the dyeability of the treated yarn is somewhat superior, and therefore, for dyeing purposes, this sequence of treatments is preferred.

The greatest feature of this resin finishing treatment is that the resin is intramolecularly crosslinked during the treatment to impart superior wet crease resistance to the yarn. If a resin finishing treatment for imparting dry crease resistance were used instead of the resin finishing treatment in accordance with this invention, it would be impossible to impart durable crimps to the yarn. Furthermore, in this case, the tenacity of the yarn is reduced extremely, as in case where the distortion is imparted to the yarn by twisting or knitting, during detwisting or deknitting the resulting twisted yarn or knitted yarn, the frictional resistance of the surface of the yarn is great owing to a large quantity of the resin adhered thereto, and the tenacity of the yarn is reduced more exceedingly. The feel of a knitted or woven fabric obtained from such a yarn is harsh and undesirable.

After performing the above-described alkali treatment and resin finishing treatment, in case where the distortion is imparted to the yarn by twisting or knitting, a detwisting treatment or a deknitting treatment is subjected to the resulting yarn, thereby to give crimped cellulosic yarns having excellent durable crimps. This completes the entire method of the present invention.

The method of producing knitted or woven fabrics using the crimped yarns obtained by the method of this invention, and the resulting products will be described below.

Knitted or woven fabrics can be produced from the crimped yarns in accordance with this invention using a conventional knitting or weaving machine in a manner known per se.

The resulting fabrics may be formed into outer garments, but owing to the elasticity ascribable to crimps, and the hygroscopicity or anti-static property of the cellulosic yarns, these fabrics are suitable for making use as underwears or undershirts.

Knitting includes warp knitting and weft knitting. In the case of the weft knitting, the crimped yarn is knitted on a single jersey machine, circular knitting machine or full fashion knitting machine under the conventional conditions (the number of gauges 12 - 28, loop length about 3.5 to 13 millimeters), and the resulting knitted fabrics are used for producing various underwear, sport shirts, casual wears, socks, or gloves. In the case of the warp knitting, a tricot knitting machine or raschel knitting machine is used under the conventional knitting conditions. The resulting knitted fabrics are used for various kinds of underwears or casual wears.

Woven fabrics can be produced from the resulting crimped yarns by any conventional weaving machine under the conventional conditions. Woven fabrics of various textures such as plain weave, sateen weave or Burberry weave. However, in view of the characteris-

tics of the crimped yarns, plain weave fabrics are preferred, and these fabrics can be used as towels or mats in addition to underwears.

The crimp characteristics and crimp-recovery characteristics of the crimped yarns obtained in accordance with the method of this invention are superior both in the dry and wet states. The greatest characteristic of the crimped yarns is that when their crimps are apparently reduced as a result of placing the yarns under tension for prolonged periods of time, the original crimps and crimp-recovery characteristics can be regained to a considerable degree upon removing the tension, and when the yarns are dipped in water, preferably warm water, almost the same crimped state as in the original state can be attained instantaneously. Usually, the crimped yarns obtained after the treatments of this invention are wound up on a skein, cone or cheese. Even when they are wound up under tension on a cone or cheese and stored for a long time, the original crimps of the yarns can be regained by unwinding them from the cone or cheese and thus placing them in the tension-free state. The crimps can also be regained by dipping the yarn in cold or warm water. Furthermore, the original crimps can be developed by first weaving or knitting the crimped yarns and then dipping the woven or knitted fabric in cold or warm water. Accordingly, when woven or knitted fabrics are to be produced from the crimped yarns obtained by the method of this invention, it is almost unnecessary to pay attention to the yarn tension in the woven or knitted goods. Even if crimps disappear apparently, they are instantaneously developed on dipping the knitted or woven fabrics in cold or warm water. This markedly enhances the operability and productivity of knitting and weaving. On the other hand, when a garment produced from such a knitted or woven fabric consisting of the crimped yarns of this invention suffers from reduced crimps during wearing, the crimps can be regained by dipping it in warm or cold water or by washing it. Thus, the crimp properties of the yarns of this invention are epochmaking in practical applications. In view of the fact that washing is essential in the apparel fields, it will be understood that the present invention is very advantageous for practical applications.

This unique advantage of this invention can be attained by a combination of the alkali treatment and the resin finishing treatment for imparting wet crease resistance which have been described above. Another advantage of the present invention is that since the crimped yarns obtained by the method of this invention have gone through the alkali treatment and the resin has been cross-linked in the fiber molecules of the yarns in the wet state, the resin is more uniformly caused to act on the fibers than in the case of a resin finishing treatment for imparting dry crease resistance. The alkali treatment in accordance with this invention further contributes to good dyeability of the resulting crimped cellulosic fibers. Furthermore, since the adhesion of the unreacted resin to the yarn is far more reduced, the tenacity of the yarn is not reduced appreciably, and the dyeability of the yarn is not impaired at all.

Thus, the method of this invention makes it possible to impart good crimps of superior durability to a yarn consisting essentially of cellulosic fibers, and has high commercial value.

The following non-limiting Examples illustrate the invention in greater detail. In the Examples, the tenac-

ity, the percentage crimp, and the crimp recovery have been measured by the following methods.

1. Tenacity

Measured in accordance with the method stipulated in JIS L1008-1959. This tenacity is the tenacity at break (g) measured by a constant rate tension-type tester at a pull speed of 30 ± 2 cm/min. In this case, the length of the sample used is 5 cm, and an initial load corresponding to 250 m of the same kind of yarn is exerted.

2. Percentage Crimp

50 wales of a sample knitted fabric are deknitted. One end of the sample yarn is fixed, and the sample yarn is hung by exerting a load of 0.1 g. The length (l_0) of the yarn at this time is measured. Then, an additional 5 g load is exerted (total of 5.1 g), and the length (l) of the sample yarn at this time is measured. Using these values, the percentage crimp is measured from the following equation.

$$\text{Percentage crimp (\%)} = \frac{l - l_0}{l_0} \times 100$$

3. Crimp recovery

50 wales of a sample knitted fabric are deknitted. One end of the sample yarn is fixed, and the sample yarn is hung by exerting a load of 0.1 g. The length (l_0) of the sample yarn at this time is measured, and then an additional 5 g load is exerted (total of 5.1 g). After allowing the yarn to stand in this state for one minute, the length (l_1) of the sample yarn is measured. Then, the 5 g load is removed, and the sample yarn is allowed to stand for 1 minute under a load of 0.1 g. The length of the sample yarn (l_2) at this time is measured. The crimp recovery of the yarn is calculated from the following equation using these values.

$$\text{Crimp recovery (\%)} = \frac{l_1 - l_0}{l_0} \times 100$$

The wet crimp recovery shown in the Examples was obtained by performing the above procedure in water at 20°C.

EXAMPLE 1

The following tests were performed on a plain stitch knitted fabric of 60 count cotton ply yarns knitted in 21 courses/inch on a 24-gauge knitting machine.

1. The sample was dipped for 1 minute in a 200 g/liter aqueous solution of sodium hydroxide without changing the density of its texture, washed with warm water and cold water to remove the sodium hydroxide completely, and then dried. The treated sample was designated Sample 1.

2. The sample was dipped in a mixed resinous liquor comprising 10% of dimethylol dihydroxy ethyleneurea, 2% of zinc nitrate and 2% of a polyoxyethylene type softener, and squeezed to a pick-up of 70% based on the weight of the knitted fabric. It was then dried, heat-treated at 150°C for 3 minutes, washed with warm wa-

ter, and then dried. The treated sample was designated Sample 2.

3. The sample was dipped in a 10% aqueous solution of dimethylol dihydroxy ethylene urea (adjusted to pH 3 with hydrochloric acid), squeezed to a pick-up of 150% based on the weight of the sample, maintained in a high humidity atmosphere at room temperature for 2 hours, well washed with water, and dried. The treated sample was designated Sample 3.

4. The sample was dipped in a 6% aqueous solution of glycidyl ether, squeezed to a pick-up of 80% based on the weight of the knitted fabric, dried, dipped in a 50 g/liter aqueous solution of sodium hydroxide, squeezed to a pick-up of 100%, allowed to stand for one hour in a high humidity atmosphere, washed with warm water to remove the alkali completely, and then dried. The treated sample was designated Sample 4.

5. The sample subjected to the alkali treatment as in (1) above was subjected to the treatment described in (2) above. The treated sample was designated Sample 5.

6. The sample subjected to the alkali treatment as in (1) above was subjected to the treatment described in (3) above. The treated sample was designated Sample 6.

7. The sample subjected to the alkali treatment as in (1) above was subjected to the treatment described in (4) above. The treated sample was designated Sample 7.

8. The sample which was first subjected to the resin finishing treatment as in (4) above was then subjected to the alkali treatment as in (1) above. The treated sample was designated Sample 8.

9. The sample was dipped in a 6% aqueous solution of diglycidyl ether, squeezed to a pick-up of 80% based on the weight of the knitted fabric, dried, dipped in a 200 g/liter aqueous solution of sodium hydroxide for 1 minute, washed thoroughly, again dipped in a 50 g/liter aqueous solution of sodium hydroxide, squeezed to a pick-up of 100%, allowed to stand in a high humidity atmosphere for 1 hour, washed with warm water to remove the alkali thoroughly, and dried. The treated sample was designated Sample 9.

Each of the above 9 Samples and the untreated sample were deknitted and wound up on a skein with a very small tension. The tenacity, percentage crimp, crimp recovery, and wet crimp recovery of the resulting yarns were measured. Furthermore, each of the samples were deknitted and were wound up on a cone under a relatively high tension, [at the time of deknitting], and allowed to stand in the wound state for 3 months. The crimp characteristics of the yarn which was unwound after 3 months from the cone were determined. Also, such unwound yarns were dipped for 1 minute in water at 40°C, and air dried, and then the crimp characteristics of these yarns were examined. The results are shown in Table 1.

TABLE 1

Run No.	Sample No.	Properties of yarns after treatment				Crimp characteristics after winding up on cones and stored for 3 months				
		Tenacity	Percentage crimp	Crimp recovery	Wet crimp recovery	After unwinding (before warm water treatment)		After warm water treatment and air drying		
		(g)	(%)	(%)	(%)	Percentage crimp (%)	Crimp recovery (%)	Percentage crimp (%)	Crimp recovery (%)	Wet crimp recovery (%)
1.	1	394	50.3	58.6	10.8	5	70	7	70	18
2.	2	240	44.4	64.7	37.3	10	78	25	64	40

TABLE I—Continued

Run No.	Sample No.	Properties of yarns after treatment				Crimp characteristics after winding up on cones and stored for 3 months				
		Tenacity	Percentage crimp	Crimp recovery	Wet crimp recovery	After unwinding (before warm water treatment)		After warm water treatment and air drying		
		(g)	(%)	(%)	(%)	Percentage crimp (%)	Crimp recovery (%)	Percentage crimp (%)	Crimp recovery (%)	Wet crimp recovery (%)
3.	3	380	31.2	43.1	30.5	10	80	28	40	47
4.	4	350	30.8	25.2	46.7	4	80	30	25	45
5.	5	259	47.8	65.1	44.3	10	80	28	67	51
6.	6	365	58.9	64.7	55.2	26	80	58	64	55
7.	7	378	61.3	64.8	57.5	28	82	60	65	58
8.	8	370	60.7	65.0	58.2	27	81	60	66	58
9.	9	373	59.6	65.2	58.4	26	80	59	66	59
10.*	—	423	19.6	20.3	5.3	1	90	0	—	—

*Original untreated fabric

As is clearly seen from Table 1, in the crimped yarns obtained in accordance with this invention, the tenacity of the yarn is not appreciably reduced, and its crimp characteristics are well balanced. Even when the crimp are reduced under tension, they return almost to the original only by immersing the yarn in warm water for a very short time. A comparison of Samples Nos. 7, 8 and 9 shows that the sequence of the alkali treatment and the resin finishing treatment is optional, and that when the yarn is reactive in alkalinity as in the case of the yarn of this invention, the alkali treatment may be performed during the resin finishing treatment, as in Run No. 9. On the other hand, even if the alkali treatment is conjointly employed with a resin finishing treatment for imparting dry crease resistance, the effect as is seen in the method of this invention cannot be obtained, as shown in Run No. 5. Incidentally, Sample 5 could not be smoothly deknitted with some hitched feel. However, in Run No. 6 in which the same resin was used for finishing treatment but the treatment was performed in the wet state and the alkali treatment was also performed, good crimp properties were obtained.

A plain stitch knitted fabric was produced by a 20-gauge single jersey knitting machine using each of the crimped yarn Samples Nos. 1, 4, 7, 8 and 9 which was wound on a cone. The resulting knitted fabric was washed with water and air dried. The texture was 30 wales/40 courses.

A long sleeve undershirt was sewn from the knitted fabric, and a wearing test was performed. In the test, the shirt was worn for two days and then washed, and this cycle was repeated for 3 months. The washing was made by a jet stream type household washer. Washing was conducted for 15 minutes, and rinsing was effected three times consuming 10 minutes each time. Then, the shirt was centrifugally dehydrated, and air dried at 50° to 60°C.

As a result, shirts made of the knitted fabrics using the crimped yarns of Samples Nos. 7, 8 and 9 (present invention) hardly showed stretch or loosening even at the elbow portions which usually underwent vigorous stretching and bending, but fitted to the body very well during a two days' wearing. In addition, by washing, the crimp characteristics substantially returned to the orig-

inal state. After a lapse of three months, there was no appreciable change in fitting and stretching properties. When these shirts were worn continuously for 10 days after this 3 month period, the fitting properties of the shirts were reduced somewhat at the elbow portions, and the shirts stretched by about 1.2 to 1.4% around the waist but the fitting properties were still good. By subsequently washing the shirts, the elbow portions returned almost to the original, and the waist showed a stretch of about 0.5% which was within the range of measuring error. The shirts gave wearing comfort because they had superior hygroscopicity and were free from static charge owing to their cellulosic fiber constituents. In the case of Samples 1 and 4, the stretchability was poor, and there was great loosening during wearing. Furthermore, there was hardly any crimp recovery by washing.

A plain weave fabric was produced from Sample 7 using a conventional weaving machine. After washing with water and drying, the density of the woven fabric was 132 warps/inch and 106 wefts/inch. When it was used as a towel, it exhibited unique feel and excellent water imbibition.

EXAMPLE 2

The same knitted fabric as used in Example 1 was used and aqueous solutions of monomethylol acrylamide in various concentrations were applied by padding to the fabric in the amounts indicated in Table 2, and squeezed to a pick-up of 100%. The treated fabric was dried at 100°C, and heat-treated for 3 minutes at 150°C. In this procedure, zinc nitrate was used as a catalyst in an amount of 1/10 of the weight of the resin. Then, the fabric was dipped in an aqueous solution of sodium hydroxide in various concentrations shown in Table 2, washed with water, and dried. Each of the knitted fabrics so treated was deknitted in the same way as in Example 1 and wound up on a skein under a very small tension, or on a cheese under relatively high tension. The same properties as shown in Example 1 of these yarns were measured, and the results are shown in Table 2. The temperature of water used for a warm water treatment was 24°C.

TABLE 2

Run No.	Amount of resin (%)	Alkali concentration (g/l)	Properties of yarns after treatment				Crimp characteristic after winding up on cones and stored for 3 months				
			Tenacity (g)	Percentage crimp (%)	Crimp recovery (%)	Wet crimp recovery (%)	After unwinding (before water treatment)		After water treatment and air drying		
							Percentage crimp (%)	Crimp recovery (%)	Percentage crimp (%)	Crimp recovery (%)	Wet crimp recovery (%)
1.	0.3	250	388	52.1	59.5	18.7	5.3	70.3	7.2	70.3	18.2
2.	0.7	250	385	55.3	61.2	38.2	40.1	58.5	40.3	45.9	50.0
3.	3.0	250	383	57.7	62.3	41.7	50.6	67.4	50.8	47.6	45.4
4.	6.0	80	376	38	41.8	46.3	20.7	40.1	35.2	28.2	45.8
5.	6.0	120	374	51	62.3	55.4	25.5	80.8	55.6	65.1	58.2
6.	6.0	200	374	58.3	64.8	57.1	25.2	78.0	60.7	65.7	58.4
7.	6.0	300	378	58.3	64.8	56.6	26.2	80.2	60.4	65.8	58.7
8.	6.0	400	375	58.0	62.0	55.0	27.1	80.6	60.2	65.8	58.8
9.	12	250	370	59.6	65.1	58.4	27.4	81.7	60.7	65.8	58.4
10.	18	250	336	60.3	65.3	58.6	27.5	81.3	60.3	65.2	58.8
11.*	—	—	423	19.6	20.3	5.3	1	90.0	0	—	—

*Original untreated cloth

It is seen from Table 2 that good results are obtained with suitable ranges of the amount of the resin to be applied and the alkali concentration used in the caustic alkali treatment, and that superior durability of crimps

and dried. These knitted fabrics were deknitted to obtain various kinds of yarns. The properties of these yarns were measured in the same way as in Example 1, and the results obtained are shown in Table 3.

TABLE 3

Run No.	Amount of resin (%)	Alkali concentration (g/l)	Properties of yarns after treatment				Crimp characteristic after winding up on cones and stored for 3 months				
			Tenacity (g)	Percentage crimp (%)	Crimp recovery (%)	Wet Crimp recovery	After unwinding (before warm water treatment)		After warm water treatment and air drying		
							Percentage crimp (%)	Crimp recovery (%)	Percentage crimp (%)	Crimp recovery (%)	Wet crimp recovery (%)
1.	0.3	250	383	48.0	58.3	17.4	5.6	70.3	8.1	70.8	60.5
2.	0.7	250	378	44.7	60.5	38.2	20.1	80.7	40.3	43.5	38.9
3.	3.0	250	374	46.2	62.3	43.1	21.6	80.9	45.0	44.7	42.7
4.	6.0	80	365	26.4	29.8	48.7	20.8	38.4	20.8	25.4	35.6
5.	6.0	120	370	47.8	38.6	55.8	26.4	80.5	46.6	46.3	51.3
6.	6.0	200	372	60.0	65.3	59.5	28.1	81.3	58.3	58.4	59.2
7.	6.0	300	370	60.1	65.3	59.6	28.5	81.3	58.4	58.4	59.2
8.	6.0	400	361	60.3	65.3	57.2	28.7	80.6	58.7	58.6	57.6
9.	12	250	320	61.2	68.6	59.3	29.3	81.7	59.0	59.0	59.5
10.	18	250	280	61.5	68.3	59.5	29.3	81.0	59.3	59.0	59.0
11.*	—	—	423	19.6	20.3	5.3	1	90	0	—	—

*Original untreated fabric

can be obtained only by a combination of these treatments within the suitable concentration ranges.

EXAMPLE 3

Using the same knitted fabric as in Example 1 and diglycidyl ether as a resin for the resin finishing treatment, various treated knitted fabrics were obtained by varying the amount of the resin applied and the concentration of the caustic alkali in the same way as in Example 2. In this Example, diglycidyl ether was applied as an aqueous solution of various concentrations, and the squeezing was performed to a pick-up of 100%. After drying, the treated knitted fabric was dipped in an aqueous solution of sodium hydroxide of various concentrations as shown in Table 3, washed with water, and then dried. Then, the fabric was further dipped in a 50 g/liter aqueous solution of sodium hydroxide, and squeezed to a pick-up of 100%, followed by allowing to stand for one hour in a high humidity atmosphere (a chamber held at a humidity of about 95 to 100% spraying water). The treated fabric was washed with warm water and cold water to remove the alkali completely,

It is seen from Table 3 that good results are obtainable with the glycidyl ether type resin being in a concentration of about 0.5 to 15%, and good durability of crimps can be obtained only by performing the caustic alkali treatment in suitable concentrations within this range.

EXAMPLE 4

A knitted fabric (21 courses/inch) was produced from a 85 count mix-spun play yarn composed of 65% of cotton and 35% of polyethylene terephthalate using a 24-gauge knitting machine. This knitted fabric was treated as follows:

1. The knitted fabric was dipped in a 6% aqueous solution of dimethylol dihydroxy ethyleneurea (adjusted to a pH 3 with hydrochloric acid), squeezed to a pick-up of 150% based on the weight of the fabric, and maintained in a high humidity atmosphere at room temperature for 2 hours. Then, the fabric was dipped in a 250 g/liter aqueous solution of sodium hydroxide, washed with water, dried, and then deknitted. The resulting yarn was designated Sample 1.

2. The knitted fabric was dipped in a 250 g/liter aqueous solution of sodium hydroxide, washed, and subjected to the resin treatment in the wet state using the same resin as in the preparation of Sample 1. The fabric was well washed, dried, and then deknitted. The resulting yarn was designated Sample 2.

3. The above knitted fabric was dipped in a 6% aqueous solution of monomethylol aminostyrene (using 1.0% of zinc nitrate as a catalyst), squeezed to a pick-up of 100% based on the weight of the knitted fabric, dried at 100°C, and heat-treated for 3 minutes at 150°C. The fabric was further dipped in a 50 g/liter aqueous solution of sodium hydroxide, squeezed to a pick-up of 100%, allowed to stand in a high humidity atmosphere for 1 hour at room temperature, washed with water, and then dried. The fabric was then dipped in a 250 g/liter aqueous solution of sodium hydroxide, washed with water, and deknitted. The resulting yarn was designated Sample 3.

4. In the procedure described in (3) above, the caustic alkali treatment was first performed, and then the resin finishing treatment was performed. The resulting yarn was designated Sample 4.

5. The above knitted fabric was dipped in a 250 g/liter aqueous solution of sodium hydroxide, dipped in a 6% aqueous solution of divinyl sebacate, squeezed to a pick-up of 100%, dried, dipped in a 50 g/liter aqueous solution of sodium hydroxide, squeezed to a pick-up of 100%, allowed to stand in a high humidity atmosphere at room temperature for 1 hour, washed well with water, dried, and then deknitted. The resulting yarn was designated Sample 5.

6. The above knitted fabric was dipped in a 250 g/liter aqueous solution of sodium hydroxide, then dipped in a 6% aqueous solution of allyl acrylate (using 0.6% of zinc nitrate as a catalyst), squeezed to a pick-up of 100%, dried at 100°C., and heat-treated for 3 minutes at 150°C. The fabric was then deknitted. The resulting yarn was designated Sample 6.

7. The same knitted fabric subjected to the same alkali treatment as described above was dipped in a 6% aqueous solution of dimethylol triazone (adjusted to a pH 3 with hydrochloric acid), squeezed to a pick-up of 150%, maintained in a high humidity atmosphere for 2 hours at room temperature, washed with water, dried, and deknitted. The resulting yarn was designated Sample 7.

The crimp characteristics of these seven kinds of yarns were measured in the same way as in Example 1. The results are shown in Table 4.

It is seen from Table 4 that using any of the resins specified, good durable crimps can be obtained. It is clear from a comparison of Runs Nos. 1 to 4 that when dimethylol hydroxy diethyleneurea is used, the crimp properties of the yarns are much the same whether the alkali treatment is performed before or after the resin finishing treatment, but in the case of monomethylol aminostyrene, somewhat better results are obtained by performing the alkali treatment first.

EXAMPLE 5

A plain stitch knitted fabric (21 courses/inch) was produced from a 80 count ply yarn of viscose rayon using a 24-gauge knitting machine. The resulting knitted fabric was dipped in a solution consisting of 6% of monomethylol acrylamide and 0.6% of zinc nitrate, squeezed to a pick-up of 100%, pre-dried at 100°C, and then heat-treated at 150°C for 3 minutes. The treated fabric was dipped in a 130 g/liter aqueous solution of sodium hydroxide for 1 minute, washed with warm water and cold water, and deknitted, followed by winding up the yarn on a skein under a very small tension thereby to form crimped yarns in accordance with this invention.

The crimped yarn had a tenacity of 340 g, a crimp percentage of 60.5%, a dry crimp recovery of 64.6%, and a wet crimp recovery of 57.2%.

Furthermore, at the time of deknitting, the yarn was wound up on a cone under strong tension, and allowed to stand for 3 months. Then, the unwound yarn was tested as to its crimp characteristics. The yarn exhibited a crimp percentage of 28% and a crimp recovery of 81%. When the yarn was dipped in water at 30°C for 1 minute and air dried, it exhibited a crimp percentage of 60% and a crimp recovery of 65%, which values were almost the same as the original values.

EXAMPLE 6

Two 60-count pure cotton yarns twisted in the right-handed direction at 30 turns/inch were given a final twist in the left-handed direction at 37 turns/inch to make a ply yarn. A predetermined length of the yarn was wound up on a skein, and used as a sample. The sample was treated as follows:

1. The sample was dipped in a 200 g/liter aqueous solution of sodium hydroxide for 1 minute while maintaining the original length, washed with warm water and cold water to remove the sodium hydroxide completely, and then dried. The treated sample was designated Sample 1.

TABLE 4

Run No.	Amount of resin (%)	Alkali concentration (g/l)	Properties of yarns after treatment				Crimp characteristics after winding up on cones and stored for 3 months				
			Tenacity (g)	Percentage crimp (%)	Crimp recovery (%)	Wet crimp recovery (%)	After unwinding (before warm water treatment)		After warm water treatment and air drying		
							Percentage crimp (%)	Crimp recovery (%)	Percentage crimp (%)	Crimp recovery (%)	Wet crimp recovery (%)
1.	9	250	254	50.5	64.3	61.5	24.4	85.6	48.3	63.0	59.2
2.	9	250	252	52.1	64.4	61.7	25.1	85.8	48.6	63.0	59.7
3.	6	250	263	51.9	63.2	62.0	25.3	86.1	49.5	62.8	58.9
4.	6	250	260	53.7	63.5	62.2	25.8	86.3	49.7	63.1	59.4
5.	6	250	257	52.9	62.7	61.4	26.2	85.9	50.2	62.8	58.3
6.	6	250	259	51.5	65.0	61.8	26.7	85.9	50.1	64.0	58.5
7.	9	250	251	51.4	64.2	61.9	25.8	85.5	49.5	60.9	59.4
8.*	—	—	276	22.2	20.8	7.4	4.3	91.0	0	—	—

*Original untreated fabric

2. The sample was dipped in a mixed aqueous solution containing 10% of dimethylol dihydroxy ethyleneurea, 2% of zinc nitrate, and 2% of a polyoxyethylene-type softener, squeezed to a pick-up of 70% based on the weight of the sample, dried, heat-treated at 150°C for 3 minutes, washed with warm water, and then dried. The treated sample was designated Sample 2.

3. The sample was dipped in a 6% aqueous solution of diglycidyl ether, squeezed to a pick-up of 80% based on the weight of the sample, dried, dipped in a 50 g/liter aqueous solution of sodium hydroxide, squeezed

Each of the nine treated samples and the untreated ply yarn sample was detwisted by a twister, and the tenacity, percentage crimp, crimp recovery, and wet crimp recovery of the resulting yarns were measured.

Furthermore, each of the above samples was detwisted and wound up on a cone under relatively strong tension, and allowed to stand for three months, followed by unwinding. The crimp characteristics of the unwound yarns and those of the unwound yarns after immersing in water for 1 minute at 40°C and air drying were also examined. The results obtained are shown in Table 5.

TABLE 5

Run No.	Properties of yarns after treatment				Crimp characteristics after winding up on cones and stored for 3 months				
	Tenacity (g)	Percentage crimp (%)	Crimp recovery (%)	Wet crimp recovery (%)	After unwinding (before water treatment)	After water treatment and air drying			
					Percentage crimp (%)	Crimp recovery (%)	Percentage crimp (%)	Crimp recovery (%)	Wet crimp recovery (%)
1.	418	31.2	68.6	15.8	4	70	6	70	28
2.	251	24.7	74.4	57.0	8	78	15	63	41
3.	362	20.3	46.7	58.2	3	80	21	24	46
4.	305	26.8	75.3	50.4	9	80	20	70	58
5.	368	27.0	35.7	35.1	10	80	18	68	59
6.	353	42.0	74.5	66.6	26	85	40	67	67
7.	389	41.3	74.5	67.3	28	85	39.8	64	68
8.	382	40.8	74.8	68.2	27	85	38.5	67	68
9.	386	39.6	75.0	68.7	26	82	39	67	69
10.*	415	10.5	39.8	11.3	1	90	0	—	—

*Control; original untreated yarn

to a pick-up of 100%, allowed to stand in a high humidity atmosphere for 1 hour, washed with warm water to remove the alkali completely, and dried. The treated sample was designated Sample 3.

4. The sample was subjected to the alkali treatment in the same way as in (1) above, and then to the treatment described in (2) above. The treated sample was designated Sample 4.

5. The sample was dipped in a 10% aqueous solution of dimethylol dihydroxy ethyleneurea (adjusted to a pH 3 with hydrochloric acid), squeezed to a pick-up of 150%, maintained in a high humidity atmosphere at room temperature for 2 hours, well washed with water, and then dried. The treated sample was designated Sample 5.

6. The sample was subjected to the alkali treatment as in (1) above, and then to the treatment described in (5) above. The treated sample was designated Sample 6.

7. The sample was subjected to the alkali treatment as in (1) above, and then to the treatment described in (3) above. The treated sample was designated Sample 7.

8. The sample was subjected to the resin finishing treatment as in (3) above, and then to the alkali treatment as described in (1) above. The treated sample was designated Sample 8.

9. The sample was dipped in a 6% aqueous solution of diglycidyl ether, squeezed to a pick-up of 80% based on the weight of the sample, dried, dipped in a 200 g/liter aqueous solution of sodium hydroxide, thoroughly washed, then dipped in a 50 g/liter aqueous solution of sodium hydroxide, squeezed to a pick-up of 100%, allowed to stand in a high humidity atmosphere for 1 hour, washed with warm water to remove the alkali completely, and then dried. The treated sample was designated Sample 9.

It is clearly seen from the results shown in Table 5 that in the present invention in which the alkali treatment and the resin finishing treatment for imparting wet crease resistance are conjointly employed, the tenacity of the resulting crimped yarns is not appreciably reduced, and their crimp properties are well balanced, and especially when the crimp characteristics are deteriorated under tension, the original crimp characteristics can be regained substantially merely by dipping the yarns in water. A comparison of Samples 6, 7, 8 and 9 shows that the alkali treatment may be carried out either before or after the resin finishing treatment, and in the case of the alkali reaction type, the alkali treatment may be combined in the process of resin finishing treatment as shown in Run No. (9). On the other hand, even if a resin finishing treatment intended primarily for imparting dry crease resistance is conjointly employed as in Run No. (4), the effects as shown in the present invention are not produced. A comparison of it with Run No. (6) shows that it is important to perform the resin finishing treatment for imparting wet crease resistance. Incidentally, Sample 4 has a high coefficient of friction, and is difficult to detwist uniformly.

EXAMPLE 7

The same sample as used in Example 6 was dipped in an aqueous solution of monomethylol acrylamide of various concentrations to apply the resin in the amount indicated in Table 6. The treated sample was dried at 100°C, and heat-treated at 150°C for 3 minutes. At this time, zinc nitrate was used as a catalyst in an amount of 1/10 of the weight of the resin. The application of the resin was performed by padding, and squeezing was made to a pick-up of 100%. Then, the sample was dipped in an aqueous solution of sodium hydroxide in the concentrations shown in Table 6, washed with wa-

ter, and dried. The properties of the treated samples were measured in the same way as in Example 6, and the results obtained are shown in Table 6.

tion of the caustic alkali. In the present Example, the yarn was dipped in an aqueous solution of diglycidyl ether in various concentrations, and squeezed to a

TABLE 6

Run No.	Amount of resin (%)	Alkali concentration (g/l)	Properties of yarns after treatment				Crimp characteristics after winding up on cones and stored for 3 months				
			Tenacity (g)	Percentage crimp (%)	Crimp recovery (%)	Wet crimp recovery (%)	After unwinding (before water treatment)		After water treatment and air drying		
							percentage crimp (%)	Crimp recovery (%)	Percentage crimp (%)	Crimp recovery (%)	Wet crimp recovery (%)
1.	0.3	250	399	37.1	59.5	20.3	3	81.3	9	80.2	28.2
2.	0.7	250	394	40.8	71.8	52.3	20.0	68.5	36.5	56.5	60.5
3.	3.0	250	395	42.1	72.9	59.6	25.5	67.8	38.3	57.2	65.8
4.	6.0	80	384	33.0	52.3	59.5	15.8	52.5	28.2	38.2	65.8
5.	6.0	120	382	43.3	72.6	65.4	25.0	85.4	37.9	70.3	69.2
6.	6.0	200	382	43.3	74.4	68.1	25.2	83.2	38.2	70.9	69.0
7.	6.0	300	386	43.0	74.5	69.3	25.8	85.1	38.2	71.4	69.0
8.	6.0	400	380	44.0	72.7	66.7	27.6	85.3	38.5	71.1	70.0
9.	12	250	383	44.6	73.3	69.5	27.2	86.2	38.7	71.2	68.0
10.	18	250	340	45.3	73.1	69.8	27.2	86.1	39.0	72.8	69.2
11.*	—	—	415	10.5	39.8	11.3	1	90	0	—	—

*Control; original untreated yarn

It is seen from Table 6 that good results are obtained when the amount of the resin to be applied and the alkali concentration in the caustic alkali treatment are within suitable ranges. It is also clear that especially good durability of crimps can be obtained only by a combination of these treatments within suitable concentration ranges.

EXAMPLE 8

Two 100-count pure cotton yarns twisted in the right-handed direction at 34 turns/inch were subjected to final twist in the right-handed direction at 40 turn-

pick-up of 100%. Then, the yarn was dried, dipped in an aqueous solution of sodium hydroxide in the various concentrations shown in Table 7, then dipped in a 50 g/liter aqueous solution of sodium hydroxide, squeezed to a pick-up of 100%, and allowed to stand in a high humidity atmosphere (a chamber held at a humidity of about 95 to 100% spraying water) for one hour. The yarn was then washed with warm water and with cold water to wash out alkali completely, and dried. The properties of the treated yarns were measured in the same way as in Example 6, and the results are shown in Table 7.

TABLE 7

Run No.	Amount of resin (%)	Alkali concentration (g/l)	Properties of yarns after treatment				Crimp characteristics after winding up on cones and stored for 3 months				
			Tenacity (g)	Percentage crimp (%)	Crimp recovery (%)	Wet crimp recovery (%)	After unwinding (before water treatment)		After water treatment and air drying		
							Percentage crimp (%)	Crimp recovery (%)	Percentage crimp (%)	Crimp recovery (%)	Wet crimp recovery (%)
1.	0.3	250	235	28.0	68.7	22.4	4	82.3	10	81.3	29.1
2.	0.7	250	230	29.6	72.5	54.5	17.2	69.4	37.3	58.7	61.2
3.	3.0	250	229	30.5	74.6	58.7	25.5	68.8	39.2	60.3	65.8
4.	6.0	80	225	16.2	51.5	59.6	15.8	54.5	29.1	38	65.8
5.	6.0	120	230	36.5	76.6	66.8	26.2	85.9	32.4	65.6	69.7
6.	6.0	200	230	40.7	78.3	69.5	25.4	83.7	35.9	66.2	69.8
7.	6.0	300	232	41.0	78.3	69.7	26.0	85.2	36.8	66.8	69.3
8.	6.0	400	231	41.0	77.2	65.9	27.6	85.0	36.8	67.1	69.0
9.	12	250	218	42.5	78.1	70.3	28.2	86.3	38.4	67.1	69.5
10.	18	250	171	42.8	78.0	70.3	28.2	86.1	38.3	75.2	80.2
11.*	—	—	270	11.2	40.5	12.8	1	92	0	—	—

*Control; Original unreacted yarn

s/inch. A predetermined length of the resulting ply yarn was wound up on a skein, and used as a sample. Using diglycidyl ether as the resin for resin-finishing, the yarn was subjected to various treatment by varying the amount of the resin to be applied, and the concentra-

It is seen from Table 7 that the amount of the resin is suitably about 0.5 to 15%, and especially good durability of crimps can be obtained by performing the alkali treatment conjointly using an aqueous solution of an alkali hydroxide of suitable concentrations.

EXAMPLE 9

Two 85-count mix-spun yarns composed of 70% of cotton and 30% of polyethylene terephthalate fiber twisted in the right-handed direction at 32 turns/inch were subjected to final twist in the left-handed direction at 38 turns/inch using a twister. A predetermined length of the resulting ply yarn was wound up on a skein, and used as a sample. The sample was treated as follows:

1. The sample was dipped in a 6% aqueous solution of dimethylol dihydroxy ethyleneurea (adjusted to a pH 3 with hydrochloric acid), squeezed to a pick-up of 150% based on the weight of the sample, maintained in a high humidity atmosphere at room temperature for 2 hours, subsequently dipped in a 250 g/liter aqueous solution of sodium hydroxide, washed with water and dried, followed by detwisting. The resulting yarn was designated Sample 1.

2. The sample was dipped in a 250 g/liter aqueous solution of sodium hydroxide, washed, and then subjected to the same resin finishing treatment in the wet state using the same resin as used in Run No. (1) above. The sample was then washed well with water, dried,

tion of sodium hydroxide, squeezed to a pick-up of 100%, allowed to stand in a high humidity atmosphere at room temperature for 1 hour, thoroughly washed with water, dried, and then detwisted. The resulting yarn was designated Sample 5.

6. The sample was subjected to the same alkali treatment as above using a 250 g/liter aqueous solution of sodium hydroxide, dipped in a 6% aqueous solution of allyl acrylate (using 0.6% of zinc nitrate as a catalyst), squeezed to a pick-up of 100%, dried at 100°C, and then heat-treated at 150°C for 3 minutes, followed by detwisting. The resulting yarn was designated Sample 6.

7. The sample was subjected to the alkali treatment in the same way as above, dipped in a 6% aqueous solution of dimethylol triazone (adjusted to a pH 3 with hydrochloric acid), squeezed to 150%, allowed to stand in a high humidity atmosphere at room temperature for 2 hours, washed with water, dried, and detwisted. The resulting yarn was designated Sample 7.

The crimp characteristics of these seven kinds of yarns were examined in the same way as in Example 6, and the results obtained are shown in Table 8.

TABLE 8

Run No.	Amount of resin (%)	Alkali concentration (g/l)	Properties of yarns after treatment				Crimp characteristics after winding up on cones and stored for 3 months				
			Tenacity (g)	Percentage crimp (%)	Crimp recovery (%)	Wet crimp recovery (%)	After unwinding (before water treatment)	After water treatment and air drying			
							Percentage crimp (%)	Crimp recovery (%)	Percentage crimp (%)	Crimp recovery (%)	Wet crimp recovery (%)
1.	6	250	261	43.0	74.2	72.5	22.2	85.4	40.1	73.1	72.9
2.	6	250	259	45.1	74.3	72.7	25.1	85.5	40.6	73.2	72.9
3.	6	250	274	43.2	73.8	73.1	25.4	86.0	41.2	72.6	71.5
4.	6	250	268	43.5	74.0	74.1	25.6	86.2	41.3	72.8	71.7
5.	6	250	265	42.7	72.7	71.7	26.0	85.7	42.0	72.5	70.9
6.	6	250	266	45.1	75.0	71.9	26.5	86.1	41.9	74.0	72.3
7.	9	250	263	44.2	74.6	72.3	25.4	85.4	40.6	70.7	70.0
8.*	—	—	283	10.8	40.2	11.3	6.2	92	0	—	—

*Control; Original unreacted yarn

and detwisted. The resulting treated yarn was designated Sample 2.

3. The sample was dipped in a 6% aqueous solution of monomethylol aminostyrene (using 1.0% of zinc nitrate as a catalyst), squeezed to a pick-up of 100% based on the weight of the sample, dried at 100°C, and then heat-treated at 150°C for 3 minutes. Then, the sample was further dipped in a 50 g/liter aqueous solution of sodium hydroxide, squeezed to a pick-up of 100%, allowed to stand in a high humidity atmosphere at room temperature for 1 hour, washed with water, and dried. Then, the sample was dipped in a 250 g/liter aqueous solution of sodium hydroxide, washed with water, dried, and detwisted. The resulting yarn was designated Sample 3.

4. In Run No. (3), the sample was first subjected to the alkali treatment, and then the same resin finishing treatment. The resulting yarn was designated Sample 4.

5. The sample was subjected to the alkali treatment in the same way as above using a 250 g/liter aqueous solution of sodium hydroxide, dipped in a 6% aqueous solution of divinyl sebacate, squeezed to a pick-up of 100%, dried, then dipped in a 50 g/liter aqueous solu-

It is seen from Table 8 that good durable crimps are obtained by using any of the resins. A comparison of Runs Nos. (1) to (4) shows that when dimethylol dihydroxy ethyleneurea is used, the crimp properties of the resulting yarns are much the same whether the alkali treatment is carried out before or after the resin-finishing treatment, but in the case of monomethylol aminostyrene, somewhat better results are obtained by performing the alkali treatment first.

While the invention has been described in detail and with reference to specific embodiments thereof, it will be apparent to one skilled in the art that various changes and modifications can be made therein without departing from the spirit and scope thereof.

What is claimed is:

1. A method for manufacturing crimped yarns consisting substantially of cellulosic fibers and having durable crimps and excellent crimp-recovery characteristics in wet and dry states which comprises, in the listed order, the steps of:

- imparting distortion to the yarn by knitting,
- subjecting the knitted yarn to a resin finishing treatment for imparting wet crease resistance in a

wet state with a compound selected from the group consisting of monomethylol aminostyrene and monomethylol acrylamide in a concentration of about 0.5 to 25% by weight together with a catalyst in an amount of about 20 to 50% by weight based on the weight of the resin,
drying the resin-treated yarn at a temperature of from 50° to 100°C,
heat-treating the dried yarn at a temperature of from 130° to 150° for 1 to 15 minutes,
subjecting the yarn to a caustic alkali treatment with an aqueous solution of an alkali hydroxide in a concentration of 200 to 350 g/liter at a temperature of not higher than 50°C,
washing the yarn with water to remove the alkali hydroxide adhered to the yarn,

g. drying the yarn, and
h. deknitting.
2. The method of claim 1 wherein said catalyst is a member selected from the group consisting of magnesium borofluoride, magnesium chloride and zinc nitrate.
3. Crimped cellulosic yarns obtained by the process claimed in claim 1.
4. A woven or knitted fabric comprising the crimped cellulosic yarns obtained by the process claimed in claim 2.
5. The method of claim 1 wherein the knitting is a weft knitting.
6. The method of claim 1 wherein the knitting is a plain stitch knitting.

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