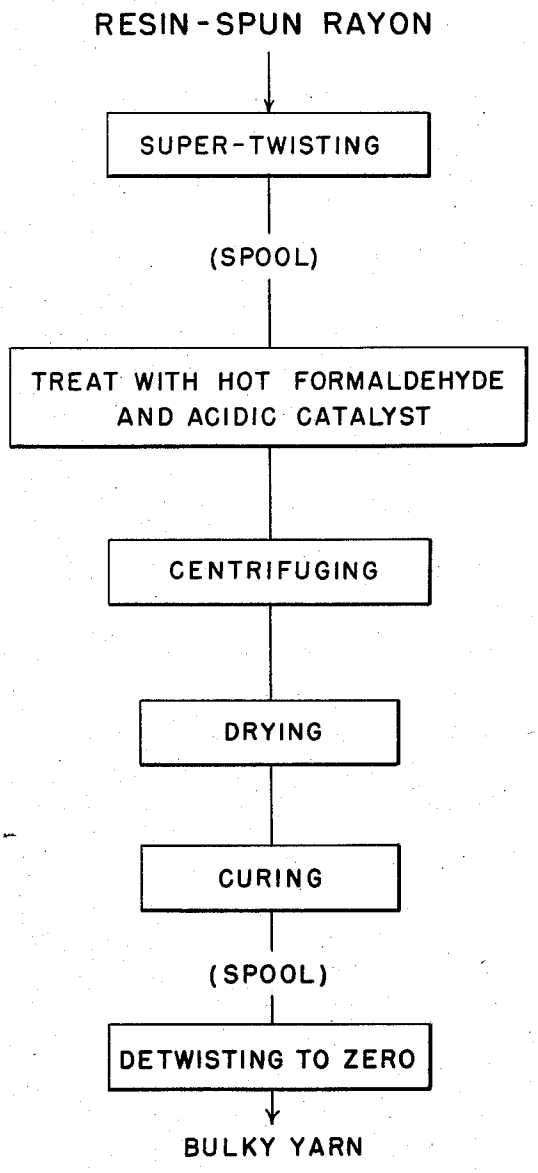
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PRODUCTION OF BULKY RESIN SPUN RAYON YARN

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PRODUCTION OF BULKY RESIN SPUN RAYON YARN

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Application September 21, 1956, Serial No. 611,216

14 Claims. (Cl. 57—164)

The present invention is directed toward a process for the preparation of bulky yarn. More specifically it is directed to a process for making a laundry-resistant bulky rayon yarn by treating yarn chemically along with mechanical twisting and detwisting.

It is known in the prior art that thermoplastic yarns such as nylon may be given a fairly permanent crimp by heating highly twisted yarn, preferably in the presence of steam, to set the twist, followed by untwisting. The resulting yarn has a strongly curled or crimped wooly appearance (see U.S. 2,290,253 and 2,564,245). The prior art describes a process wherein a rayon yarn is impregnated with formaldehyde, twisted, cured, and detwisted to produce a wooly yarn. In a modification of this process a rayon yarn is given a supertwist, moistened to set the twist, untwisted to produce a wool-like yarn, and then treated with formaldehyde in the presence of an acidic catalyst followed by thermal curing. Both processes however require reacting the cellulosic yarn with formaldehyde under strongly acidic conditions which cause severe damage to the fiber structure through depolymerization and hydrolysis of the cellulose, as well as causing excessive cross-linking, with resulting embrittlement of the fiber and reduced extensibility. In addition such yarns are difficult to dye after this treatment due to resinification of the surface. A process has been needed which will preserve the residual yarn properties of the fiber while at the same time effecting the desired cross-linking.

Accordingly it is an object of the present invention to prepare a cross-linked cellulosic fiber by means which will avoid the degradation of the fiber which accompanies conventional methods of formaldehyde treatment. A further object is the provision of means for producing a bulky cellulosic yarn which can be more rapidly cross-linked by conventional means than plain viscose rayon and will have a lower water retention and a correspondingly greater dimensional stability when wet. A further object is the provision of a process of the foregoing type which will avoid the dyeing difficulties mentioned above.

These objects are achieved according to the present invention by supertwisting a resin spun rayon yarn, setting the twist therein by treating the supertwisted yarn with hot liquid formaldehyde in the presence of a mildly acidic catalyst, then drying and curing to effect cross-linkage between the formaldehyde, resin, and the cellulose, followed by detwisting, this process being illustrated diagrammatically by the drawing. The resulting yarn is very fluffy and crimped due to retention of some of the twist and it retains the twist when immersed in water. It has been established that the aforesaid treatment effects a three-way cross-linkage between the resin, the cellulose, and the formaldehyde with a correspondingly stronger bond than the conventional two-way linkage between rayon and formaldehyde. This in turn gives the formaldehyde-treated fiber an unusually low water retention property and the ability to retain its fluffy and bulky structure when immersed in water. It is also evident that it requires less time to effect the same amount of cross-linkage between the formaldehyde and the two fiber components as compared to that required to effect a conventional two-way bond. This means a shorter time of exposure of the fiber to the acid reaction environment and correspondingly less of the fiber degradation described above. A preferred modification of this invention involves injecting a pigment into the viscose along with the resin just prior to spinning; this avoids the uneven dyeing which would result if the dye were applied to the cross-linked detwisted fiber.

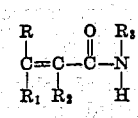
In accordance with this invention, I prepare a high quality water-resistant crimped cellulosic yarn by incorporating a suitable linear polymer into the viscose formed, the filaments are spun, followed by reacting the spun-in polymer with formaldehyde while the yarn is in highly twisted form and then bringing the reaction product to heat-hardened, insoluble condition in and on the fiber.

The composition of the resins must satisfy the requirements of linearity and proper degree of polymerization as those parameters determine their behavior. With this combination the resin loss to the spin bath can be kept low and the swelling of the fibers can be reduced. In addition they must also contain the necessary functional groups to make them soluble in the viscose solution, without causing undesirable reactions. Furthermore, they must lead to a desired modification of the fiber properties such as reduced swelling without embrittlement, i.e., without undue reduction in extensibility.

The polymers or resins which fulfill these conditions are limited in number and so far as presently known are limited to three types. The first of these is polyacrylamide or a substituted derivative thereof, the second is a poly (ureidoalkyl vinyl ether), the third is a poly(vinyloxyalkyl alkylene urea).

These reactive linear polymers are long-chain linear substances and although they are water-dispersible at the time they are added to the viscose, and are added in the form of their water dispersions, there is no scumming of the bath or other evidence that they are leached out during spinning or aftertreating. Also, analysis for nitrogen on the final articles comprising the fully reacted condensate shows that the resin is retained. This is apparently an advantage of the linear structure of these resins which causes them to become tangled or meshed with, and restrained from leaching out by, the cellulosic chains of the viscose. At the same time, their linear structure permits them to flow and align themselves with the cellulose chains during extrustion of the mixture and stretching of the article for orientation.

The polyacrylamide type of resin mentioned above is referred to generally hereinafter as a "monoamide polymer" or "polymer of a monoamide". The term "monoamide" is intended herein as a generic expression for the restricted class of related compounds which may be defined in more technical fashion as follows: a monoamide, having a single unsaturated carbon to carbon bond, of an acid of the group consisting of acrylic acid and alpha-alkyl- or beta-alkyl-substituted alpha-methylene monocarboxylic acids, and N-alkyl substituted derivatives thereof, the alkyl substituents consisting of methyl or ethyl, the amide having only a single carbonyl group attached to the N atom, and at least one hydrogen atom attached to the N atom. These amides have the general formula



wherein R, R_1, R_2, R_3 are each selected from the group consisting of hydrogen, methyl, and ethyl.

The term "monoamide polymer" or "polymer of a monoamide" is intended to be generic to homopolymers and copolymers of the compounds just defined, whether they are produced directly by polymerization or copolymerization or indirectly by hydrolysis, saponification, or other reaction upon a previously produced polymer or copolymer. When copolymers are used, the monomeric unit other than that containing the amide group may be considered to be derived from any other ethylenically unsaturated monomer, such as vinyl acetate, vinyl chloride, vinyl alcohol, acrylic acid, acrylonitrile, methacrylic acid, methacrylonitrile, vinylidene chloride, ethylene, etc., or mixtures thereof. The spinning technology of this class of polymers is discussed further in related application Serial No. 266,243, filed January 12, 1952, same assignee.

Turning to the second group of polymers employed in this invention, the term "ureidoalkyl vinyl ether polymer" or "polymeric ureidoalkyl ether" as hereafter used means homopolymers and copolymers of the formula



wherein R is hydrogen or a hydrocarbon group and A is an alkylene group. When R is a hydrocarbon group, it may readily contain 18 or more carbon atoms and may be alkyl, alkenyl, alkynyl, cycloalkyl, aralkyl, or aryl. It preferably contains not over 10 carbon atoms. The alkylene group is of straight or branched chain structure with at least two carbon atoms between oxygen and nitrogen. It may conveniently have two to eighteen carbon atoms.

Examples of monomers include 3-ureidopropyl vinyl ether-ureidoisobutyl vinyl ether, ureidohexyl vinyl ether, N-methyl-ureidoethyl vinyl ether, vinoxyethoxyethylurea, N,N-di(vinoxyethyl)urea, N-benzyl-N - vinoxyethylurea, and 4-ureido-4-methyl-2 pentyl vinyl ether. The preferred ureidoalkyl vinyl ether monomers have the formula

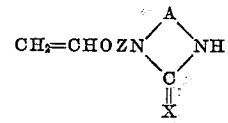
$$CH_2{=}CHOC_nH_{2n}N(R)CONH_2$$

where C_nH_{2n} represents an alkylene group of two to eighteen carbon atoms, and R is a hydrocarbon group, especially an alkyl group of not over four carbon atoms, a benzyl, a phenyl, a cycloalkyl, or an alkenyl group, or hydrogen. The preferred member of this group is the homopolymer of $CH_2{=}CHOCH_2CH_2NHCONH_2$ hereafter referred to as poly UEVE.

As useful unsaturated compounds for forming the copolymers there may be used acrylic acid, methacrylic acid, esters of acrylic acid or methacrylic acid and monohydric alcohols such as methyl, ethyl, butyl, octyl, dodecyl, cyclohexyl, allyl, methallyl, undecenyl, cyanoethyl, aminoethyl, and the like; esters of itaconic acid and similar alcohols; esters from maleic, fumaric or citraconic acids, and likewise similar alcohols; vinyl esters of carboxylic acids such as acetic, propionic, butyric, and the like; vinyloxyalkyl esters such as vinyloxyethyl acetate, etc.; vinyl ethers such as ethyl vinyl ether, butyl vinyl ether, octyl vinyl ether, allyl vinyl ether, hydroxyethyl vinyl ether, aminoethyl vinyl ether, aminopropyl vinyl ether, dimethylaminoethyl vinyl ether, vinyloxyethoxyethanol, vinyloxypropoxyethanol; methacrylonitrile or acrylonitrile; acrylamide, or methacrylamide, and N-substituted amides of these types; vinyl chloride, vinyl bromide, vinylidene chloride, 1-chloro-1-fluoroethylene, or ethylene; 1-acetoxy-1,3-butadiene; styrene, 2-vinylpyridine, 4-vinylpyridine, or divinylbenzene; ethylene diacrylate or dimethacrylate, bis(vinoxyethyl)urea, vinoxyethyl acrylate, vinoxypropyl acrylate, etc.

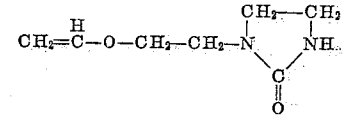
The spinning of this class of polymers with viscose is discussed further in related application Serial No. 606,781, filed August 28, 1956, same assignee.

The third class of polymers which may be employed here is composed of linear polymers of vinyloxyalkyl-alkyleneurea, and have the formula



wherein X is selected from the class consisting of oxygen and sulfur, A is an alkylene group of two to three carbon atoms at least two of which occur between the nitrogen atoms, and Z is an alkylene chain of not over 18 carbons, of which at least two carbon atoms are between oxygen and nitrogen; the latter chain may be substituted by phenyl, alicyclic, vinyl, or alkyl radicals. The preparation of these polymers is described in U.S. 2,727,019. After regenerating the cellulose by extrusion of the solution into an aqueous coagulating bath, the regenerated cellulose is treated with formaldehyde and heated to cross-link the polymer chains.

Examples of the polymers of this group are the homopolymers of 2-(2-ketoimidazolidyl) ethyl vinyl ether, 1-(2-vinyloxyethyl)-2-hexahydropyrimidone, 1-(2-vinyloxypropyl)-2-imidazolidone, 1-(2-phenyl-2-vinyloxyethyl)-2-imidazolidone, 1-(3-vinyloxypropyl-2-hexahydropyrimidone, 1-(2-cyclohexyl-2-vinyloxyethyl)-2-imidazolidone, 1-(2-cyclohexyl-2-vinyloxyethyl)-2-thioimidazolidone, 1-(2-vinyl-2-vinyloxyethyl)-2-imidazolidone, 1-(4-vinyloxycyclohexyl)-2-imidazolidone, N-(vinyloxyethyl)-2-thioimidazolidone, etc. A preferred member of this group is poly (vinyloxyethylethyleneurea), the monomer of which has the formula



Its molecular weight is in the range of 8000–15,000. Throughout the specification it will be referred to as poly (VEEU).

Copolymers of the vinyloxyalkyl imidazolidones or hexahydropyrimidones and another vinylidene compound which is polymerizable with a free radical catalyst can be readily prepared. Typical vinylidene compounds include acrylic acid, methacrylic acid, acrylamide, methacrylamide, N-substituted acrylamide and methacrylamide, such as the N-methyl or N-benzyl amides, esters of acrylic or methacrylic acid, such as the methyl, ethyl, butyl, amyl, octyl, dodecyl, octadecyl, methoxyethyl, phenoxyethyl, ethoxyethyl, cyclohexyl, benzyl, tetrahydrofurfuryl, oleyl, and nitroethyl, alkyl itaconates, vinyl esters, such as the acetate, propionate, butyrate, and laurate, vinyl ethers other than those of this invention, allyl esters, such as the acetate and butyrate, styrene, methylstyrenes, and vinylpyridine, as typical examples of monovinylidene compounds which form soluble copolymers. Polyvinylidene compounds can also be used as comonomers, such as allyl acrylate, vinyloxyethyl acrylate, ethylene diacrylate, or the comparable methacrylate, divinylbenzene, diallyl phthalate, etc. These lead to cross-linking and insolubilizing of the interpolymers, an effect which is sometimes desired.

EXAMPLE I

An aqueous dispersion of a reactive polyacrylamide (i.e., polymeric acrylamide containing free amido groups) was mixed with viscose containing 7% cellulose, 7% sodium hydroxide, 37% CS_2 and aged to a sodium chloride salt test value of 4.7. The amount of the aqueous solution added to the viscose was such that the viscose contained 10% of the polyacrylamide based on the cellulose. The mixture was spun into an aqueous coagulating and regenerating bath containing 10% sulfuric acid, 4.5% zinc sulfate, and 24% sodium sulfate at about 45° C. The filaments thus formed were given a 13-inch

immersion in the bath, withdrawn, and stretched 40% between godets to produce a 150 denier, 40 filament yarn which was box spun, and the cake processed by the following steps: washed acid free, treated with a desulfiding solution comprising a weak solution of sodium sulfide and sodium carbonate, and then treated successively with a water rinse, a bleach, an acid, an antichlor (sodium thiosulfate), and a water wash.

A skein of the finished yarn of 150/40 denier (3¾ denier per filament) was given a twist of 55 t.p.i. (turns per inch) and wound on a spool under tension. In this form it was soaked for 20 minutes at 84° C. in a water solution of 10% formaldehyde, 3.6% methanol, and 0.3% of a catalyst comprising the reaction product of 1.0 mole HCl, 0.9 mole monoethanolamine, and 2.0 moles formaldehyde (percentages are by weight based on total solution). The pH of the soaking bath was 3.5. The impregnated yarn was then dried for 25 minutes at 75° C., cured for 35 minutes at 150° C., and detwisted 57 t.p.i. The resulting yarn is strongly crimped and wool-like, and this effect is substantially fast to washing. In addition, its swelling capacity in water is reduced compared to that of plain viscose yarn.

A sample of this yarn was then compared with a sample of Viscose Helanca to determine the relative percent fixed formaldehyde in the two yarns. Results are given in Table I.

Table I

Bulky Yarn Sample	Percent HCHO	
	1st run	2d run
PAA resin spun	0.74	0.70
Helanca [1]	0.66	0.65

[1] Viscose Helanca is made by supertwisting a 400 denier bright rayon yarn, then treating it with a urea-formaldehyde resin, curing, and detwisting.

EXAMPLE II

Into an aged viscose stream containing 7.4% cellulose and 6.6% sodium hydroxide by weight and having a salt test of 4.8 was blended an aqueous solution of 25% poly UEVE at a rate resulting in a spinning solution containing 5% by weight polymer based on cellulose. The mixture was extruded at the rate of 60 m./m. into a coagulating bath containing 8.9% sulfuric acid, 2.1% zinc sulfate, and 16.9% sodium sulfate. The bath temperature was 47° C. After a 14 inch immersion in the spinning bath the filaments were withdrawn as a single yarn from the bath, stretched 35%, and collected as a cake in a conventional box spinning unit. The cake was doffed and cabinetted for 24 hours at 90% relative humidity and a temperature of 33° C. to effect complete regeneration of the cellulose therein. A skein prepared from the cake was then washed acid free, treated with a desulfiding solution comprising a weak solution of sodium sulfide and sodium carbonate, and then treated successively with a water rinse, a bleach, an acid, an antichlor (sodium thiosulfate), and a water wash.

A skein of the finished yarn of 150/40 denier (3¾ denier per filament) was then given a twist of 55 t.p.i. (turns per inch) and wound on a spool under tension. In this form it was soaked for 20 minutes at 84° C. in a water solution of 10% formaldehyde, 3.6% methanol, and 0.3% of a catalyst comprising the reaction product of 1.0 mole HCl, 0.9 mole monoethanolamine, and 2.0 moles formaldehyde (percentages are by weight based on water). The pH of the soaking bath was 3.5. The impregnated yarn was then dried for 25 minutes at 75° C., cured for 35 minutes at 150° C., and detwisted 57 t.p.i. The resulting yarn is strongly crimped and wool-like, and this effect is substantially fast to washing. In addition, its swelling capacity in water is reduced compared to that of plain viscose yarn.

A sample of this detwisted yarn was compared for swelling with a sample of the polyacrylamide-spun yarn of Example I. Under the same conditions the poly UEVE spun yarn swelled 22.5% as compared to 31.1% for the other. When it is remembered that regular rayon yarn swells 85–90%, the remarkably low swelling of this resin-spun sample is evident.

Samples of the detwisted yarn from Examples I and II were compared for percent fixed formaldehyde, both with each other and with Viscose Helanca. Results were:

Table II

Bulky Yarn Sample	Percent HCHO	
	1st run	2nd run
Swiss Viscose Helanca	0.66	0.65
Poly UEVE resin spun	1.50	1.45
PAA resin spun	0.74	0.70

It is believed that the explanation for the improved crimp imparted to the fibers by the process of this invention results in large part from the fact that when the yarn is formaldehyde-treated in supertwisted form the outer portions of the yarn are reacted to a greater extent than the portion in the interior of the yarn. Since the individual filaments are looped in and out of the twisted fiber because of the helical pattern of the twisted yarn, any given filament in the yarn will inevitably emerge to the surface of the yarn at regular intervals and disappear into the interior of the yarn at intermediate intervals. Hence at regular intervals along the length of the filament it will be heavily cross-linked while in the intervening portion there will be less cross-linking. Thus, uneven periodic treatment along the length of the filament will result in a differential crimp, with the more rigid portions taking the interior of the loop and the less-reacted portions taking the exterior of the loop. Thus, if the degree of formaldehyde treatment were to be plotted against the length of the filament a sine curve pattern would result. In order to demonstrate the heterogeneous fiber treatment a portion of yarn treated according to the process of Example II (poly UEVE resin spun yarn) was divided into two adjoining segments, labelled A and B, and several individual filaments in each segment were compared for swelling, and their deviation from the average was noted. The results are set out in Table III below:

Table III

Section	Filament No.	Percent Swelling	Percent Deviation from Average
A	1	19.7	−8.9
A	2	24.4	+12.8
A	3	15.6	−28.0
A	4	23.4	+8.3
A	5	25.0	+15.8
Average		21.6	
B	6	19.4	−26.3
B	7	25.8	−1.6
B	8	32.2	+23.0
B	9	23.6	−10.0
B	10	30.1	+15.0
Average		26.2	

A possible reason why the poly UEVE gives better results than PAA may come from the inactivity of the amide group in the latter. Polyacrylamide has but one nitrogen atom per polymeric unit, and the carbonyl group draws the odd pair of electrons of the nitrogen toward itself, diminishing their availability for reaction. In the case of poly-UEVE, there are two nitrogens per

one carbonyl group, leaving a better possibility for reaction.

In general it may be said that the degre of supertwist varies inversely with the denier of the yarn. A range of 150–400 denier would be translated into a range of about 55–40 t.p.i. of supertwist.

While the process of this invention is of very practical value in imparting a permanent crimp to a continuous filament yarn and in reducing its water retention and wet extensibility, the process is of even greater value with staple fibers. Dimensional stability is much more important in staple than in continuous filament. In addition the bulking is better in the case of yarn spun from staple prepared by this process than in the case of a plain regenerated cellulose staple, because of the resin-containing staple is stiffer than the other and therefore it resists packing together in the spun yarn. This leaves voids in the resin-containing yarn which are absent in the ordinary staple yarn and thereby increases its volume per unit weight accordingly. Furthermore the incorporation of the resin in the filament improves its crush resistance in pile fabrics both in the form of continuous filament and staple. In addition, the inclusion of the resin increases the crease resistance of flat fabrics since the fabric is less water sensitive and therefore faster drying. The difference in dyeing properties between the resin-containing fiber and the conventional regenerated cellulose fiber can be put to good use in fabrics. Since the plain cellulose fiber takes dye better than the other it is possible to effect a plaid pattern in a textile by alternating the number of parallel strands of resin-containing cellulose with the number of strands of plain cellulose and then subjecting the combination to a level dyeing operation. It should be noted here that if the yarn is to be dyed this should be done prior to twisting and formaldehyde-treating since the resinified twisted fiber is not receptive to dyeing. Because it is not receptive to dyeing the most practical method of coloring is to color-spin, i.e., to add the pigment to the viscose along with the resin as the viscose is spun.

Suitable colored inorganic pigment may be employed to obtain the desired color or shade. For a yellow color, ochre, sienna, chrome yellow, tin bronze, etc., may be employed. For a red color Venetial red, red lead, vermilion, etc., may be employed. For a blue color, ultramarine, Prussian blue, Milori blue, etc., may be used. For green, Guignet's green verdigris, chrome green may be employed. For brown, raw umber, burnt umber or Vandyke brown may be used. To obtain metallic effects, finely divided or colloidal metals may be employed. For shading, that is to get darker colors, lamp black, graphite or other black pigment may be added. To obtain any other colors, the pigments may be mixed as is well understood in the paint art.

The pigment is preferably added to the dope or spinning solution containing the cellulose compound in the form of a concentrated suspension in a liquid; usually about a 20% pigment-in-water dispersion. The amount of pigment added will vary with the depth of color desired and the nature of the pigment employed and will generally be from 0.1 to 10% of the weight of the cellulosic material present in the finished yarn. The pigment is preferably in very fine form, the particles having a diameter of less than 0.1 to 5 microns for increased covering power. It is of importance to have the pigment of very fine size in order to obtain the desired depth of color without the necessity of incorporating such a large amount of pigment as to deleteriously affect the strength and the other properties of the yarn. This fine size may be obtained by grinding the inorganic colored pigment either with water, an oil, part of the spinning solution, or the solvent used in the spinning solution in a ball mill or colloid mill.

It will be apparent from the foregoing that the invention provides a new method of improving the bulk or crimp while reliably decreasing and controlling the water-swelling and wet extensibility of regenerated cellulose yarns and textiles.

Various modifications and adjustments may be made in practicing the invention without departing from its spirit and scope.

I claim:

1. A process for producing a bulky yarn from a resin spun cellulosic yarn comprising supertwisting the yarn, setting the twist therein by impregnating the twisted yarn with formaldehyde at an elevated temperature and in the presence of an acidic catalyst, followed by thermal curing of the impregnated yarn, and then detwisting the cellulosic yarn to produce a wooly effect which is substantially fast to washing.

2. Process of claim 1 wherein the catalyst is an ammonium phosphate.

3. Process of claim 1 wherein the catalyst is a heterogenous reaction product of monoethanolamine, HCl, and formaldehyde.

4. Product of claim 3 wherein the reaction product is formed from about 0.9 mole monoethanolamine, about 1.0 mole HCl, and about 2.0 moles formaldehyde.

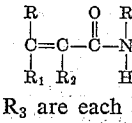
5. Process of claim 1 wherein a coloring matter is incorporated into the yarn at a point prior to supertwisting.

6. A process for producing a bulky yarn from a resin spun cellulosic yarn of about 150–300 denier comprising supertwisting the yarn to a twist of about 55–40 turns per inch, impregnating the twisted yarn with a formaldehyde solution containing about 0.25–0.3% of an acidic catalyst, centrifuging, drying at an elevated temperature, curing for a time of 10–40 minutes at a temperature of 100–175° C., and then detwisting to zero to produce a crimped yarn.

7. Process of claim 6 wherein the yarn is a pigmented yarn.

8. Process for producing a bulky yarn from a resin-spun cellulosic yarn having distributed therethrough a linear polymer capable of reacting with formaldehyde to form a resinous condensate in situ, comprising supertwisting the resin-spun yarn, setting the twist therein by treating the twisted yarn with hot formaldehyde, and heating the impregnated yarn in the presence of an acidic cross-linking catalyst to cure the resinous condensate, and then detwisting the yarn to about the zero point to form thereby a crimped and bulky yarn.

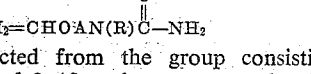
9. Process of claim 7 wherein the polymer is a linear polymer of an amide having the formula:



wherein R, R_1, R_2, R_3 are each selected from the group consisting of hydrogen, methyl, and ethyl.

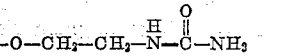
10. Process of claim 9 wherein the polymer is polyacrylamide.

11. Process of claim 8 wherein the polymer is a linear polymer of a compound of the formula:



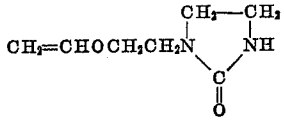
wherein A is selected from the group consisting of an alkylene group of 2–18 carbon atoms and a hydrocarbon-substituted alkylene group of 2–18 carbon atoms, at least two thereof occurring between the oxygen and nitrogen, and R is a member of the class consisting of H and monovalent hydrocarbon groups of not over 18 carbons.

12. Process of claim 11 wherein the polymer is poly(ureidoethyl vinyl ether), the monomer having the formula



13. Process of claim 8 wherein the polymer is a poly(vinyloxyalkyl alkyleneurea).

14. Process of claim 13 wherein the polymer is poly(vinyloxyethyl ethyleneurea), the monomer having the formula



References Cited in the file of this patent

UNITED STATES PATENTS

2,019,185	Kagi	Oct. 29, 1935
2,516,562	Graham	July 25, 1950
2,777,277	Lyon	Jan. 15, 1957

FOREIGN PATENTS

534,698	Great Britain	Mar. 14, 1941