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PRODUCTION OF HIGH-TWIST ARTIFICIAL YARNS

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This invention relates to the production of high-twist synthetic fiber yarns, and to agents for use in such production. The present application Serial No. 481,096 is closely related to the copending application of E. A. Robinson and A. DeCastro, entitled "High-twist yarn production," filed concurrently herewith.

It has long been recognized that a rather high degree of twist must be imparted to artificial yarns if such yarns are to compete with natural silk in elasticity, dull finish, tenacity and snag-resistance. This ideal has not been realized in practice, however, due to the intractability of high-twist artificial yarns, especially in knitting machines which require yarns which are both pliable and free from any tendency to snarl. In the absence of special treatment, high-twist artificial yarns have a strong tendency to snarl; on the other hand, when attempts are made to control this tendency by the use of gelatin or other similar sizes, the resultant yarns are inflexible, harsh and unmanageable upon knitting and working in other textile machines. To remedy this difficulty, it has been proposed to subject artificial yarns to reverse twisting operations, designed to overcome their tendency to snarl. While these last processes secure the desired result, they obviously require twice the normal spinning capacity and involve an additional step in the processing of the yarns, which step is moreover unfamiliar to, and outside the experience of, those engaged in the art.

Accordingly, it is an object of this invention to produce artificial fiber yarns not subject to snarl, but nevertheless possessing the degree of pliability necessary for machine processes, such as knitting.

Another object is to produce pliable, snarl-free artificial yarns without the use of excess spinning capacity or other equipment not required in the conventional processing of artificial yarns.

A further object is to produce such yarns with the minimum of departure from processes familiarly employed in connection with artificial yarns.

The foregoing and other objects are attained in accordance with this invention by applying to any selected artificial yarn, prior to the twisting thereof, an aqueous emulsion containing a hydrogenated vegetable, animal, or marine fatty oil having a melting point upwards of 30° C. The yarn is then dried, whereby a coating of hydrogenated oil is deposited upon the fibers of the yarn. Thereafter, the yarn is twisted, and the

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twisted yarn subjected to heat, which causes the hydrogenated oil coating to coalesce and retain the twist of the yarn, while nevertheless leaving the yarn sufficiently pliable for working in even the most exacting of mechanical processes, such, for instance, as hosiery knitting.

Treatment according to this invention is applicable to any artificial yarn to which it may be desired to impart a high degree of twist, including the regenerated cellulose yarns such as viscose and cuprammonium yarns; cellulose derivative yarns such as cellulose acetate, propionate, butyrate and ethyl ether yarns; and noncellulosic yarns such as the linear polyamide and polyvinyl yarns.

The emulsions applied to artificial yarns in accordance with this invention in general consist of aqueous media in which are dispersed variable quantities of hydrogenated oils, the dispersion being stabilized by suitable emulsifying agents. The emulsions may likewise contain minor proportions of subsidiary components, such as lubricants, sizing materials, etc.

Hydrogenated oils employed in emulsions according to this invention may be any hydrogenated animal, vegetable or marine oils having melting points upwards of 30°, and preferably upwards of 50° C. Selection of oils with regard to melting point is to be made with a view to the maximum temperature at which the treated yarns are to be worked, higher melting points being chosen when it is expected that the yarn will be worked at high temperature, i. e., in the summer time or in warm climates. Practically any commercial animal, vegetable or marine oil can be hydrogenated to the degree necessary for this purpose. Examples of oils which when hydrogenated possess properties suitable for use in this invention include animal oils, such as beef tallow, mutton tallow, lard oil, lard wool fat, bone fat and horse fat; vegetable oils such as mustard, castor, coconut, corn, cottonseed, grapeseed, olive, palm, palm kernel, peanut, soyabean and teaseed oils; and marine oils such as cod, pilchard, whale blubber, sperm, and train oils.

The emulsions as finally applied to the fiber may contain varying proportions of the hydrogenated oil, this being adjusted, as hereinafter more fully explained, so that, under the particular conditions of treatment, the finished yarn will contain a sufficient amount of hydrogenated oil to retain the twist thereof in a satisfactory manner under the conditions of subsequent mechanical working. The most economical amount is best determined by experiment under the expected

conditions of treatment and working of the yarn; it may be stated in a general way that a yarn containing between about 2% and about 30% of hydrogenated oil, based on the dry weight of the untreated yarn, will be a satisfactory product.

The emulsifying agents employed to stabilize the emulsions of this invention may be any of the conventional emulsifiers such as alkali metal, ammonium, amine and alkylolamine soaps; partial fatty esters, such as the mono-glycerides, glycolates, etc.; alkaline compounds, such as the caustic alkalis, amines and alkylolamines; fatty sulfo derivatives, such as sulfated fatty oils and fatty alkyl sulfates; sulfated and sulfonated amides and esters of alkylolamines and polyalcohols; and fatty quaternary derivatives, such as the salts of fatty amines of polyamines, etc. These emulsifiers are listed as suggestive only, not being critical to the operation of this invention, as any emulsifier capable of dispersing the hydrogenated oil would be suitable.

As mentioned above, minor proportions of various auxiliary agents may be incorporated in the emulsion, examples of these being small percentages of paraffin or other oils, for the purpose of lubrication, or small percentages of sizings such as gelatin, starch, etc. For instance, it may be necessary to lightly size yarns to hold them together for the throwing operation such as, for instance, the cuprammonium yarns which are ordinarily manufactured without any twist, in which case a small proportion of gelatin size might be incorporated.

The emulsions for use in this invention may be prepared in accordance with the usual techniques. Inasmuch as the emulsions will not ordinarily be formulated by the ultimate user, but will be prepared originally in a central establishment, the original emulsion will in such cases be prepared in highly concentrated form and subsequently diluted by the ultimate consumer before application to the yarns to be treated. In general, emulsions containing as much as 50% solids may be prepared for distribution and subsequent dilution for use. As mentioned above, the concentration of hydrogenated oil in the emulsions as diluted for application to the yarns should be such that the amount of oil deposited on the yarn will result in satisfactory working properties.

The step of applying the hydrogenated oil emulsions to yarns may be effected by means of any suitable apparatus and procedure, and may advantageously be carried out in the same manner, and by the same equipment, as is usual in the soaking of artificial fibers for other purposes, for instance, the customary size-soaking conducted upon yarns intended for crepe fabrics. Particular care should be taken to insure access of the emulsion to all portions of the yarn being treated, as the treatment greatly modifies the working properties of the yarn and any unevenness of application will interfere with subsequent mechanical processing. Accordingly, the temperature of the emulsion should preferably be maintained high enough to obtain optimum minimum viscosity of the emulsion, for instance between 140° and 180° F., to insure rapid and complete penetration of emulsion into the yarns being treated. Likewise, when the yarns are soaked in open vats or tubs, precaution should be taken to introduce the skeins, bundles or other packages of yarn into the vats in individual layers, and each layer should be completely immersed in the treating bath before the succeeding layer is

introduced. In such soaking procedures the yarn should be retained in the bath for a sufficiently long time to insure complete and thorough penetration of the emulsion into the fiber, periods of from about one quarter hour to one hour generally sufficing for this purpose. Other devices such as the Johnson skein-soaking machine, spray-soaking machines or roller applicators may be used for the application of the emulsions of this invention and have the advantage of greater rapidity and certainty of complete treatment. Likewise when the fiber is received in the form of spinning-pot cakes, these cakes may be impregnated with the emulsion by treatment in a pressure chamber.

The concentration of the hydrogenated oil in the emulsions as applied to the yarns in the soaking operation should be such that the finished yarn will contain sufficient hydrogenated oil to fix the twist therein, this quantity being roughly 2% to 30%, based on the dry weight of the untreated yarn. In general, since the usual soaking and centrifuging procedures will leave approximately 100% of liquid in the fiber, based on the weight of air-dry fiber, the percentage of hydrogenated oil in the emulsion will be roughly equal to the percentage of oil desired on the yarn, i. e., usually between 2% and 30%. However, if more emulsion is left in the fiber, the emulsion should be correspondingly more dilute, and vice versa.

After the soaking operation, the yarn should be drained of the emulsion freely flowing therefrom, after which still further quantities of emulsion may be removed by centrifugation. The degree to which the emulsion is removed may be varied, but in general it will be convenient to leave approximately 100% of emulsion in the yarn based on the air-dry, untreated weight thereof, since this amount is left in yarns by centrifugation as usually carried out.

Subsequent to the centrifugation the yarns, which will usually be in skeins, should be "dressed" or "snapped out" so as to minimize any caking thereof during the drying. The yarns should then be dried down to the moisture content desired in the throwing to be subsequently carried out, drying being effected in an atmosphere having a temperature preferably between 140° and 160° F.

Following the drying, the skeins should again be "dressed" or "snapped out," after which they are placed upon swifts and wound onto spool or bobbin packages. The yarns from the spool packages are then twisted, the twist inserted being, of course, of the high degree long desired by the industry and now made practical by this invention. For instance, as high as 50 or 60 turns per inch may be inserted into yarns treated in accordance with this invention without resulting in any serious tendency to snarl. The degree of twist at which the treatment of this invention becomes advantageous, i. e., at which serious snarling will occur in the absence thereof, varies greatly with the composition, denier, and filament number of the yarn, and with the nature of the mechanical working to which it is to be subjected, and accordingly no attempt will be made to lay down a rule on this point. By way solely of example, it has been found that trouble is experienced with a particular brand of viscose yarn when more than 5 turns per inch are inserted into 200 denier yarn, or when more than 20 turns per inch are inserted into 50 denier yarn, the limit in general varying inversely to the de-

nier of the yarn. These figures, of course, refer to twisting in the absence of treatment according to this invention.

Following the twisting, the twist is preferably set by treatment in a steam cabinet in the usual manner, with the exception that the time and temperature of steaming may be somewhat less than those required for other purposes, such as steaming of yarns for crepe effects. In some cases, where the twist is not too high, the twist-setting may even be entirely omitted. The steaming, when applied, causes the hydrogenated oil to flow and coalesce into a homogeneous film which retains the twist in the yarn during subsequent working, while nevertheless leaving the yarn in a highly flexible and pliable condition.

Following the setting, the yarn is wound into a cone package and is then in a condition suitable for working up into fabrics. The treatment hereinabove set forth will have rendered the twist highly stable so that it will be substantially free of any tendency to snarl even in the most exacting processes, such as knitting. The treatment does not, however, unduly reduce the flexibility of the yarn, so that it remains amenable to any and all mechanical processes. In practice, for instance, it has been found possible to knit full-fashioned stockings from high twist yarns prepared in accordance with this invention with a clear, uniform stitch—a result not hitherto obtainable on a practical basis with high twist synthetic yarns. The hydrogenated oils applied to yarns in accordance with this invention may be readily scoured from the articles finally elaborated therefrom, and thus do not adversely effect any subsequent dyeing or like operations.

Following are examples of procedures in accordance with the general principle above outlined. All parts given are by weight.

Example I

	Parts
Hydrogenated soyabean oil	13.7
Paraffin oil	2.4
Diethylene glycol	2.5
50% Aqueous potash	1.3
Stearic acid	.5
Water	79.6
	100.0

The hydrogenated soyabean oil, paraffin oil and diethylene glycol were melted together in a steam jacketed kettle at 180° F. Thereafter, the potash was added and the mixture agitated at 180° F., until clear. The stearic acid was then added, after which the water, preheated to 180° F., was stirred in to form a smooth emulsion.

100 parts by weight of 75 denier, 30 filament viscose rayon were taken for treatment. The rayon came in skeins of one-half pound each, and these skeins were wrapped into bundles of four, each bundle then being covered with a light-weight cheesecloth having a construction of 20 warp and 16 filling threads per inch. A layer of these bundles was placed in the kettle and the layer forced under the surface of the emulsion by means of a grating. Thereafter a second layer of bundles was placed in the kettle and forced under by means of the grating and so on, successive layers of bundles being added and forced under until all of the yarn was in the bath. The bath was kept at a temperature of 180° F. and the rayon left therein for one-half hour. Thereafter the unabsorbed emulsion was drained out of the kettle, and the bundles were removed and

placed in a single layer around the periphery of a centrifuge. The rayon was centrifuged to an emulsion content of 100%, based on the original weight of the rayon. Thereafter the bundles were removed from the centrifuge and opened up, and the skeins were removed, dressed, snapped out and hung in a drier maintained at 140° F. The drying proceeded to substantial equilibrium within five hours, after which the skeins were removed, again snapped out, wound onto spools and twisted to 35 turns per inch. The twisted rayon was then steamed in a steam chest at 160° F. dry bulb, 155° F. wet bulb for 45 minutes to melt the hydrogenated oil into a homogeneous coating which served to set the twist. The rayon was then wound on cones, and the cones used to knit directly the body of a 45 gauge full-fashioned stocking. The yarn behaved well on the knitting machine, yielding clear and even stitches and giving absolutely no trouble from snarling or unmanageability. The stockings so knitted were then scoured in a 0.1% soap bath at 190° F. for 45 minutes, rinsed, dyed in a bath consisting of the usual direct hosiery dyes used on rayon, dried and boarded. The product stocking was evenly dyed, was characterized by a desirable dull finish, was highly resistant to snagging and possessed an even construction of uniform, clear, open stitches.

Example II

	Parts
Hydrogenated fish oil	7.5
Paraffin oil	1.3
Stearic acid	3.0
Glyceryl mono-oleate	1.0
Mono-ethylene glycol mono-oleate	2.0
Triethanolamine	0.2
Water	85.0
	100.0

An emulsion was prepared from the foregoing ingredients, and substituted for the emulsion of Example I, the procedure of that example being carried out identically in all other respects. The resultant treated yarn had the same excellent working properties, and the stocking body knitted therefrom had the same high quality, as were secured in the procedure of Example I.

Example III

	Parts
Hydrogenated cottonseed oil	7.3
Sulfated cottonseed oil	3.6
Gelatin	0.5
Water	88.6
	100.0

An emulsion was prepared having the composition set forth in the recipe, placed in a Johnson skein-soaking machine, and the temperature adjusted to 130° F. Cuprammonium rayon (50 denier 36 filament) in skeins was placed on the arms of the soaking machine, and revolved through the bath for 20 minutes. The skeins were removed from the machine and centrifuged until the readily extractable fluid had all been removed. The skeins were removed and dried in an atmosphere maintained at 140° F. for 5 hours. The skeins were then weighed, whereby it was ascertained that the yarn had taken up 8.3% of treatment, based on the weight of the original untreated yarn. The yarn was then thrown and twisted to 50 turns per inch, in which processes it gave no trouble. The twisted yarn was steamed

at 140° F. wet bulb, 134° F. dry bulb for 15 minutes. The yarn so produced had an excellent "hand" and was free of excessive tendency to snarl.

Example IV

	Parts
Hydrogenated tallow	6.4
Tetraethylene glycol	1.1
50% aqueous potash	.5
Water	92.0
	100.0

All the ingredients except the water were melted and stirred together at 180° F. until a clear homogeneous mass was obtained, after which the water, preheated to 180° F., was added with continued stirring. The resultant emulsion was placed in a kettle provided with a removable perforated basket and with a steam coil, by means of which latter the temperature of the emulsion was maintained at 180° F. throughout the subsequent operations.

100 parts of 75 denier 20 filament acetate rayon in half-pound skeins were taken for treatment. The skeins were enclosed in mesh bags, four to the bag, and the bags immersed layer by layer in the emulsion inside the perforated basket. Soaking was continued for 45 minutes, after which the basket and contained bags of yarn were hoisted from the kettle and the freely-draining emulsion allowed to run back into the kettle. The bundles were then centrifuged to remove excess liquor. The skeins were removed from the bags, dressed, and hung up to dry for one hour in an atmosphere maintained at 160° F. Thereafter the yarn was twisted to 45 turns per inch and the twist set by steaming at 150° F. dry bulb and 145° F. wet bulb for 30 minutes. The steamed yarn was made up into cone packages and the body of a 51 gauge full-fashioned stocking was directly knitted therefrom. The yarn behaved well on the knitting machine by virtue of its stability of twist and pliability. Moreover, the slightly hydrophilic character of the emulsion-deposited coating improved the take-up at the moistening trough. The stocking body so produced was of high quality, having clear, uniform and open stitch, dull luster, elasticity and good snag-resistance.

From the foregoing general description and specific examples, it is apparent that the applicants have devised a process whereby is obtained a result not hitherto realized, viz., the production of high twist synthetic yarns which are characterized by dull finish, elasticity, resistance to snag and tenacity, but which are nevertheless amenable to the most exacting mechanical processes, particularly knitting. Moreover, the process fits in well with the conventional practice and apparatus employed in rayon throwing establishments, since it has been customary to soak rayon intended for crepe fabrics previous to the throwing operation by means of manipulative steps very similar to those involved in the present invention. The treatment is furthermore economical in that it may be carried out in a relatively short period of time and by relatively simple procedures and makes use of very plentiful treating agents, viz., the hydrogenated fatty oils.

We therefore claim:

1. Process for producing pliable, nonsnarling high twist yarn from an artificial fiber yarn which comprises distributing throughout the yarn an aqueous emulsion of a hydrogenated oil; drying the yarn; twisting the yarn to a degree such that kinking would normally occur in the subsequent mechanical processing; and setting the twist in the yarn by means of heat.

2. Process for producing pliable, nonsnarling high twist yarn from a viscose yarn which comprises distributing throughout the yarn an aqueous emulsion of a hydrogenated oil; drying the yarn; twisting the yarn to a degree such that kinking would normally occur in the subsequent mechanical processing; and setting the twist in the yarn by means of heat.

3. Process for producing pliable, nonsnarling high twist yarn from acetate yarn which comprises distributing throughout the yarn an aqueous emulsion of a hydrogenated oil, drying the yarn; twisting the yarn to a degree such that kinking would normally occur in the subsequent mechanical processing; and setting the twist in the yarn by means of heat.

4. Process for producing pliable, nonsnarling high twist yarn from cuprammonium yarn which comprises distributing throughout the yarn an aqueous emulsion of a hydrogented oil; drying the yarn; twisting the yarn to a degree such that kinking would normally occur in the subsequent mechanical processing; and setting the twist in the yarn by means of heat.

5. Process for producing pliable, nonsnarling high twist yarn from an artificial fiber yarn which comprises distributing throughout the yarn a sufficient quantity of an aqueous emulsion of a hydrogenated oil to contain between about 2% and about 30% of the hydrogenated oil, based on the dry weight of the yarn; drying the yarn; twisting the yarn to a degree such that kinking would normally occur in the subsequent mechanical processing; and setting the twist in the yarn by means of heat.

6. Process for producing pliable, nonsnarling high twist yarn from cuprammonium yarn which comprises distributing throughout the yarn a sufficient quantity of an aqueous emulsion of a hydrogenated oil to contain between about 2% and about 30% of the hydrogenated oil, based on the dry weight of the yarn; drying the yarn; twisting the yarn to a degree such that kinking would normally occur in the subsequent mechanical processing; and setting the twist in the yarn by means of heat.

7. Process for producing pliable, nonsnarling high twist yarn from acetate yarn which comprises distributing throughout the yarn a sufficient quantity of an aqueous emulsion of a hydrogenated oil to contain between 2% and about 30% of the hydrogenated oil, based on the dry weight of the yarn; drying the yarn; twisting the yarn to a degree such that kinking would normally occur in the subsequent mechanical processing; and setting the twist in the yarn by means of heat.

8. Process for producing pliable, nonsnarling high twist yarn from viscose yarn which comprises distributing throughout the yarn a sufficient quantity of an aqueous emulsion of a hydrogenated oil to contain between about 2% and about 30% of the hyrogenated oil, based on the dry weight of the yarn; drying the yarn; twisting the yarn to a degree such that kinking would normally occur in the subsequent mechanical processing; and setting the twist in the yarn by means of heat.

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