

[54] **MULTIFILAMENT POLYETHYLENE
TEREPHTHALATE YARN**

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[58] **Field of Search** **117/138.8 F, 7, 90, 66, 117/87, 72, 139.5 F, 139.5 CQ, 66, 76 I; 252/8.75, 8.8, 8.9; 57/164, 157 S**

[56] **References Cited**

UNITED STATES PATENTS

3,103,448 9/1963 Ross 117/139.5 CQ

3,672,977 6/1972 Dardoufas 117/138.8 F
3,681,244 8/1972 Obetz et al. 117/138.8 FX
3,687,721 8/1972 Dardoufas 117/138.8 F

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[57] **ABSTRACT**

An improved multifilament polyethylene terephthalate yarn having excellent translational efficiency for cordage use is prepared by first applying to the yarn a liquid composition comprising refined coconut glyceride, hexadecyl stearate, ethoxylated lauryl alcohol, sodium petroleum sulfonate, ethoxylated tallow amine, an antioxidant, and a mineral oil, and then applying to the yarn a liquid composition of an oxidized polyethylene wax. The yarn is preferably used in heavy duty ropes and cords.

7 Claims, No Drawings

MULTIFILAMENT POLYETHYLENE TEREPHTHALATE YARN

BACKGROUND OF THE INVENTION

This invention relates to improved multifilament yarns, and particularly to multifilament polyethylene terephthalate yarns having excellent translational efficiency when fabricated into cord or rope.

High-strength polyethylene yarns presently available commercially for cord or rope manufacture suffer from one of the following deficiencies: low breaking strength in rope form or so-called slip/stick friction characteristics. The latter is characterized by "creeking" of the rope at loads below the breaking load.

A number of patents have issued in this field. U.S. Pat. No. 3,103,448 relates to a process for increasing the durability of a synthetic continuous filament yarn which comprises applying to said yarn a water-resistant coating of an oxidized polyethylene wax having an average molecular weight between about 1,000 and about 3,000 and an oxygen content between about 3 percent and about 9 percent by weight.

U.S. Pat. No. 3,681,244 relates to a finishing composition and more specifically to a composition capable of imparting excellent translational efficiency to high-strength multi-filament yarns. The composition is particularly suitable for finishing high-strength yarns to be used for the production of tire yarns, conveyor belts, seat belts and the like. The finishing composition comprises the reaction products of polybasic carboxylic acids and polyesters. These simple esters are obtained by reacting monocarboxylic acid with a polyhydroxy alcohol.

U.S. Pat. No. 3,687,721 relates to improved polyester yarns. A multifilament yarn having a lubricating protective film allowing higher stretching for increased molecular orientation is prepared by applying to the yarn a liquid composition of about 0.4 to about 1.5 weight percent based on the weight of the yarn, said film composition comprising decaglycerol tetraoleate, glycerol monooleate, ethoxylated tall oil fatty acid, sulfated glycerol trioleate, ethoxylated alkylamine and a lubricant of hexadecyl stearate. Other additives, such as antioxidants may be added, and the composition may be aqueous or nonaqueous.

U.S. Pat. No. 3,672,977 relates to an improved multifilament polyethylene terephthalate yarn having a lubricating protective film applied thereon of from about 0.3 to about 0.6 weight percent based on the weight of the yarn of a liquid composition consisting essentially of about 10 to about 20 weight percent of said composition of each hexadecyl stearate and refined coconut oil, about 3.0 to about 6.0 weight percent of said composition of ethoxylated tallow amine, about 10 to about 20 weight percent of said composition of ethoxylated lauryl alcohol, about 8.0 to about 12.0 weight percent of said composition of sodium salt of alkylarylsulfonate, about 1.0 to about 3.0 weight percent of dinonyl-sodium-sulfosuccinate, about 1.0 to about 3.0 weight percent of said composition of 4,4'-thio-bis(3-methyl-6-tert-butylphenol), about 35 to 50 weight percent of said composition of white mineral oil having a boiling point of between 510°F. and 620°F. wherein at least about 0.15 to about 0.30 weight percent is retained on said yarn, and then treating said yarn with from about 0.7 to about 1.2 weight percent on said yarn of a liquid composition selected from the group consisting of (a)

about 95 to about 98 weight percent of said composition of triethylene glycoldipelargonate and about 2 to about 5 weight percent of said composition of 2,2'-methylene-bis-(4-methyl-6-tert nonylphenol), and (b) about 13 to about 25 weight percent of said composition selected from the group consisting of glycerol monooleate and decaglycerol tetraoleate with ethoxylated tall oil fatty acids, about 12 to about 20 weight percent of said composition selected from the group consisting of sulfated glycerol trioleate and ethoxylated alkylamine, and about 55 to about 75 weight percent of said composition of hexadecyl stearate.

Unfortunately, polyester yarns made in accordance with said patented processes are not completely satisfactory for cordage use, i.e., they suffer from either relatively low breaking strength in rope form or slip/stick friction characteristics. Accordingly, research has continued in an effort to solve these deficiencies.

SUMMARY OF THE INVENTION

The chief object of this invention is to provide an improved multifilament yarn having high translational efficiency for cordage use. This improved yarn can be made into ropes or cordage which have significantly higher strength than ropes or cordage made from known polyethylene terephthalate yarns, and, surprisingly, show no creeking at all, all the way to the breaking load.

The present invention may be considered an improvement over the process of U.S. Pat. No. 3,672,977, mentioned hereinabove, wherein an improved polyester yarn is produced, desirably by use of two finishes. In said patent, the first finish is referred to as a process finish and the second finish is called a yarn finish or overfinish. For convenience, the same terminology is generally used herein; however, it will be understood that the present invention requires use of two finishes.

Briefly stated, the present invention is directed to an improved multifilament polyethylene terephthalate yarn having a lubricating protective film applied thereon of from about 0.3 to about 0.6 weight percent based on the weight of the yarn of a liquid composition consisting essentially of about 10 to about 20 weight percent of said composition of each hexadecyl stearate and refined coconut oil, about 3.0 to about 6.0 weight percent of said composition of ethoxylated tallow amine, about 10 to about 20 weight percent of said composition of ethoxylated lauryl alcohol, about 8.0 to about 12.0 weight percent of said composition of sodium salt of alkylarylsulfonate, about 1.0 to about 3.0 weight percent of dinonyl-sodium-sulfosuccinate, about 1.0 to about 3.0 weight percent of said composition of 4,4'-butylidene-bis-(6-tert-butyl-m-cresol), thio-bis-(di-sec-amyphenol), trinonyl phenol phosphite, and 2,2-methylene-bis-(4-methyl-6-tert-nonylphenol), about 35 to 50 weight percent of said composition of white mineral oil having a boiling point of between 510°F. and 620°F. wherein at least about 0.15 to about 0.30 weight percent is retained on said yarn, and then treating said yarn with from about 0.05 to about 2.0 weight percent, based on the weight of the finished yarn, of an oxidized polyethylene wax having an average molecular weight between about 1,000 and about 4,000 and an oxygen content between about 3 percent and about 6 percent by weight.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The preferred composition for use as the process finish in accordance with this invention consists of a non-aqueous homogeneous blend comprising a lubricant, an emulsifier, an antistat, a wetting agent and an antioxidant. The blend is a clear liquid free of suspended solids, and having a viscosity of 22 to 34 centipoises at room temperature. The lubricating and continuous phase of the composition consists of about 39 weight percent mineral oil of low viscosity of about 40 SSU at 100°C., flash point of 260°F., and boiling range of about 510°F. to 620°F., about 14.5 weight percent coconut oil and 14.5 weight percent hexadecyl stearate which have low volatility and excellent heat stability. The remainder consists of about 10 weight percent of petroleum sulfonate (sodium salt of alkylarylsulfonate) which is an excellent emulsifier and antistat due to its high ionization, about 5 weight percent of ethoxylated (20 ETO) tallow amine which is an excellent emulsifier and antistat, about 13 weight percent of ethoxylated (4 ETO) lauryl alcohol emulsifier coupling agent, about 2 weight percent of sodium salt of nonyl sulfosuccinate which is an excellent wetting agent, and 2 weight percent of an antioxidant 2,2-methylene-bis-(4-methyl-6-tert-nonylphenol).

The process finish composition is applied onto the yarn in such a way as to allow about 0.3 to about 0.6 weight percent of said composition to be initially applied with at least about 0.15 to about 0.30 weight percent retained on the yarn to protect the fiber surface and provide required lubricity and antistatic properties. During the heat treatment of the yarn subsequent to the application of the process finish composition, about 30 to about 50 weight percent of the composition is volatilized. The volatiles consist mainly of the low viscosity mineral oil. The volatiles are condensed and can be recovered through an exhaust system. The process finish composition provides adequate surface lubrication, antistatic properties and antioxidant to protect the yarn surface during the subsequent drawing operation. An important advantage of this process finish composition is its thermal stability when exposed to extremely high temperatures as required in a polyester spin draw or conventional spinning and drawing process, i.e., it suffers substantially no decomposition, thus preventing possible deposits on processing rolls and other thread-path components that affect processing efficiency.

The process finish composition is important not only due to its composition which provides all requirements of lubrication, antistatic properties and protection from heat degradation, but because of the following physical properties which are critical for uniformity of application and efficient fiber thermal treatment. First, low viscosity of less than 40 centipoises at 25°C. is necessary for application at room temperature. Second, good wetting ability measured by contact angle method on polyester film is necessary. A contact angle of less than 10° gives substantially ideal conditions of finish spreadability. Third, it is important that the process finish composition is a uniform blend, clear, and free of any suspended solids. Just a minor variation or modification of ratio of the composition ingredients results in an unstable blend of cloudy appearance with suspended solids or complete separation of layers. Fourth, the composition yields low specific heat and the lowest

possible heat of vaporization of the more volatile components which provides good conditions to minimize heat losses during the thermal treatment of the fiber. This limitation is one of the more critical limitations that aqueous compositions and emulsions cannot overcome. And, lastly, the composition is heat stable when exposed to high process temperatures.

The yarn finish or overfinish composition which comprises oxidized polyethylene wax is preferably applied onto the yarn in such a way as to allow about 0.1 to about 1.2 weight percent to remain on said yarn to improve its translational efficiency of yarn to tensilized cord. The yarn or overfinish composition can be applied at any stage of the process subsequent to the drawing stage; however, it is critical that the overfinish not be applied prior to the drawing stage. Normally, the yarn is subjected, prior to its fabrication into ropes or cordage, to treatment with an aqueous emulsion of a readily emulsifiable, oxidized polyethylene wax, preferably followed by heating to a temperature above about 100°C. to evaporate excess water from the yarn.

Oxidized polyethylene wax materials suitable for use in the process of the present invention are described in U.S. Pat. No. 3,060,163, according to which normally solid, hard, waxy polymers of ethylene, which are saturated aliphatic compounds characterized by a recurring $-\text{CH}_2-$ group and which have average molecular weights between about 1,000 and about 4,000, especially polyethylene/alkanol telomers of this character, are subjected, in the liquid phase, to the action of an oxygen-containing gas to cause reaction of at least about 5 pounds of oxygen per 100 pounds of wax, preferably between about 5 pounds and about 17 pounds of oxygen, per 100 pounds of wax, i.e., to provide an oxidized polyethylene wax containing at least 3 percent, preferably between about 3 percent and about 9 percent of oxygen by weight, based on the weight of the oxidized wax, and acid numbers of not more than about 50, preferably between about 10 and about 45. The oxidized polyethylene/isopropanol telomer waxes prepared according to the above method containing between about 3 percent and about 6 percent oxygen and having average molecular weights between about 1,000 and about 4,000, melting points between about 90°C. and about 110°C., acid numbers between about 10 and about 20, are especially preferred. The preferred oxidized wax products are characterized by an extremely low incidence of, or in many cases, substantially complete absence of ester groups. Thus, the saponification number (which measures both acid and ester groups) is substantially identical to or slightly greater than the acid number (which measures only acid groups) so that these products all have an extremely low or zero ester number (saponification number minus acid number) and have ratios of saponification number to acid number of about 1 to about 1.2 and not more than about 1.5.

In carrying out the process according to our invention, the oxidized polyethylene wax as described, is emulsified in water by known methods using any suitable emulsifying agent. In general, we prefer to melt the polyethylene wax together with the emulsifying agent and then pour the melted wax gradually with stirring into hot water at a temperature slightly below the boiling temperature. Concentration of the wax component in the emulsion is not critical, and will be adjusted to provide the desired coat weight on the yarn under the

particular application conditions employed. Concentrations between about 5 percent and about 20 percent are suitable, and between about 10 percent and about 15 percent are preferred.

The oxidized polyethylene wax emulsion is applied to yarn in any of the conventional ways of applying yarn finishes. A satisfactory manner of applying the coating is by feeding the emulsion to a trough equipped with a rotatable roll dipping therein, and passing the yarn in contact with this roll at a relative speed with respect to the rate of rotation of the roll adjusted to provide the desired pick-up of coating by the yarn, for example, between about 1 percent and about 6 percent pick-up of the liquid coating by weight, based on the weight of the yarn.

The coated yarn may be heated, if desired, to a temperature above about 100°C. for a short period, for example, a few seconds, preferably to between about 100°C. and about 135°C. to cause volatilization of part or all of the water in order to prevent shrinkage of the yarn when packaged by winding on cones, etc.

The amount of oxidized polyethylene wax remaining on the yarn after the heat treatment should be sufficient to form at least a thin coating on the yarn. Even extremely thin coatings of oxidized polyethylene wax on the yarn result in significant reduction of the fiber to fiber friction of such yarns when fabricated into rope. Thus, quantities equivalent to as little as about 0.05 percent of the weight of the finished yarn impart excellent durability properties to the yarn. We prefer, however, to apply sufficient emulsion to produce coatings of between about 0.05 percent and about 2 percent by weight of the finished yarn. Larger proportions may be applied, up to 10 percent or more, if desired.

The oxidized polyethylene wax emulsion may be applied to the yarn either alone, or together with other additives commonly applied to yarns as yarn "finishes," for example, antistatic agents.

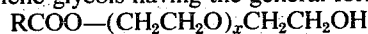
Any suitable emulsifying agent may be used in preparing the oxidized polyethylene wax emulsions used in the process of our invention. Mixtures of higher fatty acids, for example C₁₂ to C₂₀ saturated aliphatic acids with volatile amines such as morpholine, methoxy propylamine, 2-amino-2-methyl-1-propanol, etc., may be used as emulsifiers as may also the long chain alkyl aryl sulfonates such as alkyl benzene sodium sulfonate, dodecyl benzene sodium sulfonate, and alkyl aryl polyether alcohols. Also useful are the general class of non-ionic emulsifiers especially the condensation products of ethylene oxide with hydrophobic material such as a long chain aliphatic alcohol, acid, ester, ether or alkyl phenol. These products are characterized by containing as the hydrophilic portion of the molecule, a plurality of oxyethylene moieties as illustrated in the formulas below.

1. $R-O-(CH_2-CH_2O)_x-CH_2-CH_2OH$ wherein R is an alkyl group having from 12 to 22 carbon atoms or an alkyl phenol residue wherein the alkyl group contains from 6 to 13 carbon atoms inclusive and wherein x is at least 4 especially between about 6 and about 40.

Commercial examples of products in this group include "Triton X-100" wherein R is an alkyl phenol residue wherein the alkyl group is isooctyl and wherein x is 7 to 9; "Triton X-102" wherein R is an isooctyl phenol residue and x is 11; "Tergitol NPX" wherein R is

ethylhexyl phenol residue and x is 8 to 9, "Neutronic 600" wherein R is nonyl phenol residue and x is 9; "Emulphor ELN" wherein R is dodecyl phenol residue and x is 19.

2. Condensation products of fatty acids and polyethylene glycols having the general formula



wherein R is a long chain alkyl group having from 12 to 18 carbon atoms inclusive and x is an integer from 8 to 40 inclusive.

3. Polyoxyethylene derivatives of hexitol anhydride or sorbitol fatty acid esters such as "Tween 80."

4. Polyoxyethylene ethers,



wherein R is an alkyl group having from 6 to 18 carbon atoms and x is an integer from 4 to 40 inclusive. A commercial product which is an example of this group is "Brij 30" in which R is lauryl and x is believed to be 10.

The above ethers are well known commercial products, many specific examples of which are disclosed in German Pat. No. 965,722, issued June 19, 1957.

Usually between about 15 percent and about 50 percent or more of emulsifier based on the weight of the oxidized polyethylene wax may be used.

The resulting oxidized polyethylene wax-coated yarns are especially adapted for fabrication into ropes of unusually high strength, by well known commercial processes. In preparing such continuous filament yarns for subsequent fabrication into ropes, the yarns are given a slight twist, for example ½ turn per inch. Ropes are prepared from such yarns by a multi-stage process, the steps of which may vary somewhat depending on the type of rope desired. In general, the first step involves forming strands by "laying" together a plurality of rope yarns, for example, 70-80 or more, in a left hand direction, i.e., with an S or left hand "lay" or twist. The next step involves plying the desired number of the above strands, usually 3 or more, to form a rope with a Z twist or "right lay" in which, in general, no previously imparted twists are lost, and on occasion, additional twisting is produced. This procedure results in a finished rope of linear structure composed of a limited number, usually 3 to 9 "laid" or twisted strands which strands are made up of a plurality of plies of twisted yarn, and in which the yarn is made up of a plurality of continuous filaments.

The following specific examples further illustrate our invention. Parts are by weight except as otherwise noted.

EXAMPLE 1

A process finish composition for use in accordance with the present invention is prepared by mixing the following finish components:

Finish Components	Parts	Function
Refined coconut glyceride	14.7	Lubricant
Hexadecyl stearate	14.7	Lubricant
Ethoxylated lauryl alcohol (4 EO)	12.7	Emulsifier
Sodium petroleum sulfonate 60-62% active in mineral oil	9.8	Antistat emulsifier
Ethoxylated tallow amine		Antistat

-Continued

Finish Components	Parts	Function
(20 EO)	4.9	emulsifier
Sodium salt of sulfonated succinic ester	2.0	Wetting agent
"Naugawhite" (2,2-methylene-bis-(4-methyl-6-tert-nonylphenol))	2.0	Antioxidant
Mineral oil viscosity 40 SSU	39.2	Continuous phase

The resulting finish composition is a clear oil blend having a viscosity of 29.0 centipoises (Brookfield) and a surface tension of 31.8 dyn./cm.

Similar process finishes may be prepared in which the 2,2-methylene-bis-(4-methyl-6-tert-nonyl-phenol) is replaced with an equal weight of one of the following antioxidants: 4,4'-butylidene-bis-(6-tert-butyl-m-cresol), thio-bis-(di-sec-amylphenol), and trinonyl phenol phosphite.

EXAMPLE 2

For use as the overfinish in accordance with the invention, an aqueous emulsion of oxidized polyethylene wax of the following composition is prepared:

	Parts
Oxidized polyethylene wax	40
"Triton X-100" (emulsifier)	10
20% aqueous KOH solution	3
Water	147

Said overfinish is prepared by melting the wax and the emulsifier together at 255°F. and then cooling to 230°F. With the melt temperature at 230°F., the potassium hydroxide solution is added gradually with stirring. The melt at 230°F. is added gradually with stirring to water which has been heated to just below the boiling temperature. The finish is then allowed to cool to room temperature with agitation, water being added to replace any loss by agitation. The oxidized polyethylene wax is a polyethylene/alkanol telomer wax having an average molecular weight of about 3,500, a hardness (ASTM D1321) of 5.5, an oxygen content of about 3 percent, melting point 100°-105°C. and acid number 15. Prior to use as overfinish, the emulsion is diluted with an equal weight of water.

EXAMPLE 3

The yarns of this invention can be processed by any spin draw process or spinning and separately drawing process available to the art in the patent and technical literature, using any suitable polyester which provides the high tenacity yarn of about 9 grams per denier and minimum elongation of about 13 percent. The following example demonstrates a suitable procedure for preparing polyester yarn and applying the two finishes of the present invention.

45 pounds per hour of terephthalic acid and 26 pounds per hour of ethylene glycol are continuously fed to the direct esterification system of a continuous polymerization train. The esterified product is partially polymerized in a horizontal agitated vacuum reactor to a product having intrinsic viscosity of 0.6 (measured in 60:40 phenol:tetrachloroethane) and carboxyl end group concentration of 17 milliequivalents per kilo-

gram. This product is continuously fed into another horizontal reactor at 280°C. and 1 torr pressure. This reactor has an internal diameter of 30 inches and an effective length of 25 inches. It contains an agitator with a series of wheels having projections on their outer circumference, connected to a central shaft, each wheel rotating between baffles. During operation the agitator is rotated at about 0.5 rpm. The level is maintained at the minimum required to obtain a constant discharge from the exit screw. The product from this reactor has an intrinsic viscosity of 0.98 and a carboxyl end group concentration of about 20 milliequivalents per kilogram. This product is pumped to a spin block and converted into a 1,300 denier, 192 filament yarn using conventional spinning and drawing procedures. In accordance with the present invention, the process finish of Example 1 is applied to the yarn before the drawing step, and the overfinish of Example 2 is applied to the yarn after the drawing step. The process finish is applied onto the yarn in such a way as to furnish about 0.3 to about 0.6 weight percent of the finish on the yarn to protect the fiber surface and provide lubricity and anti-static properties. The overfinish is preferably applied onto the yarn in such a way as to provide about 0.1 to 1.2 weight percent of the oxidized polyethylene wax on the finished yarn. Desirably, the diluted overfinish of Example 2 is applied to the yarn at about 3 percent of said diluted overfinish based on the weight of the yarn. This yarn is hereinafter called Yarn A.

EXAMPLE 4

The properties of Yarn A of Example 3 were compared with the properties of Yarn B which yarn is identical in all respects except for omission of the oxidized polyethylene wax treatment.

Properties	Yarn A	Yarn B
Oxidized polyethylene on yarn	0.15	0
Yarn/yarn friction, grams*	390	180-602
Yarn/metal friction, grams**	255	310
Yarn/yarn abrasion, minutes***	15+	3.9
Greige cord E _t , %****	96	90
Breaking strength of 2 inch diameter rope, lbs.	93,000	69,500
Slip/stick (creeking)*****	None	Occurs

*Friction generated by passing yarn over itself at 360° twist at 1 cm. per minute with 600 grams pretension. Note slip/stick property of yarn B.

**Friction generated by passing yarn over chrome plated stainless steel 0.25 inch pin at 360° (full turn) at 1,000 feet per minute.

***Test conditions same as * except 2,000 grams pretension is used and test is run until yarn breaks; reported in minutes.

****E_t means translational efficiency; it is a percentage comparison of the strength of cord (2 or more plies) versus the sum of the strengths of the individual yarns.

*****Measured on a 2-inch rope in a Tinius-Olsen Breaking Machine.

We claim:

1. A synthetic filamentary yarn comprised of polyethylene terephthalate filaments which are first coated with from about 0.3 to about 0.6 weight percent based on the weight of the yarn of a liquid composition consisting essentially of about 10 to about 20 weight percent of said composition of each hexadecyl stearate and refined coconut oil, about 3.0 to about 6.0 weight percent of said composition of ethoxylated tallow amine, about 10 to about 20 weight percent of said composition of ethoxylated lauryl alcohol, about 8.0 to about 12.0 weight percent of said composition of sodium salt of alkylarylsulfonate, about 1.0 to about 3.0

weight percent of said composition of dinonyl-sodium-sulfosuccinate, about 1.0 to about 3.0 weight percent of said composition of an antioxidant selected from the group consisting of 4,4'-butylidene-bis-(6-tert-butyl-m-cresol), thio-bis-(di-sec-amylphenol), trinonyl phenol phosphite, and 2,2-methylene-bis-(4-methyl-6-tert-nonylphenol), about 35 to 50 weight percent of said composition of white mineral oil having a boiling point of between 510°F. and 620°F. wherein at least about 0.15 to about 0.30 weight percent is retained on said yarn, and then coated with from about 0.05 to about 2.0 weight percent, based on the weight of the finished yarn, of an oxidized polyethylene wax having an average molecular weight between about 1,000 and about 4,000 and an oxygen content between about 3 percent and about 6 percent by weight.

2. The synthetic filamentary yarn of claim 1 wherein the antioxidant is 2,2-methylene-bis-(4-methyl-6-tert-nonylphenol).

3. The synthetic filamentary yarn of claim 1 wherein the yarn is coated with about 0.1 to 1.2 weight percent, based on the weight of the finished yarn, of the oxidized polyethylene wax.

4. In a process of producing polyethylene terephthalate yarn wherein a liquid is applied to the yarn, said process involving spinning and drawing steps, the improvement comprising first applying to the yarn prior to said drawing step from about 0.3 to about 0.6 weight percent based on the weight of the yarn of a liquid composition consisting essentially of about 10 to about 20 weight percent of said composition of each hexadecyl stearate and refined coconut oil, about 3.0 to about 6.0 weight percent of said composition of ethoxylated tallow amine, about 10 to about 20 weight percent of said

composition of ethoxylated lauryl alcohol, about 8.0 to about 12.0 weight percent of said composition of sodium salt of alkylarylsulfonate, about 1.0 to about 3.0 weight percent of said composition of dinonyl-sodium-sulfo-succinate, about 1.0 to about 3.0 weight percent of said composition of an antioxidant selected from the group consisting of 4,4'-butylidene-bis-(6-tert-butyl-m-cresol), thio-bis-(di-sec-amylphenol), trinonyl phenol phosphite, and 2,2-methylene-bis-(4-methyl-6-tert-nonylphenol), about 35 to 50 weight percent of said composition of white mineral oil having a boiling point of between 510°F. and 620°F. wherein at least about 0.15 to about 0.30 weight percent is retained on said yarn, and then applying to said yarn after said drawing step from about 0.05 to about 2.0 weight percent, based on the weight of the finished yarn, of an oxidized polyethylene wax having an average molecular weight between about 1,000 and about 4,000 and an oxygen content between about 3 percent and about 6 percent by weight.

5. The process of claim 4 wherein the oxidized polyethylene wax is applied to the yarn in the form of an aqueous emulsion and the yarn is thereafter heated to a temperature between about 100°C. and about 135°C., thereby providing a water resistant coating on said yarn.

6. The process of claim 5 wherein the antioxidant is 2,2-methylene-bis-(4-methyl-6-tert-nonylphenol).

7. The process of claim 5 wherein about 0.1 to 1.2 weight percent, based on the weight of the finished yarn, of the oxidized polyethylene wax is applied to the yarn.

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