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# TEXTILE PRODUCT

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This invention relates to a new composition of matter and articles produced therewith. More particularly, this invention concerns textile-lubricating compositions suitable for use in producing a synthetic, continuous-filament, false-twist, textured yarn as well as other yarns.

A common method of producing bulky yarns is the so-called false-twist process. The essential elements in producing bulky yarns via false twist consists of a yarn supply, a heating element to set twist in the yarn, a false-twist spindle, and a windup. Lubricants employed on yarns manufactured by the false-twist process, which are to remain for use during subsequent texturing, must be relatively stable and serve their lubrication functions at both room temperature and high temperature.

It is a primary object of the present invention to provide a textile-lubricating composition suitable for application to yarn processed at both room temperature and high temperature. It is a further object of the invention to provide a yarn lubricated with the novel lubricant, which can be used in the production of highly uniform, false-twist textured yarn.

These and other objects are attained in accordance with the present invention by a textile lubricant containing, on a weight basis, about 50 to 80 parts of a polyoxyalkylene selected from the group consisting of polyoxyalkylene diols, polyoxy alkylene monoethers, and polyoxyalkylene monoesters, in which the polyoxyalkylene contains oxyethylene groups and oxy-1,2-propylene groups in a ratio of between 3:1 and 1:1 and has a molecular weight of at least about 5,000, about 10 to 40 parts of an ester selected from the group consisting of natural and synthetic esters having a smoke point above 150° C. and a viscosity at 25° C. between 25 and 400 poises, and about 10 to 40 parts of emulsifier. The foregoing active materials are applied to yarn as a water emulsion in a manner and for purposes described hereinafter.

In conventional manufacture of continuous filament, hydrophobic yarn, such as the polyamides and the polyesters, the yarn is treated with a lubricating composition, usually in the form of an aqueous emulsion. Such compositions commonly contain an emulsifying system, an antistat, a bactericide, an antioxidant, and the like in addition to the lubricants, and should, if possible, serve the requirements of the producer and the user to provide the utmost in efficiency.

For use on yarn suitable for false-twist texturing, a lubricant must function adequately at both room temperature and high temperature. Moreover, for high temperature processing the textile-treating composition should be sufficiently stable so as not to smoke or fume, or result in the formation of a resin on the heated surfaces and also to maintain, as far as is practicable, unform frictional properties.

A particular problem in high temperature, high speed, false-twist texturing is the formation of tight spots in the textured yarn. A tight spot is a twisted, low-bulk section in the textured yarn and apparently is caused by twist slippage, i.e., sporadic failure of the false-twist device to



untwist the twist previously set in the yarn. It is believed that twisted sections of yarn slip through the twist trap due to improper frictional constraint between the yarn and the twist trap. The tight-spot sections in textured yarn are readily detectable by visual inspection and range in length from about 0.1 centimeter to about 20 centimeters in length. Yarn containing the lubricant of this invention has, upon false-twist texturing, fewer tight spots per unit length than identical yarns, similarly processed but treated with other lubricants.

Lubricating properties partly depend on viscosity, which is highly temperature-dependent generally. As is known, textile-lubricating compositions cannot have a viscosity at room temperature because of the increased friction which would result. On the other hand, for false-twist texturing the lubricant must have high enough friction at elevated temperatures to provide frictional contact between the yarn and the twist trap to minimize wist slippage. It has been discovered, surprisingly, that the compositions of this invention provide an unexpectedly low friction at room temperature and which remains relatively unchanged and at a satisfactory level at high temperature. Further, the relatively constant tension provided by these compositions also provides a highly uniform, false-twist textured yarn.

The polyoxyalkylenes of this invention can be obtained by the reaction of a compound containing an OH group with a mixture of ethylene oxide and 1,2-propylene oxide according to the following equation:

$$ROH+y(C_2H_4O)+z(CH_3—C_2H_3O)\rightarrow R(OC_nH_{2n})_xOH$$

wherein $y$ and $z$ represent the mols of ethylene oxide and propylene oxide, respectively, $n$ being both 2 and 3 in a single molecule, the number of times $n$ has a value of 2 being equal to $y$, and the number of times $n$ has a value of 3 being equal to $z$; and $x$ is the total number of oxyethylene and oxy-1,2-propylene groups, being equal to the sum of $y$ and $z$. The group R may be hydrogen, alkyl, monohydroxyalkyl, alkoxyalkyl, acyl, aryl, or alkaryl. Since the polyoxyalkylenes useful in this invention are of an exceedingly high molecular weight, e.g., 5000 or more, the nature of the R group has essentially no effect on the over-all properties of the condensate. In the useful polyoxyalkylenes for this invention, the weight ratio of the ethylene oxide groups to propylene oxide groups is between about 3:1 and 1:1 in order that the material remain fluid and water-soluble, and reaction ratios (i.e., $y:z$) are chosen accordingly. Too high an ethylene oxide content results in the formation of solid condensates, while too high of a 1,2-propylene oxide content results in decreased water-solubility. Preferably, the polyoxyalkylene is a diol containing oxyethylene and oxy-1,2-propylene groups in a weight ratio of 3:1 and having a molecular weight of about 15,000. Polyoxyalkylenes of the type suitable for use in this invention are well-known materials and may be prepared, for example, as described in U.S. Patents 2,425,755 and 2,425,545.

It has been discovered that, surprisingly, the high molecular weight and, therefore, high-viscosity polyoxyalkylenes useful in this invention, have an unexpectedly low coefficient of hydrodynamic friction that even is lower than the value for similar polyoxyalkylenes having a lower viscosity. Moreover, the coefficient of hydrodynamic friction of these materials is surprisingly independent of temperature and does not decrease, as one would expect, with increasing temperature. The coefficient of hydrodynamic friction ($f$) of a series of poly-

oxyalkylene monoethers and a series of polyoxyalkylene diols is:

TABLE I

| | Av. Mol. Wt. | Viscosity (Centipoises at 100° F.) | f |
|---|---|---|---|
| Polyoxyalkylene Monoether | 800 | 34 | 0.66 |
| Do | 1,500 | 132 | 0.80 |
| Do | 2,900 | 400 | 0.82 |
| Do | 5,000 | 1,020 | 0.68 |
| Polyoxyalkylene Diol | 1,000 | 90 | 0.87 |
| Do | 1,800 | 280 | 0.94 |
| Do | 15,000 | 18,000 | 0.64 |

The polyoxyalkylene monoethers are obtained by reacting n-butanol with a mixture of ethylene oxide and 1,2-propylene oxide, these oxides being present in a 1:1 weight ratio. The polyoxyalkylene diols contain oxyethylene and oxy-1,2-propylene groups in a ratio of 3:1 by weight. It will be appreciated that in all instances a mixture of various molecular weight polymers results, and molecular weights given throughout this application are average values. The *f* values are determined at room temperature against a polished chrome pin about 2 centimeters in diameter using a contact angle of 170° and a yarn speed of 70 yards per minute. The tension on the yarn in advance of the pin ($T_1$) is maintained at 10 grams and the yarn tension after passing the pin ($T_2$) is measured with a strain gauge. The *f* values are then calculated from the belt formula

$$\frac{T_2}{T_1} = e^{f\theta}$$

where

$T_1$=input tension—10 grams
$T_2$=output tension
$\theta$=angle of contact in radians
*f*=coefficient of hydrodynamic friction
*e*=base of Naperian system of logarithms

As is evident in those data, polyoxyalkylenes having a molecular weight of at least about 5,000 have unexpectedly low *f* values.

As reported in Table II, the high molecular weight polyoxyalkylenes useful in this invention have essentially the same *f* value at 200° C. as at room temperature. The *f* values are for the same polyloxyalkylene diols of Table I, and are measured in the same manner as described above except, as indicated, the chrome pin is heated to 200° C. for the high-temperature measurement.

TABLE II

| | Av. Mol. Wt. | f | |
|---|---|---|---|
| | | 22° C. | 200° C. |
| Polyoxyalkylene Diol | 1,000 | 0.87 | 0.49 |
| Do | 1,800 | 0.94 | 0.49 |
| Do | 15,000 | 0.64 | 0.62 |

The essential identity of the coefficient of hydrodynamic friction (*f*) at room temperature and 200° C. for the high molecular weight diol is particularly surprising when compared with the other data reported.

In addition to the high molecular weight polyoxyalkylenes, compositions of this invention include certain natural and synthetic esters. The choice of the ester must be made with care so as not to interfere with the frictional properties of the polyoxyalkylene while overcoming its deficiencies, and must not be adversely affected at elevated temperatures. Suitable esters are those of aliphatic acids having 12 to 20 carbon atoms and aliphatic alhohols containing one or more hydroxyl groups and having 3 to 18 carbon atoms, and are further characterized by having a smoke point above about 150° C., preferably above 180° C., and a viscosity at 25° C. between about 25 and 400 centipoises, preferably between 30 and 100 centipoises. Since impurities frequently contribute to low smoke points, the ester should be a relatively pure material and naturally occurring esters should be of a refined grade. Examples of suitable esters are given in Table III. The smoke point is defined as the temperature where smoke is first observed when a thin film of the ester is heated in contact with a metal surface.



TABLE III

| Ester | Smoke Pt. (° C.) | Viscosity (Centipoises at 25° C.) |
|---|---|---|
| Coconut Oil | 190 | 35 |
| Sperm Oil | 150 | 75 |
| Neopentyl Glycol Distearate | 150 | 60 |
| Glycerol Trioleate | 150 | 100 |
| Trimethylol Propane Tristearate | 170 | 100 |
| Pentaerythritol Tetrastearate | 190 | 375 |

The third essential component of these lubricants is a suitable emulsifier for the lubricating ester. Suitable emulsifiers are those commonly referred to as the non-ionic emulsifiers and are well-known in the art. Among the many examples which may be mentioned are the ethylene oxide condensates of phenols, aliphatic alcohols and acids having about 12 to 20 carbon atoms, ethylene oxide condensates of polyols or their partial higher fatty acid esters, and partial higher fatty acid esters of polyol-ethylene oxide condensates. Emulsifiers of the anionic type may also be used, and suitable examples include the ethanol amine soaps of higher fatty acids, the sulfated and sulfonated vegetable oils, ammonium or alkali metal salts of dialkylsulfosuccinic acid and the like. Preferably, the emulsifier system will contain both non-ionic and anionic emusifiers as such systems offer optimum emulsifying, wetting and antistatic action. The amount of emulsifier used will depend, in part, on the particular ester lubricant and emulsifier or emulsification system employed, but in no case should the amount of ester plus emulsifier exceed the amount of polyalkylene present. In general, somewhat higher amounts of emulsifier than normal will be used due to the higher concentration and polar nature of the polyoxyalkylene.

The textile-treating compositions of this invention are applied from aqueous emulsion. The aqueous emulsion will generally have a concentration between about 1 and 25 percent by weight of the non-aqueous components, and is applied to the yarn so as to provide between about 0.2 and 1.0% "solids" by weight based on the weight of the yarn. Application will normally be made by running the yarn across the face of a roll rotating in a trough containing the emulsion. In preparing the aqueous emulsion it is essential that the ester lubricant and its emulsifier system be prepared and emulsified separately in water and the final composition be made by adding this emulsion to an aqueous solution or admixture of the polyoxyalkylene. If this procedure is not followed, stable emulsions do not result.

The invention will be described further in conjunction with the following specific example in which the details are given by way of illustration and not by limitation.

*Example*

A first composition is prepared by mixing (1) fifteen parts of refined coconut oil, (2) 7.5 parts of a material prepared by condensing 1 mol of sorbitol with 30 mols of ethylene oxide and esterifying the condensate with 5 mols of a 4:1 (by weight) mixture of oleic and lauric acid, (3) 5 parts of the material obtained by condensing nonyl phenol with 10 mols of ethylene oxide, (4) 10 parts of a sulfated peanut oil, (5) 8 parts of oleic acid, and (6) 3.5 parts of triethanolamine. The above mixture is warmed to a temperature of 60° C. and 1 part of potassium hydroxide, as a 40% by weight aqueous solution, is then

added slowly with stirring. Ten parts of the above dispersion is then added slowly with stirring to 90 parts of water heated to 60° C.

A second composition is prepared by adding 10 parts of polyoxyalkylene glycol having a molecular weight of about 15,000 and containing oxyethylene and oxy-1,2-propylene groups in a weight ratio of 3:1 to 90 parts of water heated to 60° C. Equal amounts of the first and second compositions are then combined to give an aqueous emulsion having a concentration of 10% "solids."

The textile-lubricating composition described above is applied to a freshly-spun, 17-filament nylon yarn by running the yarn across the face of a roll rotating in a trough containing the emulsion. The yarn contains 0.51% "solids," based on the weight of the yarn. The yarn is drawn in conventional manner to provide a 70-denier nylon yarn suitable for false-twist texturing.

The yarn described above is then stocked to a false-twist texturing machine ("Superloft" Model 553) and the yarn false-twist textured. In this process the yarn is fed to the texturing elements at 72.5 yards per minute and wound up at 69 yards per minute to provide an overfeed of 5%. The false-twist spindle is rotated at a speed of 240,000 revolutions per minute and applies 80 turns per inch of false-twist to the yarn. The twist on the feed side of the spindle is set into the yarn by passing the yarn over a metal plate, 27 inches in length, heated to a temperature of about 230° C.

At the twist trap, the yarn is untwisted after which it passes to the windup where it is wound into a package. The twist trap is the conventional pin extending across the mouth of the hollow spindle and over which the yarn passes in a 360° wrap. After passing the twist trap and being untwisted, the yarn tends to resume the condition in which it was heat-set, resulting in a bulky textured yarn. Failure of the yarn to be completely untwisted results in the production of tight spots. The package prepared in this manner, identified as Item A, is then visually inspected to determine the number of tight spots. The false-twist texturing performance of Item A and two control items are given in Table IV. The two controls, Items B and C, are prepared in a manner similar to that for Item A except that the yarns are treated with different lubricating compositions. Item B is treated with a composition in which the lubricant consists essentially of refined coconut oil and a small amount of a wax, and contains about 0.5% "solids" based on the weight of the yarn. Item B is treated with a composition in which the lubricant is No. 50 White Oil, and contains about 0.7% "solids" based on the weight of the yarn. The textile lubricating compositions used for Items B and C have been used extensively for the commercial production of false-twist textured yarns.

TABLE IV

| Item | Tight Spots/100 Yards | Degree of Smoking |
|---|---|---|
| A | 0.8 | Moderate. |
| B | 51 | Slight. |
| C | 5 | Excessive. |

From the foregoing discussion and data, it is apparent that the present discovery constitutes a unique advance in the art of lubricating compositions for textile applications, especially for yarn processed by false-twist texturing. While the discovery has been described with respect to specific detail, it will be apparent that changes can be made without departing from its scope. For example, yarn prepared from any fiber-forming polyamide or polyester in the broad range of deniers presently prepared for textiles can be teated with these compositions. Moreover, it will be evident that the compositions of this invention will be especially useful for other processing wherein the treated yarn is subjected to both room temperature and elevated temperatures.



What is claimed is:

1. A textile product consisting essentially of a yarn of nylon filaments and a lubricating composition in an amount of about 0.2 to 1 weight percent based on the yarn, of a composition consisting essentially of, by weight, 50 to 80 parts of a water-soluble poly(oxyethylene-oxy-1,2-propylene)glycol, in which there are 1 to 3 parts by weight of oxyethylene groups for each oxy-1,2-propylene group and which has a molecular weight of about 15,000, about 10 to 40 parts of at least one emulsifier selected from the group consisting of sulfated peanut oil, a tetraoleate-laurate of a condensate of a mol of sorbitol and 30 mols of ethylene oxide and a condensate of a mol of nonyl phenol and about 10 mols of ethylene oxide, and about 10 to 40 parts of an ester lubricant selected from the group consisting of coconut oil, sperm oil, neopentyl glycol distearate, glycerol trioleate, trimethylol propane tristearate and pentaerythritol tetrastearate, said ester lubricant having a smoke point above about 150° C. and a viscosity at 25° C. between 25 and 400 centipoises.

2. A lubricating composition for application to textile yarns of polyamides or polyesters consisting essentially of an aqueous emulsion consisting essentially of as active ingredients by weight, about 50 to 80 parts of a water-soluble poly(oxyethylene-oxy-1,2-propylene)glycol having about 1 to 3 parts by weight of oxyethylene groups for each oxy-1,2-propylene group and having a molecular weight of about 15,000, about 10 to 40 parts of at least one emulsifier selected from the group consisting of sulfated peanut oil, a tetraoleate-laurate of a condensate of a mol of sorbitol and 30 mols of ethylene oxide and a condensate of a mol of nonyl phenol and about 10 mols of ethylene oxide, and about 10 to 40 parts of an ester lubricant selected from the group consisting of coconut oil, sperm oil, neopentyl glycol distearate, glycerol trioleate, trimethylol propane tristearate and pentaerythritol tetrastearate, the ester lubricant having a smoke point above 150° C. and a viscosity at 25° C. between 25 and 400 centipoises, the active ingredients being present in the emulsion in an amount of about 1 to 25 weight percent.


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