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ANTISTATIC TREATMENT OF TEXTILE YARNS

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This invention relates to the improvements in the treatment of textile yarns, threads, filaments, fibers and the like, hereinafter referred to as "textile yarns."

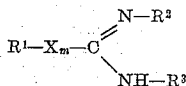
In the processing of textile yarns such as winding, spinning, knitting and weaving thereof difficulties arise on account of the formation and accumulation of static electricity on the yarns. The seriousness of these difficulties depends on a number of factors such as the speed of processing and the nature of the material from which the yarn is made. High speeds usually involve an increased development of electrostatic charge. Synthetic textile yarns, such as those made from cellulose esters or ethers or from nylon, usually develop more electrostatic charge than natural textile yarns.

The accumulation of static electricity on the textile yarns during the processing renders them difficult to wind, knit or weave owing to the repulsion between individual fibers of the yarns carrying like charge. It also causes the yarn to cling to the nearby parts of the machinery upon which the yarn is being processed. The aforesaid repulsion and clinging may result in breakage of the yarn or in uneven fabrics.

There have been numerous proposals for reducing the electrostatic charges developed on textile yarns as described above but none of them has proved wholly satisfactory, particularly in respect of textile yarns made of synthetic materials such as, for example, nylon, which have a low water content under equilibrium conditions. Thus it has already been proposed to prevent or reduce the electrification of textile materials by depositing on the materials soaps of various organic bases, such as soaps of the alkanolamines or of morpholine.

The present invention is based on the discovery that different organic bases and salts of organic bases have widely different effects on the tendency of textile yarns to accumulate electrostatic charges and that a certain type of organic base, whether free or in the form of salts, possesses the property of ultimately reversing the sign of the electrostatic charge produced on the textile yarns during processing. The precise effect on the electrostatic charge of this type of compound is a function of the quantity of the compound on the textile yarn and the particular conditions of processing. It is therefore possible under any given conditions of processing by controlling the quantity of the organic base or of its salt applied to neutralize, or substantially neutralize, the electrostatic charge produced.

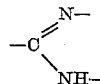
In accordance with the present invention electrostatic charges which develop on textile yarns during the processing thereof are reduced to at least a substantial degree by applying to the surface of such textile yarns, either prior to or during such processing, a compound of the class represented by the empirical formula:



wherein R¹ represents a member of the group consisting

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of hydrogen and organic radicals such as hydrocarbon radicals including alkyl, cycloalkyl, aryl, alkaryl and aralkyl; R² and R³ each represents the same or different members of the group consisting of hydrogen, alkyl radicals and alkylene radicals; R² may be joined to the radical R³ to form a cyclic nucleus containing the grouping



in the ring; X is an oxygen or sulfur atom and m is 0 or 1. The compound is applied in such quantity as to neutralize substantially the electrostatic charge developed during the said processing.

It has been found that members of the above-defined class of compounds (which compounds are hereinafter referred to as "the antistatic compounds") are not only capable of ultimately reversing the electrostatic charge as described above but they also generally greatly increase the rate at which such charges are dispersed by conduction. Moreover, the effectiveness of the antistatic compounds is much more persistent, that is, it is maintained for a much longer period of time, than that of the compounds hitherto proposed for use in the reduction of electrostatic charges on textile yarns.

Typical antistatic compounds of this invention are the appropriately substituted isoureas, isothioureas, guanidines, iminazoles, imidazolines and the hydrocarbon substituted derivatives thereof. Specific examples of such compounds are O-hydrocarbon substituted ureas such as the O-alkyl substituted ureas as O-methylurea, O-ethylurea, O-propylurea; the S-hydrocarbon substituted thioureas such as S-dodecylthiourea; the hydrocarbon-substituted imidazolines such as 1-beta-hydroxyethyl-2-heptadecyleneimidazoline, 2-naphthenylimidazoline, 2-undecylimidazoline. Salts of such compounds with inorganic or organic acids such as hydrochloric acid, acetic acid, stearic acid or oleic acid may also be used. Mixtures of the antistatic compounds may be employed. Preferred compounds of the above defined class of antistatic compounds comprise the hydrocarbon substituted imidazolines wherein the substituents are directly attached by carbon-to-carbon linkage to a member in the 1 or 2 position of the imidazoline nucleus. Particularly preferred are the hydrocarbon substituted imidazolines containing a total number of from about 7 to about 30 carbon atoms.

Compositions comprising an antistatic compound of the above-defined class and a mineral lubricating oil, which oil functions as a textile lubricant in the process of this invention, are rendered particularly effective if they also contain an oil-soluble organic compound containing an alcoholic hydroxyl group.

Accordingly, a further feature of the present invention provides textile treating compositions suitable for reducing electrostatic charges on textile yarns which comprise a mineral lubricating oil, an antistatic compound as hereinbefore defined and an oil-soluble compound containing an alcoholic hydroxyl group.

Such compositions may be used as such or they may be used as aqueous emulsions, for example, after dilution with from 10 to 50% by weight of water. Owing to the presence of the oil-soluble alcoholic compounds these compositions usually form emulsions spontaneously on the addition of water and are also easily scorable from the textile yarns after use.

The mineral lubricating oil employed in these compositions may be of any type but is preferably of the type normally employed in textile lubrication, viz: low viscosity technical white oils and other highly refined mineral lubricating oils.

A wide variety of compounds may be used as the oil-

soluble compound containing an alcoholic hydroxyl group and the following groups of compounds have proved particularly effective:

(I) Oil-soluble monohydric alcohols, e. g. the octanols, nonanols, decanols, undecanols, dodecanols and the higher aliphatic alcohols. These may be synthetic alcohols, e. g. alcohols produced by the so-called Oxo process, or they may be of natural origin, e. g. fatty alcohols from sperm oil. Also oil-soluble aromatic and cycloaliphatic alcohols such as benzyl alcohol and methylcyclohexanol may be used.

(II) Oil-soluble dihydric alcohols such as the hexylene glycols, octylene glycols, decylene glycols and the higher glycols.

(III) Oil-soluble alcohols containing substituents such as ether and/or ester groups. Particularly effective members of this class are the partial esters of polyhydric alcohols and fatty acids such as glyceryl mono- or dioleate or stearate, ethylene glycol mono-oleate or stearate and the mono-esters or ethers of polyethylene glycols such as the mono-oleate or stearate of nonaethylene glycol. The commercially available mixtures of compounds of the aforesaid types may be used. Compounds such as glyceryl di-oleate have the valuable property of lowering the friction values of the compositions.

A single oil-soluble compound containing an alcoholic hydroxyl group may be employed but often it is useful to use a mixture of 2 or more of such compounds in order to obtain optimum scourability and spontaneity of emulsion formation. Thus, a combination of glyceryl dioleate and nona-ethylene glycol mono-oleate has been found particularly effective. Also lower alcohols i. e. alcohols having less than 8 carbon atoms in the molecule, may be added to the compositions of this invention to improve their ability to spread evenly over the yarns. Typical of such alcohols are isopropyl alcohol, butyl alcohol, diacetone alcohol and the lower mono-ethers of ethylene glycol such as the monobutyl ether of ethylene glycol.

The antistatic compounds are preferably applied to the textile yarns in solution in inorganic solvents such as water or in organic solvents such as mineral oils, alcohols or ketones or in mixtures of such solvents, for example, aqueous acetic acid or mixtures of mineral oil and alcohols or ketones. Alternatively they may be applied in the form of emulsions.

The amount of the antistatic compound to be applied to the textile yarns during processing according to this invention depends upon the nature of the textile yarns and the precise conditions under which the processing is carried out. However, it is a simple matter to observe the size and nature of any charge generated during such processing and adjust either the concentration of the antistatic compound in the composition applied or the amount of the composition applied in order to reduce such charge to zero or to very small proportions. Thus, a nylon yarn which in an untreated form under the processing conditions employed develops a strong positive electrostatic charge may, when treated with one of the antistatic compounds, develop under the same processing conditions a smaller positive charge, no charge at all, or a negative charge. In the first case the quantity of antistatic compound applied to the yarn would be increased and in the last case it would be decreased in order to neutralize or substantially neutralize the charge.

The antistatic compounds may be applied to textile yarns by any of the well-known methods, for example, by spraying running textile yarns or by running textile yarns over rollers, wicks or other similar devices from which they pick up the antistatic compound, preferably in solution form as described above. Alternatively the textile yarns may be dipped in baths containing the antistatic compound.

The method of the present invention is applicable to the processing of all types of textile yarns which tend to

develop electrostatic charges during such processing. Thus, it is applicable to the processing of textile yarns made of silk, wool, cotton, regenerated cellulose, cellulose formate, acetate or propionate or other cellulose ester, methyl or ethyl cellulose or other cellulose ether and nylon or other water insensitive synthetic linear polymers such as polyvinyl chloride, chlorinated polyvinyl chloride, vinyl chloridevinyl ester interpolymers, polymethacrylic esters, polyacrylonitrile, polyethylene and condensation products of polycarboxylic acids and polyhydric alcohols or alkylene oxides. The present method is particularly effective on textile yarns which normally develop a positive electrostatic charge, e. g. nylon.

The antistatic compounds may be applied to textile yarns in conjunction with other textile treating compounds provided these do not react with the antistatic compounds other than by mere salt formation. Thus they may be applied in conjunction with textile lubricants or textile sizing compositions.

The following examples illustrate the present invention the parts referred to being parts by weight.

Example I

10 parts of 1-beta-hydroxyethyl-2-heptadecylene imidazoline were dissolved in 90 parts of spindle oil. This composition was applied to untwisted nylon yarn in an amount equal to 2.1 per cent by weight of the yarn. The treated yarn was then wound on to a spindle in an atmosphere having a relative humidity of 47 per cent and it was found that the winding was easily carried out without any formation of electrostatic charge on the yarn and without any ballooning of the fibers of the yarn. Moreover, after standing for fourteen days the wound yarn could be rewound with ease, there being no generation of electrostatic charge and no ballooning of the fibers.

Similar results were obtained working in atmospheres having relative humidities of 65 and 80 per cent respectively and also using compositions containing only 5 per cent and 2.5 per cent by weight respectively of the imidazoline derivative.

In contrast with the above results, when compositions consisting of 10 per cent by weight of dodecylamine, hexadecylamine, cyclohexylamine oleate or triethanolamine oleate in the same spindle oil were used in place of the composition described above there resulted a strong positive electrostatic charge on the nylon yarn which could then only be wound with difficulty.

Example II

1 part of 2-undecylimidazoline were dissolved in 99 parts of dilute acetic acid. This composition was applied to nylon yarn at a rate sufficient to deposit about 0.02 per cent by weight of the imidazoline derivative on the yarn. The treated yarn was wound on to a spindle in an atmosphere having a relative humidity of 47 per cent and it was found that the winding was easily carried out without any formation of electrostatic charge and without any ballooning of the fibers. After standing for 14 days the yarn was rewound under similar conditions and it was again found that winding was easy, a very small negative electrostatic charge being produced on the yarn which was insufficient to cause difficulties in winding. Similar results were obtained using a solution of 1 part of S-dodecylthiourea in 99 parts of n-butanol under the same conditions.

Without any treatment the nylon yarn developed a strong positive electrostatic charge on winding under the same conditions.

Example III

5 parts of 2-naphthenyl imidazoline were dissolved in a mixture of 95 parts of a light mineral lubricating oil and 4 parts of n-dodecanol. This composition was applied to nylon yarn in an amount equal to 2 per cent by weight of the yarn. The treated yarn was wound on to a

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spindle in an atmosphere having a relative humidity of 47 per cent and it was found that the winding was easily carried out without the formation of electrostatic charge for most of the time. At periods a small negative charge appeared on the yarn but this was insufficient to cause any ballooning of the fibers or any other difficulties in winding. Similar results were obtained using a solution of 1 part of the imidazoline derivative in 99 parts of dilute acetic acid. The nylon yarn in an untreated condition when wound under similar conditions developed a strong positive electrostatic charge.

Example IV

A composition was prepared by blending the following ingredients

- 89.5 parts of a solvent refined mineral lubricating oil having a viscosity of 63 seconds Redwood I at 140° F. and a flash point of 345° F. (Pensky-Martens open cup)
- 2.5 parts of 1-beta-hydroxyethyl-2-heptadecyleneimidazoline
- 5.0 parts glycerol dioleate
- 3.0 parts nona-ethyleneglycol mono-oleate

This composition was very effective in reducing the formation of static electricity on nylon yarn when used as described in Example I and had good spontaneous emulsifiability on dilution to 10 per cent in tap water and was easily scoured from the yarns after use. In this composition the quantity of imidazoline derivative employed can be increased to 5.0 parts or to 7.5 parts and the quantity of mineral oil decreased accordingly. The anti-static effect of the composition is then increased roughly proportional to the amount of the imidazoline derivative and hence smaller quantities of the composition can be used to produce a similar antistatic effect in the process of the invention.

Example V

A composition was prepared by blending the following ingredients:

- 87.0 parts of the same solvent refined mineral oil as is described in Example IV
- 5.0 parts of 2-naphthenylimidazoline
- 5.0 parts of glycerol dioleate
- 3.0 parts of nona-ethyleneglycol mono-oleate

This composition had similar properties to those of the composition of Example IV and effectively minimized the electrostatic charge developed on nylon yarn when applied as described in Example III.

Example VI

A composition was prepared by blending the following ingredients:

- 89.5 parts of the same solvent refined mineral oil as is described in Example IV
- 7.5 parts of 1-beta-hydroxyethyl-2-heptadecyleneimidazoline
- 3.0 parts of methyl cyclohexanol

This composition exhibited excellent antistatic properties when applied to nylon yarn as described in Example I. It exhibits good spontaneous emulsifiability. How-

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ever, the stability of the emulsion formed is not as good as that of the compositions of Examples IV and V since on standing for some time oil tends to separate. However, this oil readily re-emulsifies on agitation just before use. This composition has the comparatively low flash point of 250° F. (Pensky-Martens open cup) and therefore cannot be used where a high flash point is essential.

Example VII

A composition was prepared by blending the following ingredients:

- 86.0 parts of the solvent refined mineral oil described in Example IV
- 5.0 parts of 1-beta-hydroxyethyl-2-heptadecyleneimidazoline
- 5.0 parts of glycerol dioleate
- 3.0 parts of nona-ethyleneglycol mono-oleate
- 1.0 part of diacetone alcohol

The composition had excellent anti-static properties and owing to the presence of the diacetone alcohol had improved spreading properties on cellulose acetate rayon yarn as compared with the compositions of Examples IV, V and VI. It was applied to cellulose acetate rayon yarn at a rate sufficient to deposit about 0.02 per cent by weight of the imidazoline derivative on the yarn. The yarn could then be wound easily without any formation of electrostatic charge.

The invention claimed is:

1. The method of reducing electro-static charges which develop on yarns, filaments, fibers and similar textile materials during the processing thereof which comprises applying to said textile materials a composition comprising a major proportion of mineral lubricating oil, and a minor proportion of 2-hydrocarbon substituted imidazoline having a total of from about 7 to about 30 carbon atoms per molecule, which composition is applied in an amount sufficient to deposit on said textile materials at least about 0.02 percent by weight of said substituted imidazoline.
2. The method in accordance with claim 1 wherein a minor proportion of an oil-soluble organic compound selected from the group consisting of aliphatic alcohols, partial esters of a polyhydric alcohol with a fatty acid and mixtures thereof is included in the composition applied.
3. The method in accordance with claim 1 wherein the 2-hydrocarbon substituted imidazoline component is 2-alkylimidazoline.
4. The method in accordance with claim 3 wherein the 2-alkylimidazoline is 2-undecylimidazoline.
5. The method in accordance with claim 1 wherein the 2-hydrocarbon substituted imidazoline is 2-naphthylimidazoline.

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