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TEXTURIZABLE FIBROUS GLASS YARNS AND METHODS FOR THEIR MANUFACTURE

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ABSTRACT OF THE DISCLOSURE

An aqueous coating material for glass fibers comprising solid wax particles less than approximately 10 microns in diameter coated with a polysaccharide having lipophilic side chains of less than approximately 10 carbon atoms dispersed throughout a starch solution. When the material is placed on glass fibers, and the fibers are wound into a package, the solid wax particles being nonwater soluble, are left behind during drying of the package, and the polysaccharide having lipophilic side chains retain the starch in position around the wax particles. The wax particles have starch loosely bonded thereto, and the coating that is produced on the fibers does not have the usual oily or waxy characteristics of wax emulsions or the stiffness of starch coatings. The coating is uniquely suited for glass fiber yarns that are texturized by air jets.

CROSS REFERENCES TO RELATED APPLICATIONS

The present application is a continuation-in-part of our copending application Ser. No. 547,864 filed May 5, 1966; which in turn is a continuation-in-part of application Ser. No. 488,268 filed Sept. 17, 1965, both now abandoned.

BACKGROUND OF THE INVENTION

Monofilament glass fibers such as are used in producing woven textiles are made by attenuating small molten streams of glass. The molten streams solidify a few inches away from the heated bushing from which they issue, and after solidifying the streams of glass are brought together and wrapped around a winding drum which provides the pulling action which attenuates the molten streams. Glass fibers scratch each other when pulled together without lubrication, and/or when pulled over guide surfaces, and consequently the solidified fibers of glass must be coated with a lubricant prior to being pulled together into a strand and wrapped around the winding drum. Aqueous solutions of lubricating materials are used to coat the fibers, and cationic and nonionic lubricants are incorporated in these solutions to provide lubrication while the fibers are wet. The coiled packages of fibers produced on the winding drums must be dried before further processing, and a starch has been conventionally incorporated into the lubricating solutions to provide a dry lubricant which will protect the filaments during the twisting, quilling, beaming, and weaving operations that are necessary to transform the strands into a woven textile.

The woven textiles which are produced from the monofilament strands of glass fibers are smooth and have pronounced sheen. In order to produce glass fiber strand having an appearance and feel more nearly that of natural occurring fibers, the assignee of the present invention developed the air jet shown in Patent 3,262,177 which blows apart the filaments of a core strand, and causes the filaments of a fill strand to be blown between the filaments

of the core strand. This process is called texturizing and the process so modifies the qualities of glass fiber strand, that it has opened whole new marketing areas for glass fibers. The difficulty that has been experienced with the strand produced prior to the present invention, is that the fibers of the fill strand which are blown between those of the core strand do not have good interlock therewith and are partially removed when the strand is pulled over guide surfaces of the machinery used in the subsequent operations that are necessary to produce a woven product. The fill strand tends to be stripped from the core strand and the filaments of the fill strand broken into rings of "fuzz" which plug up the machinery and eventually break the strand.

The principal object of the present invention, therefore, is the provision of a new and improved texturized strand which can be processed satisfactorily through the texturizing and weaving equipment.

A further object of the invention is the provision of texturized glass fiber strand which will not only process satisfactorily through the texturizing and weaving equipment, but which will have interlock approaching that of natural fibers.

A still further object of the present invention is the provision of a new and improved method of chemically and/or physically treating the glass fiber strands prior to texturization which will cause the above objects to be achieved.

SUMMARY OF THE INVENTION

It would seem that the retention of the filaments of the fill strand between the filaments of the core strand is related to the physical characteristics of the surface of the fibers, and that improvements in texturizing could be predicted by known physical properties of fiber coating materials. The degree of interlock which is achieved by coating materials does not lend itself to this type of analysis, however, since the coatings are not seen on the individual filaments after they have been separated from each other, even with high powered microscopes.

According to the invention, it has been discovered that glass fibers coated with a mixture of wax particles, that are coated with a polysaccharide having lipophilic side chains and which in turn are surrounded by a starch, produces a strand of greatly improved texturizing properties. The filaments of the core strand separate well under the action of the texturizing air jet, the filaments of the fill strand penetrate between those of the core strand, and when the core filaments are pulled together again, the desired interlock is achieved. This is surprising in view of the fact that the wax particles with the polysaccharide coating do not provide a stable emulsion, and are not as uniformly dispersed in the starch as is obtained when the wax particles are emulsified by conventional lipophilic-hydrophilic emulsifying agents. Conventional wax emulsions did not provide desired interlock, and caused guide surfaces to become plugged, so that it is further surprising and unexpected that wax particles coated with the materials of the present invention would meet with success.

The coating materials of the present invention comprise small particles of wax which are coated with a polysaccharide having lipophilic side chains which cause the polysaccharide to coat the wax particles. Unlike the prior art wax and starch mixtures it appears that the coated wax particles of the present invention remain embedded throughout the starch rather than rise to the surface, and that these wax particles remain coated with the polysaccharide and/or starch coating when the filaments are pulled apart. Even though particles of wax are present, the wax does not build up and clog the guide surfaces, and the wax particles appear to remain coated with the polysaccharide and/or starch when the filaments are

pulled apart. It appears that the polysaccharide coated wax particles have greater compatibility with the starch, than do the wax particles coated with prior art emulsifying agents. Nevertheless, the starch matrix of the present invention is broken apart uniformly and cleanly by the action of the texturizing jet. This success was unexpected in view of the failure encountered with the starch, wax and lipophilic-hydrophilic emulsifying agents. The lipophilic side chains of the polysaccharide are preferably organo groups of from 2 to 10 carbon atoms and a preferred embodiment of which is propylene glycol alginate.

Preferred compositions for applications to texturizable strands comprise the following percentages by weight:

Wax emulsion (solids)	0.5–5
Stabilizer	0.1–1
Cationic lubricant	0.5–3
Starch	0.5–5
Secondary film former	0–1

Remainder, water.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The materials of the present invention before being applied to the fibers are usually aqueous dispersions which include solid wax particles stabilized by polysaccharides containing lipophilic side chains. A starch film former is either in solution between the wax particles, or is dispersed as solids in the water between the wax particles; so that when the material is applied to the glass fibers, the polysaccharide coated wax particles are separated by the film former and this physical arrangement is thereafter dried in situ. The coating materials will preferably also include a cationic lubricant which by nature has a lipophilic portion and a cationic portion. The lipophilic portion also adheres to the wax particles and may help to stabilize the wax dispersion while the cationic portion of the molecule projects away from the wax particles and is attracted to the surface of the glass. Coating materials of the present invention which include the cationic lubricant are the preferred materials, because the cooperation of the cationic lubricant and wax particles causes the wax particle to be laid down more closely to the surface of the glass with the bulk of the film former being positioned between and on top of the wax particles. This arrangement aids in preventing the wax particles from smearing together when the coated strands are drawn over stationary guide surfaces. This arrangement also helps in texturizing fibers because it causes the film former to break between the saccharide coated wax particles to leave the wax in position as descrete starch coated particles on the individual strands.

The polysaccharides containing lipophilic side chains and which are used as a stabilizer for the wax emulsion also help to provide a preferred "laydown" of the material on the fibers, because the long chain polysaccharide molecules will generally bridge two or more wax particles to space and hold the wax particles apart. The polysaccharide stabilizer is compatible with the starch which is then distributed in and among the stabilizer strings to provide a better physical wax-stabilizer-starch arrangement than has been produced in any coating material heretofore.

Any long chain polysaccharide can be used as the stabilizer material so long as it contains the lipophilic side chains. The lipophilic side chains are preferably organo groups of from 2–10 carbon atoms. These lipophilic side chains may include one or more hydrophilic groups such as hydroxyl, ether, or carboxyl groups but must not be so numerous as to do away with the lipophilic nature of the side chain. Where the lipophilic side chains are propylene radicals, they may include one hydroxyl group; where the lipophilic side chains contain six carbon atoms, they may include two OH groups; and where they contain ten carbon atoms, they may contain three hydroxyl groups. In each instance the preferred material will not have the OH group located at the end of the side chain. It will be seen that an OH group at the end of the lipophilic side chain necessitates the adherence to the wax at the middle of the side chain, whereas a hydrocarbon end to the side chain allows a better and preferred attachment to the wax. The length of the lipophilic side chains should be kept below ten carbon atoms in order that the polysaccharide will be more closely held to the surface of the wax, the side chains are preferably no longer than about six carbon atoms and most preferably about three carbon atoms long.

The polysaccharides which can be used as a stabilizer will include the starch fractions, amylose and amylopectin, the polyuronides such as the pectins, the arabans, galactans, pentosans, plant gums, polysaccharides containing nitrogen and sulphur, chitin, heparan, xylans, and the alginates. Each of these materials can be at least part of the film former and when they contain the lipophilic side chains above described, are also compatible with wax so that they produce the unique physical arrangement of the coating compositions of the present invention.

The secondary film formers will include the above polysaccharides, with or without the lipophilic side chains, as well as gelatin and polyvinyl alcohol.

Any type of wax can be used such as paraffin wax, bees wax, carnauba wax, cerese wax, mineral waxes, Japan wax, vegetable waxes, micro crystalline waxes, or the like and mixtures thereof. Inasmuch as the stabilizers of the present invention will stabilize waxes in the solid condition, waxes of any melting point can be used, although the waxes of the lower melting points, as between 100 and 200° F., are preferred because they shear more easily, and therefore are softer in nature.

Broadly, the coatings of the invention are dispersions of wax particles separated by starch and have the following solids in percent by weight:

	Percent
Wax particles (emulsion size)	10–80
Stabilizer and starch	20–90
Cationic lubricant	0–30

with the stabilizer being more than approximately 1% of the wax. In an aqueous vehicle the above solids will usually comprise from approximately 2% to approximately 7% by weight for ease of application to the fibers, but may be applied in a much higher solids ratio as a gel.

In a preferred embodiment the forming size composition comprises the combination of starch and a suspension of minute particles of solid wax as shown by the following example:

Example 1

	Percent by weight
Wax suspension (40% solids)	6.1
Hydroxyethylated amylose starch	1.0
Water	Remainder

In the above formulation, the wax suspension comprised particles of a paraffin wax having a melting point of 125° F., and an average diameter of 1 micron and in the preparation of such suspension, stabilizers or protective colloids are employed.

In preparing the forming size composition 40 parts by weight of the paraffin wax were melted at 160° F., and added with mixing to 60 parts by weight of water maintained at 160° F., and containing 1.5 parts by weight of propylene glycol alginate having a molecular weight of approximately 3,000 which acts as a stabilizer for the suspension. The resulting system was then homogenized until the average wax particle size was 1 micron. The system was then permitted to cool to room temperature and below the solidification point of the wax. A stable, readily dilutable suspension resulted and was added with agitation to a cooked starch solution of 10 parts by weight of the starch in 100 parts by weight of water.

The above composition was applied to glass fibers at forming while maintained at temperatures below the melting point of the wax. Consequently, the wax was applied as a suspension of solid particles. Application of the size composition was achieved by means of the belt or apron applicator of U.S. 2,873,718 and the composition was applied to fibers traveling at a rate of 12,000 feet per minute. The stabilizer comprises propylene glycol esters of alginic acid derived from several species of brown seaweed. This cream-colored fibrous powder is approximately 80 mesh, is readily soluble in water to form a solution having a pH of about 4.

Example 2

The method of Example 1 was repeated with the addition of 0.5% by weight of gelatin to the forming size compositions.

Example 3

Example 1 was repeated with the addition of 1% by weight of a cationic lubricant comprising an imidazoline modified polyester. This lubricant is the reaction product of diethylene glycol, maleic acid, diethylene triamine and stearic acid as disclosed by U.S. 3,097,963. This reaction product of an unsaturated polyester and the fatty acid derivative of a diamine or imidazoline, is a cationic lubricant with an affinity for the glass surface.

Example 4

Example 1 was repeated without the homogenization of the wax suspension. As a consequence, the average diameter of the wax particles present in the forming size composition was 40 microns.

Example 5

A forming size composition was formulated from the following ingredients:

	Percent
Wax emulsion (40% solids)	6.0
Propylene glycol alginate	0.1
Corn starch	1.5
Water	Remainder

The above wax emulsion comprised a melted scale wax having a melting point of 123° F., and was a true emulsion in that the wax was dispersed in an aqueous phase while in a molten form, and was constantly maintained above the melting point of the wax including at the time of application of the composition to the glass fibers at forming. The starch was cooked at a temperature of 212° F. Although in this example the application was made at a temperature higher than the melting temperature of the wax, this is not preferred. The treating compositions are applied generally at a temperature between 80–100° F.

Example 6

An improved forming size comprises the following ingredients in weight percent:

Wax emulsion (20% solids)	6.1
Stabilizer	0.03
Imidazoline modified polyester (cationic lubricant)	1.05
Starch	1.05
Gelatin	0.62
Water	Balance

While this example uses a parafin wax melting between 120° to 125° F., other waxes having higher melting points can be used. The wax emulsion preferably includes propylene glycol alginates, i.e., propylene glycol esters of alginic acids which serve as a stabilizer. The mix solids are 3.5% and the pH about 4.6.

The small amount of gelatin acts as a film former to provide improved yarn integrity and its presence in the treatment improves twist operation efficiencies. A preservative such as tertiary butyl tin oxide or phenyl mercuric acetate salt may be added to preserve the starch and gelatin before and after application to the fibers.

The cationic lubricant added to the Example 6 composition was increased without changing the other ingredients or their proportions. When 0.75 percent was added, improved yarn integrity was achieved and fuzziness was reduced. The percentage of cationic lubricant was increased to 1.05% with good results.

Examples 7 and 8

Two other suitable size compositions have the following ingredients in percent by weight:

Ingredients	Ex. 7	Ex. 8
Paraffin wax emulsion (solids)	0.76	0.913
Propylene glycol alginate	0.0186	0.022
Cationic lubricant (imidazoline modified polyester)	0.362	0.917
Pearl corn starch	1.22	9.917
Gelatin	0.725	0.541
Water	Balance	Balance

The materials of the above examples were prepared in the same manner used in Example 1 and described below.

Examples 9 and 10

Ingredients	Ex. 9	Ex. 10
Paraffin wax emulsion	1.02	0.95
Propylene glycol alginate	0.026	
Imidiazoline modified polyester	0.424	0.424
Pearl corn starch	0.890	0.890
Gelatin	0.527	0.527
Sorbitan monopalmitate		0.031
Polyoxethylene sorbitan monopalmitate		0.018
Water	Balance	Balance

Test results	Ex. 9	Ex. 10
Twist ringers	3 per 10 pkgs	1 per 10 pkgs.
Broken filaments per package	8.5 aver	20 aver.
Texturizing fuzz:		
Tension disk	V. v. light	Heavy.
Guide eye	Very light	Light.
Guide finger	None	Do.
Air jet	1 fuzz bug	Strand broke.
Interlock check	1.27 ln	2.95 in.

The ingredients of the two examples given above were prepared using generally the same procedure as that given above for Example 1, excepting that in Example 10, the two monopalmitate ingredients are substituted for the alginate. A mixture of the emulsifying agents was used because it is recognized that the mixture provides optimum emulsification and better results than achieved with a single emulsifying agent. The interlock check is performed by inserting a pair of dividers in a loop of the finished texturized yarn and spreading the dividers until the filaments forming the loop break. The spread of the dividers is measured at the breaking point, and the higher the value the poorer the interlock. In addition to the numerical results given above, a very pronounced difference in the yarn is seen when the texturized strand is pulled between the fingers. The strand of Example 10, when pulled between the fingers, tends to strip the fill strand from the core strand. The strand of Example 9 does not have the fill strand stripped from the core strand under the same condition.

Various cooked starches have been used. Non-modified potato starch, cationic corn starch, ethylated corn starch, modified potato starch and non-modified corn starch can be used. The cationic lubricant can also be octadecyl amine acetate or a quaternary ammonium product.

The preferred compositions are prepared by mixing the starch and water in a main tank with good agitation to prevent lumping. The mixture is heated while agitation is continued and then cooled by addition of water. The cationic lubricant is mixed with hot water in a separate container and then added to the starch with mild agitation. The gelatin is added to warm water and, after it is dissolved, added to the main mix with gentle agitation.

Propylene glycol alginate is added to water in a separate tank with rapid agitation to prevent lumping. The stabilizer and water are heated to form a solution. The wax is heated in a separate container and then added slowly to the stabilizer and water with rapid agitation. The wax emulsion is homogenized and then added to the main mix along with water. The solids content is then adjusted. The pH is adjusted by addition of acetic acid or ammonia to about 4.6.

Of primary significance, fibrous glass yarns coated with the inventive compositions are possessed of vastly superior processing characteristics. Very little migration of the coating materials occur in the forming package, so that the yarns texturize uniformly. In the first instance, broken filaments and fly are practically non-existent in the processing of the inventive products. Yarn integrity is excellent. Still further, fabrics woven from the inventive yarns are free from the previously mentioned streak or color banding problem thus demonstrating the ready removability of the coating compositions. The inventive yarns have yielded pronounced superiority in texturizing processes in which the yarns are bulked by means of a fluid jet to yield an aesthetic or novelty effect in the finished fabric. Conventionally coated fibrous glass yarns have consistently yielded problems in such processing in failing to be uniformly bulked or texturized probably as the result of excessive and non-uniform quantities of the coating material and the stiff inter-filament bonding effect of coating compositions such as starch. Finally, apparatus used in the processing of the inventive products are markedly free from flaked off coating composition and fibrous fly with consequent reductions in down time and maintenance. The treating compositions of this invention are relatively non-migrating as compared to other commercial size compositions.

It will be seen that the improved texturizing ability produced by the coatings of the present invention are attributable to unexpected and unique cooperation between the polysaccharide having lipophilic side chains and the starch film former. The polysaccharide having lipophilic side chains causes the starch to surround the wax and provide a different coating structure than is achieved with lipophile-hydrophile emulsifying agents. Violent mixing of the polysaccharide material and the wax in water, such as is accomplished by homogenization processes and equipment is necessary in order to obtain the desired particle size and uniformity.

While the invention has been described in considerable detail, we do not wish to be limited to the particular embodiments described, and it is our intention to cover hereby all novel adaptations, modifications, and arrangements thereof which come within the practice of those skilled in the art to which the invention relates.

We claim:

1. The method of texturizing strands of glass fibers comprising: attenuating molten streams of glass into fibers; coating the individual fibers with an aqueous dispersion consisting essentially of: from approximately 0.5 to approximately 5% by weight of solid wax particles no larger than approximately 10 microns in size, from approximately 0.1 to approximately 1% by weight of proplylene glycol alginate, from approximately 0.5 to approximately 3% by weight of a cationic lubricant, from approximately 0.5 to approximately 5% by weight of starch, and up to approximately 1% by weight of an additional film former other than starch from the group consisting of gelatin and polyvinyl alcohol, the balance being essentially water; collecting the coated fibers into a strand; drying the strand; and passing the strand through an air jet to partially separate and texturize the fibers of the strand.

2. The method of claim 1 wherein the wax is a paraffin wax having a melting point above approximately 120° F.

3. The method of claim 2 including up to 1% of a secondary film former from the group consisting of: gelatin and polyvinyl alcohol.

4. The method of claim 1 wherein the solids of the aqueous dispersion consist essentially of:

	Parts, approx.
Wax particles (less than 10 microns)	2.5
Starch	1
Propylene glycol alginate	1.5
Secondary film former	0.5
Cationic lubricant	1

5. Texturized glass fiber strand produced in accordance with the method of claim 1.

6. The method of claim 1 wherein the solids of the aqueous dispersion consist essentially of:

	Parts, approx.
Wax emulsion (20% solids)	6.1
Propylene glycol alginate	0.03
Imidazoline modified polyester (cationic lubricant)	1.05
Starch	1.05
Gelatin	0.62

7. The method of claim 1 wherein the solids of the aqueous dispersion consist essentially of:

	Parts, approx.
Paraffin wax emulsion (solids)	0.76
Propylene glycol alginate	0.0186
Cationic lubricant (imidazoline modified polyester)	0.362
Pearl corn starch	1.22
Gelatin	0.725

8. The method of claim 1 wherein the solids of the aqueous dispersion consists essentially of:

	Parts, approx.
Paraffin wax emulsion (solids)	0.913
Propylene glycol alginate	0.022
Cationic lubricant (imidazoline modified polyester)	0.917
Pearl corn starch	0.917
Gelatin	0.541

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