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TEXTILE SIZE COMPRISING AN AQUEOUS SOLUTION OF A STYRENE-MALEIC ANHYDRIDE COPOLYMER AND A WATER SOLUBLE BORATE

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This invention relates to an improved warp size and to a method of preparing the same, as well as to a method of treating textile material, especially yarns made from synthetic fibers such as regenerated cellulose and cellulose acetate, with said size.

It is common practice to treat yarns, intended to be woven as warps, with an aqueous solution of an adhesive or binding substance such as starch, modified starch products, e. g., thin boiling starch, soluble starch, and dextrine, natural gums, e. g., locust bean gum, and gum arabic or animal or vegetable proteins, e. g., glue, gelatin, casein, soya bean and peanut protein.

It is customary to apply this sizing at the slasher or sizing machine. The yarn, in sheet form, is immersed in the size solution, nipped once or twice between heavy metal rolls covered with flannel cloth or rubber, and then dried over steam heated cans, or in hot air boxes.

Warps so sized with starch, modified starch or natural gums tends to dust excessively when the threads are split open and separated one from the other in front of the slasher before they are wound on the loom beam. They also lose a substantial part of the size film when subjected to the friction and abrasion concomitant with the weaving operation. When this dusting is excessive, as often happens, the warps lose their stiffened character and weaving efficiency is adversely affected.

Sizes made from proteins show a greater adhesion to the fibers, and dusting is not as bad with those as with the starch size. These sizes, however, have a tendency to thicken and jell on cooling. Consequently the viscosity of the size solution is subject to wide variations on slight changes of temperature. Furthermore, protein sizes have the disadvantage of being subject to decomposition and putrefaction.

It has recently been suggested to employ, for the finishing of textile fabrics, aqueous solutions of the sodium or ammonium salts of copolymers of styrene and maleic anhydride. The use of such salts has an important disadvantage in that it is necessary, to obtain satisfactory aqueous solutions thereof, to react with the styrene-maleic anhydride copolymer an amount of alkali metal or ammonium hydroxide or carbonate sufficient to raise the pH to 10 or above. Such a high pH in a size solution is undesirable, especially in the treatment of yarns made from cellulose acetate, because a pH higher than about 8 or 8.5 may easily cause superficial saponification and thereby change the dyeing properties of the yarn.

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It is a primary object of the present invention to provide a warp size that is substantially free from dusting, has greater affinity for natural and synthetic fibers, possesses greater stability and uniformity of viscosity, and is absolutely free of any tendency to decompose or putrefy.

The size of the present invention is an aqueous solution of an alkaline, water-soluble boron salt reacted with a copolymer of styrene, or a substituted styrene such as methyl styrene, butyl styrene, chlorostyrene or the like, with maleic anhydride or a partially esterified maleic anhydride such as the half ester of butyl maleate.

This size is substantially free from dusting, has excellent affinity for natural and synthetic fibers, possesses superior stability and uniformity of viscosity, and does not decompose or putrefy. Furthermore, completely satisfactory solutions in water are obtainable at pH values of the order of 7 to 7.5.

While it is to be understood that the invention is not to be limited by any theory advanced herein, it is believed that the remarkable difference between the sodium and ammonium salts and the boron salts of the styrene-maleic anhydride copolymers is essentially due to the effectiveness of the boron-oxygen group in bringing about a strong crossbonding of the copolymer's molecular chains and thereby increasing the intrinsic viscosity, continuity and strength of the film.

The copolymers used in forming the size of this invention are well known products which may be prepared in several ways, e. g., either by heating together the two components or by reacting them in the presence of a mutual solvent and a catalyst. The copolymers so produced are not soluble in water, but form water soluble salts of alkali metals, ammonium hydroxide, and organic bases such as triethanolamine, morpholine, etc.

Any of the water-soluble, alkaline boron salts may be used for reaction with the copolymer in accordance with this invention. These include sodium borates, such as:

Sodium metaborate—
$NaBO_2$ (or $Na_2B_2O_4$)
$NaBO_2 \cdot 2H_2O$ (or $NaH_2BO_3 \cdot H_2O$)
Sodium tetraborate—
$Na_2B_4O_7$
$Na_2B_4O_7 \cdot 5H_2O$
$Na_2B_4O_7 \cdot 10H_2O$ (borax)
Sodium perborate—
$NaBO_3 \cdot H_2O$ (or $NaBO_2 \cdot H_2O_2$)
$NaBO_3 \cdot 4H_2O$ (or $NaBO_2 \cdot H_2O_2 \cdot 3H_2O$)

as well as corresponding potassium, lithium and ammonium salts, such as:

Potassium metaborate, KBO_2 (or $K_2B_2O_4$)
Potassium tetraborate, $K_2B_4O_7 \cdot 5H_2O$
Potassium pentaborate, KB_5O_8
Potassium perborate, $KBO_3 \cdot \frac{1}{2}H_2O$
Lithium metaborate—
$LiBO_2$
$LiBO_2 \cdot 8H_2O$
Lithium tetraborate, $Li_2B_4O_7 \cdot 5H_2O$
Ammonium perborate—
NH_4BO_3 (or $NH_4BO_3 \cdot \frac{1}{2}H_2O$)
Ammonium tetraborate—
$(NH_4)_2B_4O_7 \cdot 4H_2O$
$NH_4HB_4O_7 \cdot 3H_2O$
Ammonium pentaborate—
$NH_4B_5O_8 \cdot 4H_2O$
$(NH_4)_2B_{10}O_{16} \cdot 5H_2O$

The proportion of the reacting components is determined partly by the acid value of the copolymer of styrene and maleic anhydride, and partly by the relative alkalinity of the boron salt. The amount of boron salt should be sufficient to give a pH of about 7 to 7.5 to a 5% suspension of the copolymer and salt in water. The addition of more boron salt serves no useful purpose. Ordinarily the ratio, by weight, of copolymer to boron salt varies between about 1:1 and 2:1.

The size solution of this invention is prepared by blending the copolymer with the boron salt and any other additional ingredients referred to more specifically hereinafter, dispersing the resulting dry size blend in water, heating the dispersion to a temperature of about 190° to 200° F., and maintaining it at about that temperature until the powder is completely dissolved.

Size solutions thus prepared can be kept indefinitely without spoilage or decomposition.

It is within the contemplation of the invention to add to the size solution other ingredients in order to alter, as the need may be, or improve the adhesive, plastic and penetrating qualities of the size bath.

As plasticizer for the sizing film such material as glycerine, ethylene- or diethylene glycol, sorbitol, urea, etc., can be used. Urea is preferred because it imparts to the sizing film excellent flexibility without reducing the adhesive properties, or dangerously increasing the hygroscopic absorption of moisture, especially in the case of yarns made from regenerated cellulose.

The amount of plasticizing agent can be varied, depending upon the type of fiber and the relative humidity of the weave room, from 5% to 25% by weight of the dry size blend.

As the commercial powdered copolymer of the styrene and maleic anhydride is very fluffy, light, and dusty, it is desirable that it be sprayed with a small amount, e. g., 2% to 5% by weight of the dry size blend, of light mineral oil. Typical among such light oils are kerosene and oils available in commerce under the trade names "Amsco-Solv. F," "Bayol," etc.

Also due to its lightness and fluffiness, the styrene-maleic anhydride copolymer is very hard to wet out and mix with water. For this reason it is desirable also to add to the mixture a small percentage (.5% to 5%) of a wetting-out agent such as soluble pine oil, sulfonated oil, and sulfated long chain alcohols. This may be mixed or dissolved in the mineral oil and sprayed at the same time.

The following examples illustrate several of the preferred embodiments of the invention:

Example 1

The following materials were blended together, the parts being by weight:

46% styrene-maleic anhydride copolymer
26% borax
20% urea
3% pine oil (Hercules Powder Co., "Yarmor 302")
5% light oil ("Amsco Solvent F")

100 lbs. of this dry blend were dispersed in 1200 lbs. of water and the mixture heated to 190°–200° F. and kept at this temperature until the powder was completely dissolved. The resultant pH of the solution was between 7 and 7.5.

Cellulose acetate warps sized with this solution had excellent weaving qualities, there was no dusting in the sizing machine or in the loom. The size solution can be kept indefinitely without spoilage or decomposition.

Example 2

The following materials were blended together, the parts being by weight:

41% styrene-maleic anhydride copolymer
33% sodium metaborate ($NaBO_2 \cdot 2H_2O$)
20% urea
3% pine oil ("Yarmor 302")
3% Bayol mineral oil

60 lbs. of this dry blend were dispersed in 1200 lbs. of water and the mixture heated to 190°–200° F. and kept at this temperature until the powder was completely dissolved. The resultant pH was between 7 and 7.5.

Regenerated cellulose warps sized with this solution had excellent weaving qualities, there was no dusting in the sizing machine or on the loom. The size was removed completely from the woven cloth in a bath of plain warm water, there was no need to use enzymes, or any other desizing agent, as is necessary with starch and gelatine.

Example 3

The following materials were blended together, the parts being by weight:

49% styrene-maleic anhydride copolymer
39% sodium metaborate ($NaBO_2 \cdot 2H_2O$)
6% glycerine
3% pine oil ("Yarmor 302")
3% light oil ("Amsco Solvent F")

100 lbs. of this dry blend were dispersed in 1000 lbs. of water and the mixture heated to 190°–200° F. and kept at this temperature until the powder was completely dissolved. The resultant pH of the solution was between 7 and 7.5.

Warps made from spun yarns of cellulose acetate and wool blended together and sized with this solution had excellent weaving qualities. There was very little dusting in the sizing machine, and much less than with other ordinary sizing materials in the loom. The sizing solution can be kept indefinitely without spoilage or decomposition.

It is to be understood all such modifications and changes in the components, proportions and procedures described as will readily occur to those skilled in the art upon reading this description are intended to be included within the scope of the invention as defined in the accompanying claims.

I claim:

1. A size solution for textile material com-

prising an aqueous solution of the reaction product of a water-soluble salt and a copolymer of a substance selected from the group consisting of styrene, an alkyl-substituted styrene and a halogen-substituted styrene with a substance selected from the group consisting of maleic anhydride and a partial ester of maleic anhydride, said water-soluble salt being selected from the group consisting of sodium borates, potassium borates, lithium borates and ammonium borates.

2. A size solution for textile material comprising an aqueous solution of the reaction product of a sodium borate salt and a copolymer of a substance selected from the group consisting of styrene, an alkyl-substituted styrene and a halogen-substituted styrene with a substance selected from the group consisting of maleic anhydride and a partial ester of maleic anhydride.

3. A size solution for textile material comprising an aqueous solution of the reaction product of a water-soluble boron salt selected from the group consisting of sodium borates, potassium borates, lithium borates and ammonium borates and a copolymer of styrene and maleic anhydride.

4. A method of preparing a size solution for textile material which comprises blending a water-soluble boron salt with a copolymer prepared by copolymerizing a substance selected from the group consisting of styrene, an alkyl-substituted styrene and a halogen-substituted styrene with a substance selected from the group consisting of maleic anhydride and a partial ester of maleic anhydride, said salt being selected from the group consisting of sodium borates, potassium borates, lithium borates and ammonium borates, dispersing the resulting blend in water, and heating said dispersion to a temperature of the order of about 190° to 200° F. for a time sufficient to dissolve the blend substantially completely.

5. A method of preparing a size solution for textile material which comprises blending a water-soluble sodium borate with a copolymer prepared by copolymerizing a substance selected from the group consisting of styrene, an alkyl-substituted styrene and a halogen-substituted styrene with a substance selected from the group consisting of maleic anhydride and a partial ester of maleic anhydride, dispersing the resulting blend in water, and heating said dispersion to a temperature of the order of about 190° to 200° F. for a time sufficient to dissolve the blend substantially completely.

6. A method of preparing a size solution for textile material which comprises blending a water-soluble boron salt selected from the group consisting of sodium borates, potassium borates, lithium borates and ammonium borates with a copolymer of styrene and maleic anhydride, dispersing the resulting blend in water, and heating said dispersion to a temperature of the order of about 190° to 200° F. for a time sufficient to dissolve the blend substantially completely.

7. A dry blend comprising a mixture of a water-soluble salt selected from the group consisting of sodium borates, potassium borates, lithium borates and ammonium borates, and a copolymer of a substance selected from the group consisting of styrene, an alkyl-substituted styrene and a halogen-substituted styrene with a substance selected from the group consisting of maleic anhydride and a partial ester of maleic anhydride.

8. A dry blend comprising a mixture of a water-soluble sodium borate and a copolymer of a substance selected from the group consisting of styrene, an alkyl-substituted styrene and a halogen-substituted styrene with a substance selected from the group consisting of maleic anhydride and a partial ester of maleic anhydride.

9. A dry blend comprising a mixture of a water-soluble boron salt selected from the group consisting of sodium borates, potassium borates, lithium borates and ammonium borates and a copolymer of styrene and maleic anhydride.

10. The method defined in claim 4 wherein the boron salt is a water-soluble potassium borate.

11. The method defined in claim 4 wherein the boron salt is a water-soluble lithium borate.

12. The method defined in claim 4 wherein the boron salt is a water-soluble ammonium borate.

13. The dry blend defined in claim 7 wherein the boron salt is a water-soluble potassium borate.

14. The dry blend defined in claim 7 wherein the boron salt is a water-soluble lithium borate.

15. The dry blend defined in claim 7 wherein the boron salt is a water-soluble ammonium borate.

16. The size solution defined in claim 1 wherein the boron salt is a water-soluble potassium borate.

17. The size solution defined in claim 1 wherein the boron salt is a water-soluble lithium borate.

18. The size solution defined in claim 1 wherein the boron salt is a water-soluble ammonium borate.

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