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STARCH SIZE AND METHOD OF PREPARING
THE SAME

Stoney Drake, Atlanta, Ga.

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The present invention relates to textile sizing and finishing solutions, and it particularly relates to improvements in starch-containing sizing and finishing solutions, to be utilized for the sizing of threads and yarns, particularly warp yarns, and for the finishing of cloth in the textile industries.

In the manufacture of textile fabrics from yarns composed in whole or part of cotton, wool, rayon, linen and/or other textile materials, it is usually desirable to size the yarn or threads before, or during the course of, textile processing, so as to give them sufficient body and stiffness to enable them to be readily handled during weaving and other textile processing operations.

In addition, these sizes and finishes are also utilized to decrease the breakages in the yarns or threads in the processes of weaving, to decrease stoppages of the textile machinery, to cause the cloth or fabric to have a better texture and feel and to eliminate loose strands and fibers which might project from the yarn or thread and catch the various apparatus or other elements utilized in connection with the textile processing machinery.

Among the materials which have been widely employed for this purpose are starch and similar mucilaginous or colloidal carbohydrates, and so forth.

The present invention will be illustratively described in connection with its application to starch sizing and finishing solutions.

Although these sizes are desirably utilized to enable the yarns or threads to be most conveniently handled during textile processing and for the other purposes set forth above, they nevertheless result in many disadvantageous effects. Starch sizes often cause the yarns or threads to become unduly stiff or brittle, particularly over periods of time, and frequently the yarns or threads to which the starch sizes have been applied acquire an undesirable harsh, tough, and coarse feel or texture.

To eliminate this difficulty, it has been the practice in the textile industries to add lubricating or softening materials to the sizing or finishing baths, such as oils, fats, or waxes, and the like.

Soaps may also be formed by neutralization of the sulphonic or carboxylic radicals in the oils, waxes or fats themselves, and/or by combination of free fatty acids in the oleaginous materials with the alkali which may be derived from the yarns, particularly when such yarns

have been dyed in an alkaline environment before being sized.

However, when such soapy starch sizing or finishing solutions are utilized, they are most frequently contained in the size boxes or troughs of slasher machines and/or cloth finishing machines, in which containers they are kept boiling briskly.

Because of this boiling there is a tendency for the colloidal starch size solutions to foam or froth, particularly when they contain substantial amounts of soap or sodium salts of higher molecular weight fatty acids, which foaming or frothing is quite undesirable in assuring satisfactory application of the sizing to the fabric.

It has been suggested to offset these foaming and frothing difficulties with certain salts or compounds, such as the chlorides of calcium, zinc, magnesium, aluminum, and other metals, which will form insoluble soapy materials. The calcium, zinc, magnesium, aluminum, or other insoluble metal soaps tend to deposit upon the goods and are most difficult to remove in subsequent processes of bleaching, dyeing, and/or finishing and the inclusion of these insoluble soaps often causes the difficulty in bleacheries referred to as lime soap stains or metallic soap stains.

Furthermore, the presence of metallic chlorides of calcium, zinc, magnesium, tin and aluminum often results in a disadvantageous production of acids or acid materials, such as hydrochloric acid, particularly in subsequent processes where the fabrics produced are subject to relatively high temperatures, as in singeing or calendaring. The production of these acids tends to destroy, weaken, or tender the fabric, particularly when the fabric contains cellulosic yarns, as for example, cotton and/or rayon.

It is among the objects of the present invention to eliminate the frothing or foaming characteristics of starch and similar sizes or finishing solutions, whether such solutions contain starch alone or starch in combination with substantial amounts of soapy materials, all without the necessity of adding calcium, magnesium, zinc, or aluminum salts or chlorides to the sizing or finishing solutions, thus eliminating the possibility of forming insoluble soaps tending to stain or mar the fabric or textile material, and without the danger of depositing chlorides on the fabric with resultant liability of tendering such fabric subsequently on singeing or calendaring.

Another object is to prepare an improved starch or similar sizing or finishing solution, which may contain substantial quantity of sodium soaps or sodium salts of high molecular weight fatty acids, without excessive tendency toward frothing or foaming, and without the inclusion of chlorides of various metals tending to form insoluble soapy materials or produce tendering acids.

Furthermore, in the case of cotton or other cellulosic yarns, threads, or fabrics, it has been found that the structure of the fiber is particularly sensitive to acid influences with resultant tendency to tender, deteriorate and lose its strength, and it is still a further object of the present invention to provide a process of sizing and finishing and a sizing and finishing compound, mixture, solution or bath, which not only will be substantially resistant to frothing and foaming, but which will also render the fabric or textile material particularly resistant to acid or acid materials, preventing tendering or deterioration, and which in addition will tend to toughen the fabric or textiles so that they will have increased breaking strength and be much more durable in processing and wear.

Other objects will be obvious or will appear during the course of the following specification.

It has been found that the above objects may be most satisfactorily accomplished by the inclusion in the starch sizing and finishing bath of a relatively small amount of a fluoride and particularly a water-soluble fluoride, such as the fluorides of ammonium or the alkali metals, as sodium or potassium.

These fluorides may be utilized as the normal salts (Na_2F_2 , K_2F_2 , $(\text{NH}_4)_2\text{F}_2$), or in the form of their acid salts, such as the bifluorides (NaF.HF , KF.HF , $\text{NH}_4\text{F.HF}$), or in the form of complex salts including a combination of a fluoride of an alkali metal or ammonium or a non-metal, such as boron, and so forth, depending upon the exact effect it is desired to attain.

It has been found most satisfactory in practice to utilize the fluorides in the final textile sizing or finishing bath in amounts substantially less than 10% and preferably between 1% to 5% with an optimum at about 3%, based upon the dry weight of starch or similar size.

The fluorides may be combined with the starch and/or with the waxy, fatty or oily material in either the form of a concentrated emulsion or paste or a divided solid, which is to be added to a bath to form a suspension or emulsion to be utilized for the impregnation or treatment of the yarn, the fabric, or other textile material.

The sizing compound as sold to mills for adding to, or forming, the sizing bath may, for example, contain tallows, fats, waxes, soaps, gums, dextrans, glycerine, glycols, or other types of softening agents, adhesive agents, and hygroscopic agents. The mixture to be supplied to the textile mill for purposes of economy and shipping and storage, preferably is in the form of a very viscous liquid or paste, so that when between 5% to 30% of this material, or say between 15% to 20% of this paste or viscous liquid is added to the bath, the soluble salts of hydrofluoric acid will constitute about 2% to 4% of the mixture based upon the weight of the colloidal size or finish.

For this purpose the concentrated size solution which is sold to the mills, may contain between 15% to 25% of fluorides, or other percentages in case the starch material is to be added separate-

ly to the bath, so that in the resultant bath there will be about 3% of the fluorides based upon the dry weight of the starch or similar colloid present.

It has also been found most desirable from the viewpoint of efficiency of the solution to employ the sizing or finishing solution containing the starch and hydrofluorides in a slightly acid condition or preferably at a pH between 7 to 2 with the pH preferably approaching neutrality in most cases or being about or above 4 to 5.

It is generally desired to keep the pH above 4 or between 4 and 7, since this will avoid any tendency of the cotton to tender when dried at elevated temperatures. In this connection the sodium fluoride tends to buffer the action of any mineral acids which may be present due to the tendency of the sodium fluoride to combine with the acid to form an acid fluoride, such as sodium hydrogen fluoride.

Although the pH may be controlled in various manners, it has been found that the bifluorides or acid fluorides or combination of the normal fluorides and acid fluorides give a buffer mixture which enables the attainment or regulation of a pH in a most satisfactory manner.

In addition, it has been found satisfactory to use mixtures of the normal and acid or bifluorides in making up the fluoride content of the bath (e. g. in proportions of 4 parts of fluoride to 1 part of bifluoride), in view of the fact that such a combined solution appears to be more adhesive. As a possible theory, the fluoride combination seems to effect the colloidal size of the starch particles, both upon cooking and boiling, to render the starch more adhesive and soluble.

With such combined size solutions, it has been found that there is substantial elimination of difficulties arising from loose fiber ends projecting from the surface of the threads and even loosely spun-in fibers. It seems that these fiber ends or fibers are bound or combined so well to the surface of the threads, of which they are a part, that the shedding off of these fibers from the warps while being woven into cloth in the looms is minimized, with the result that the usual practice of adding adhesive or sticky gums to the size mixture is made entirely unnecessary and at the same time the shedding of the fibers from the warps substantially entirely disappears.

In respect to toughening or increasing the strength of the fabric material, particularly when it is composed of cotton or other cellulosic materials, it has been found that the fluorated starch size of the present invention causes the cotton or cellulosic fibers to resist tendering or disintegrating action of acids to a marked degree.

To give an illustration, if cotton cloth is boiled for five minutes in a solution composed of 30 cc. of water and 5 cc. concentrated hydrochloric acid and removed in saturated condition and allowed to dry in air at room temperature, the resultant fabric is tendered or weakened to such a degree that the breaking strength of the cloth is only about 40% of its original strength.

On the other hand, where the test is duplicated with only a small amount of soluble alkali metal salts of hydrofluoric acid present in the acid-water mixture, no tendering effect is noted and the breaking strength of the cloth is not affected even after it has been aged for thirty days. On the contrary, there appears to be an actual increase in the breaking strength and compared to the original breaking strength of the cloth before being treated. The treatment of the cellu-

losic fibers with the hydrofluorides appears to be substantially toughen and strengthen the cellulosic fibers.

The inclusion of these fluorides even though in as small an amount of 3% based on dry weight of starch content, as stated above, in colloidal sizing solutions, will substantially decrease or altogether eliminate tendency toward frothing or foaming when said solutions are boiled or heated, even though there are present substantial amounts of soluble soaps of sodium salts of high molecular weight fatty acids.

Moreover, the fabric, yarns, or other textile materials so treated not only are resistant to the tendering and deteriorating effect of acid or acid materials, but in addition the size seems to be absorbed more satisfactorily into the threads, causing the yarn or fabric to have enhanced sized or finished properties.

Particularly in the case of yarns loose fibers sticking out from the body of the yarn or loosely spun-in portions of the strands themselves are coalesced with the body of the yarn so that it is much more readily handled throughout textile processing.

As another advantage of the acid fluorated size solutions of the present application, is the fact that iron stains are substantially eliminated due to the formation of water soluble iron fluoride and the removal of insoluble iron oxides thereby from the fabric.

It is apparent that various other substances or compounds may be incorporated in the sizing or finishing mixture before or after it is diluted to form a bath, among which materials may be other alkali metal or alkali earth metal salts of other acids than hydrofluoric acid, such as sulfates, phosphates, or even of the hydrofluoric acid itself, ethanolamine compounds, and particularly in the fluorides of these compounds, castor oil or olive oil, cocoa fat in sulphonated or unsulphonated condition, cyclo-aliphatic or aromatic acids of either sulphonated or carboxylic derivation, methylcellulose, and so forth.

There may also be incorporated into the size solution various soluble gums or resins either of natural or synthetic origin, such as soluble vinylite resins, soluble acetone resins, soluble urea formaldehyde resins, latex, and similar materials.

It is preferred, however, that alkalies or alkaline reacting materials be avoided since the fluorides function most satisfactorily in an acid bath and it is also desirable that all materials of the nature of dyes or having dyeing properties be eliminated from the sizing or finishing solution.

If the fabric or yarn is also to be dyed, it is preferably treated after dyeing, before the sizing or finishing, to eliminate the traces of dye therein, or it is first sized or finished before the dye is applied thereto. In the latter case it is often desirable to remove the sizing or finishing together before the application of the dyeing material.

The components of the starch sizes of the present invention as used in the size boxes of the slashers would need be varied to obtain different desired effects, such as the amount of weight to be added to the threads by the process of sizing, the amount of outside surface coating, and penetration of the size into the interstices between the fibers without penetration of the fibers, and degree of stiffness or suppleness of the sized article.

A typical size solution for adding about 14% weight, with the best proportioning of penetra-

tion and surface coating, to produce best weaving quality in the loom would be:

For each 100 gallons of finished size mixture, (that is, after all ingredients have been added and the cooking has been completed):

	Pounds
Thin boiling starch (dry basis)-----	100
Tallow softener-----	6
Sodium fluoride-----	2.4
Sodium bifluoride-----	.6
Water to make 100 gallons	
or	
Thick boiling starch (dry basis)-----	100
ARCY 4-X (a starch solubilizing enzyme product)-----	1
Tallow softener-----	6
Sodium fluoride-----	2.4
Sodium bifluoride-----	.6
Water to make 100 gallons.	

As appears above, it is not desirable to have the fluorides present much in excess of 1% based on the weight of the dry starch, and it is desirable to have the sodium fluoride and the sodium bifluoride present in a by-weight proportion of about 2½ to 1. If desired, the fluoride may be added in the form of ammonium or zinc silico fluoride.

It is to be understood that the various specific proportions and compounds above mentioned have been mentioned by way of illustration and not by way of limitation and that many alternatives, modifications and changes may be made in the above identified procedures and compositions specifically described without departing from the essential features of the present invention, all of which it is intended to cover broadly by the present invention.

What is claimed is:

1. A process of sizing and finishing cotton warps and woven cloth which comprises immersing the warp and cloth in a boiling solution of a boiling starch containing a relatively small amount of an agent decreasing the frothing and foaming of the starch solution and rendering the cotton materials resistant to acid tendering consisting of a water soluble alkaline metal fluoride.

2. A process of sizing and finishing cotton warps and woven cloth which comprises immersing the warp and cloth in a boiling solution of a boiling starch containing a relatively small amount of an agent decreasing the frothing and foaming of the starch solution and rendering the cotton materials resistant to acid tendering consisting of a water soluble alkaline metal fluoride, said starch being used in the amount of about 100 parts by weight of starch to about eight hundred parts by weight of water.

3. Warp sizing and cloth finishing compositions having an acid reaction and consisting of water, a thick boiling starch, a starch solubilizing enzyme, a mixture of sodium fluoride and sodium bifluoride, said bifluoride being present in substantially smaller quantities than said fluoride and being present in such quantity as to give the composition a pH of between about 2 and 7, said composition having non-foaming or non-frothing characteristics and giving the warp and cloth acid-resistant properties and increased strength, toughness and durability without tendering or weakening the warp or cloth.

4. Warp sizing and cloth finishing compositions having an acid reaction and consisting of water, a boiling starch, a mixture of sodium fluoride and sodium bifluoride, said bifluoride and said

fluoride being present in said mixture in proportions by weight of about 1 to 4, said fluorides being present in the proportion of approximately 3% based on the dry weight of the starch matter present, said composition having non-foaming or non-frothing characteristics and giving the warp and cloth acid-resistant properties and increased strength, toughness and durability without tendering or weakening the warp or cloth.

5. Warp sizing and cloth finishing compositions having an acid reaction and consisting of water, a boiling starch and a combination of soluble salts of hydrofluoric acid having the formulae X_2F_2 and XHF_2 where X represents sodium, potassium or ammonium in the proportion of approximately 3% based on the dry weight of the starch matter present with sufficient HF present to adjust the starch size mixture to a pH below 7 and above 2, said former salt X_2F_2 being present in much greater proportion than said latter salt XHF_2 by weight in proportion of about 4 parts of the former to 1 part of the latter, said composition having non-foaming or non-frothing characteristics and giving the warp and cloth acid-resistant properties and increased strength, toughness and durability without tendering or weakening the warp or cloth.

6. Warp sizing and cloth finishing composi-

tions having an acid reaction and comprising water, a boiling starch, and an alkali metal fluoride, said composition having non-foaming or non-frothing characteristics and giving the warp and cloth acid-resistant properties and increased strength, toughness and durability without tendering or weakening the warp or cloth.

7. Warp sizing and cloth finishing compositions having an acid reaction and comprising water, a boiling starch and a combination of soluble salts of hydrofluoric acid having the formulae X_2F_2 and XHF_2 where X represents sodium, potassium or ammonium, said composition having non-foaming or non-frothing characteristics and giving the warp and cloth acid-resistant properties and increased strength, toughness and durability without tendering or weakening the warp or cloth.

8. Warp sizing and cloth finishing compositions having an acid reaction and consisting of water, a thick boiling starch, a starch solubilizing enzyme, a mixture of sodium fluoride and sodium bifluoride, said composition having non-foaming or non-frothing characteristics and giving the warp and cloth acid-resistant properties and increased strength, toughness and durability without tendering or weakening the warp or cloth.

STONEY DRAKE.