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Oct. 2, 1962 J. A. ANDERSON ETAL 3,056,645

PROCESS OF BLEACHING SIZED COTTON FABRICS

Filed Oct. 9, 1959 2 Sheets-Sheet 1

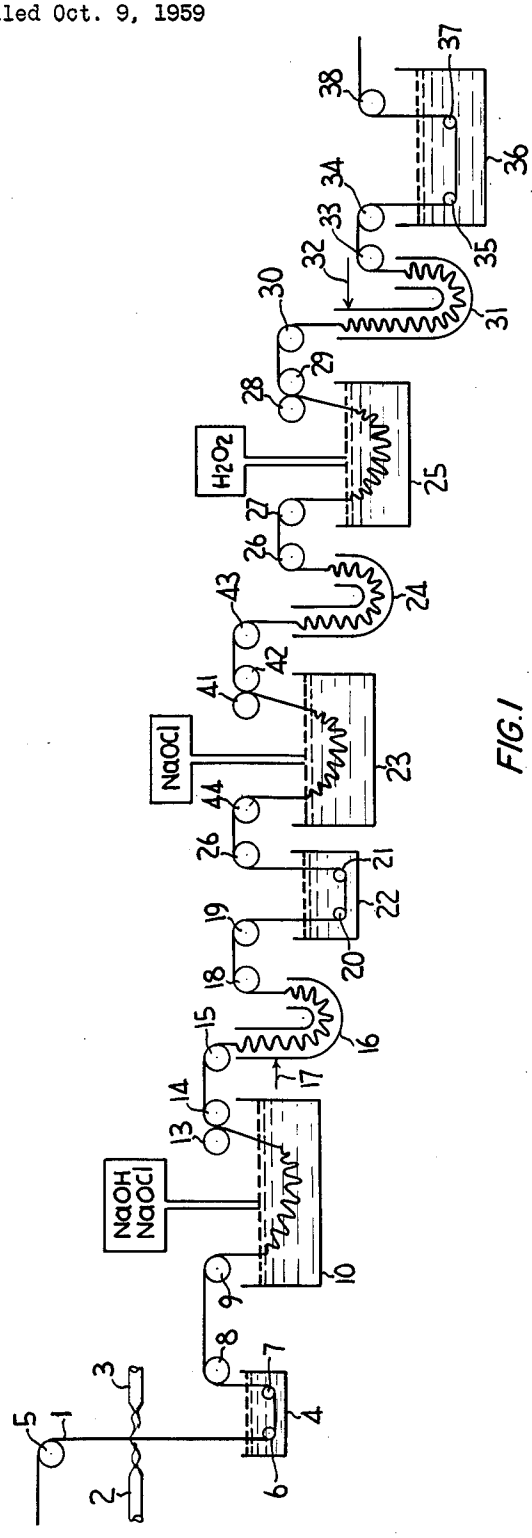


FIG. 1

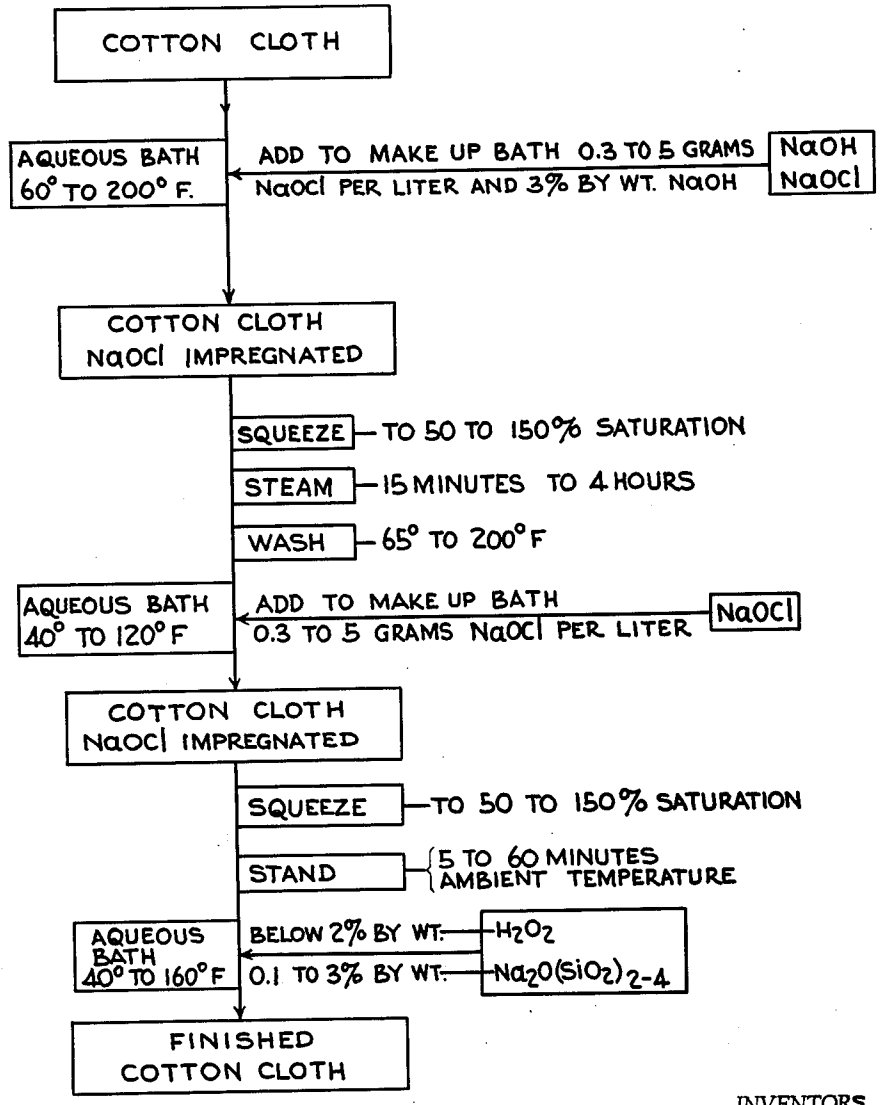
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FIG. 2



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PROCESS OF BLEACHING SIZED COTTON FABRICS

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The present invention is concerned with bleaching of woven or knitted cellulosic and like vegetable fabrics, especially cotton fabrics. Still more particularly, the present invention relates to the bleaching of sized fabrics of this character and in particular sized cotton fabrics.

In the bleaching of textile fabrics, many different processes have been employed. Among the more common bleaching processes are those involving the use of alkali metal hypochlorite solutions and aqueous hydrogen peroxide solutions or combinations of both. While these processes have proved effective in many applications, quite frequently, disadvantages or deleterious effects arise which render them unacceptable. Thus, in some cases while the strength of the fabric is not affected by the bleaching operation conducted, some sacrifice in the whiteness of the material treated is necessitated. In other cases good whiteness is achieved at the expense of a reduction in the strength of the fibers contained in the fabric treated. A further disadvantage of many of the chemical bleaching treatments heretofore undertaken is the substantial costs of the chemicals involved.

Cotton fabrics as used herein in the specification and claims are intended to include those fabrics which are composed essentially entirely of cotton fibers as well as fabrics which are mixtures of cotton fibers with other fibers such as wool, rayon, nylon, and other synthetic and natural fibrous materials easily blended with cotton fibers. Cotton unions as contemplated generally contain at least 15 percent by weight of cotton therein. The fabrics include cloth which has been woven, as well as knitted cloth.

According to the present invention, a novel process has been provided which effectively solves many of the problems encountered in bleaching woven or knitted cotton and like fabrics, especially cotton fabrics which have been sized, that is, impregnated with various starch materials well known in the art. By employing a novel sequence of steps, as hereinafter set forth, a bleaching process is provided which produces a plurality of beneficial effects in bleaching cotton fabrics. Thus, cotton fabrics are bleached to a high degree of brightness while at the same time fibrous strength in the fabric bleached is substantially unaffected. Conventional desizing operations may be eliminated entirely without deleterious effect utilizing the teachings of this invention and exceptionally high degrees of brightness still achieved by the bleaching operation. A further advantage of the process is that it is easily adapted to conventional bleaching equipment, thus providing an improved bleaching process with little or no equipment changes necessitated. A further advantage of the process involves a considerable reduction in the quantities of bleaching chemicals employed, especially hydrogen peroxide requirements, thereby reducing considerably the costs of a given bleaching operation.

In accordance with this invention, a sized woven or knitted vegetable fabric such as cotton is introduced, without desizing, into an aqueous solution of an alkali metal hydroxide and an alkali metal hypochlorite and/or an alkaline earth metal hypochlorite. Sodium, potassium and calcium hypochlorite are typical of the hypochlorites employed. The fabric is permitted to remain in the solution for a period of time sufficient to substantially impregnate the fabric with the solution. After nipping

the fabric if necessary to give a 50 to 150 percent liquor pickup in the cloth basis the weight of the dry cloth, the goods are heated in steam for a period of time sufficient to disperse the motes and render the non-fibrous content of the fabric or cloth water extractable. Thus, starches are solubilized and oils and fats emulsified during the steaming operation. During the steaming operation, fibers in the fabric treated swell and softening and dispersion of the motes occur and, in addition, the hypochlorite content of the solution impregnated fabric is substantially removed.

The material after the heating operation is water washed and introduced into an aqueous solution of sodium hypochlorite. The fabric is permitted to remain in the hypochlorite solution for a period of time sufficient to impregnate substantially the woven fabric with the sodium hypochlorite solution. After the fabric has been impregnated with between 50 to 150 percent liquor by weight basis the weight of the dry goods, the fabric is removed from the hypochlorite bath and stored at ambient temperatures for at least 5 minutes preferably between 15 and 60 minutes. The material after storage is then introduced into an aqueous solution of hydrogen peroxide. The fabric is permitted to remain in the hydrogen peroxide solution for a period of time sufficient to impregnate substantially the woven fabric with the hydrogen peroxide solution. After the fabric has been impregnated with between 50 and 150 percent by weight of the aqueous peroxide solution basis the weight of the dry goods, it is then heated for a period of time sufficient to bleach it to the desired degree.

In the treatment of extremely heavy fabrics such as cotton poplins and the like, a desizing step may conveniently be employed to insure adequate bleaching of the material. Thus, in bleaching a material of this type, the fabric is desized in a conventional enzyme desizing solution and then subsequently introduced into an aqueous solution of an alkali metal hydroxide and a hypochlorite of the group consisting of alkali metal hypochlorites and alkaline earth metal hypochlorites in the fashion as hereinabove described.

After the desized cloth is treated with the aqueous solution of alkali metal hydroxide and the hypochlorite, the hypochlorite bleaching step, storing step, and the peroxide bleaching step hereinabove described are conducted.

For a more complete understanding of the present invention, reference is made to the accompanying drawings. FIGURE 1 is a diagrammatic illustration of the method and apparatus utilized in bleaching woven vegetable fabrics according to this invention. FIGURE 2 is a flow diagram of the process as carried out on cotton cloth.

FIGURE 1 shows the fabric **1**, flameburners **2** and **3**, a washing tank **4**, the caustic-hypochlorite saturator **10**, J-box **16**, washer **22**, hypochlorite bleaching tank **23**, J-box **24**, hydrogen peroxide bleaching tank **25**, J-box **31**, washer **36**. In the operation of the process in conjunction with the equipment shown in the drawing, a woven fabric is drawn over rollers **5**, **6** and **7** so that the fabric is essentially intermediate between the positioning of burners **2** and **3** and the flames produced by these burners. Passage of the cloth intermediate the burners effectively singes lint, fuzz and other like material from the cloth surface. The fabric is then drawn through washer **4** and, after washing or quenching, is delivered by way of rollers **8** and **9** to caustic saturator **10**. In saturator **10** the fabric is contacted with an aqueous alkali metal hydroxide solution containing an alkali metal hypochlorite or an alkaline earth metal hypochlorite. A holdup of cloth in saturator **10** is permitted to accomplish a substantial saturation of the material with the solution

contained therein. Upon leaving saturator **10**, the fabric is passed through rollers **13** and **14** and excess solution expressed or squeezed therefrom. The fabric is then passed over roller **15** and introduced into the J-box **16**. Located at a point on the J-box is a steam inlet line **17**. Steam is introduced into the J-box at a temperature of approximately 212° F. at atmospheric pressure, and the cloth is permitted to remain therein for a substantial period of time.

After the steam treatment, the cloth is drawn over rollers **18**, **19**, **20**, **21** and **26** through a washer **22**. The cloth is then drawn over roller **44** and introduced into a saturator **23** where it is contacted with an aqueous solution of sodium hypochlorite. A holdup of cloth in the saturator **23** is permitted for a period of time sufficient to accomplish a substantial saturation of the cloth with the hypochlorite solution. After the cloth has been thoroughly saturated with the hypochlorite solution contained in the saturator **23**, it is drawn through rollers **41** and **42** and passed over roller **43** into a J-box **24** where it is stored for at least five minutes usually at ambient temperature (75° F.). The cloth is then drawn over rollers **26** and **27** and introduced into the hydrogen peroxide bleaching tank **25**. A holdup of cloth in the tank **25** is permitted for a period of time sufficient to accomplish a substantial saturation of the cloth with hydrogen peroxide solution. After the cloth has been thoroughly saturated with the hydrogen peroxide solution contained in the tank **25**, it is drawn through rollers **28** and **29** over roller **30** and into the J-box **31**. Rollers **28** and **29** function to express solution from the cloth leaving saturator **25**. Steam is introduced into the J-box **31** through a steam inlet **32** at a temperature of approximately 212° F., and the cloth is permitted to remain therein for a period of time sufficient to accomplish bleaching of the impregnated cloth. Upon completion of the bleaching operation in the J-box **31**, the cloth is drawn over rollers **33**, **34**, **35**, **37** and **38** through a washer **36** where it is thoroughly washed with water and removed from the tank for further processing, for example, dyeing operations or merely to be dried and utilized as such.

The singeing of the cloth is accomplished by recourse to ordinary flame-burners. The cloth is positioned between the burners so that it is essentially equidistant from the flames issuing from both burners, and a uniform distribution of the flame to both sides of the fabric traversing the flame area takes place. At this point in the operation, the cloth is passed through at a relatively rapid rate so that scorching or burning does not take place. Usually a travel speed of 150 yards of cloth per minute is sufficient to successfully permit a singeing of the cloth without producing any deleterious effects thereon. The singeing operation is conducted on the woven fabric to remove hair, lint and materials of this nature which adhere to the surface of the cloth.

All of the washers conveniently employ tap water maintained at room temperatures, that is, 65° to 80° F.; however, hot water may be used where desired or needed. Thus, water temperature of 100° to 200° F. may be employed. If desired, the washers may be equipped with heaters to facilitate maintenance of elevated temperatures.

The composition of the alkaline solution of the alkali metal or alkaline earth metal hypochlorite utilized in the caustic saturator in accordance with this invention is important for the accomplishment of the results desired. Thus, the hypochlorite concentration in the aqueous alkaline solution is controlled so that there is provided in this solution between 0.3 to 5 grams active chlorine per liter of solution. Preferably the hypochlorite concentration is so maintained that there is provided between 1 and 3 grams active chlorine per liter of solution. The solution is maintained in the alkaline state and within a definite alkaline range (i.e., above 7). The pH of the solution is usually maintained between 10 and 14 preferably in the 12 to 13 range on the pH scale.

While in the accompanying drawings sodium hydroxide is utilized as the alkaline medium, it is of course understood that other alkali metal hydroxides may be employed such as potassium hydroxide. Generally speaking alkali metal hydroxide concentrations are adjusted such that the fabric leaving the saturator contains between 2 and 5 percent by weight of the alkali metal hydroxide on weight of dry goods. Preferably alkali metal hydroxide concentration is on the order of 3 percent by weight basis the weight of the dry goods.

The fabric treated in the aqueous alkaline solution containing hypochlorite is contacted with the solution for a period of time sufficient to essentially saturate the cloth with the solution. This may be accomplished by adjusting the pressure applied by the nip rolls at the exit end of the saturator so that an adequate pickup of solution within the saturator is accomplished. Cloth which picks up solution in the saturator on the order of 50 to 150 percent by weight basis the weight of the dry fabric is considered sufficiently saturated with solution for the purposes of this invention.

Temperature conditions within the caustic saturator are considerably variable and generally range between 60 and 200° F. Preferably temperatures are maintained so that the solution temperatures are relatively hot and range between 100 and 140° F. Operation in this latter range produces the most satisfactory results.

In treating cloth in the caustic-hypochlorite saturator as hereinabove described, the most beneficial use of the chemicals involved is thereby attained. The main function of the solution contained in the saturator is to supply adequate chemicals to the cloth to accomplish dispersion of motes, seeds and shives contained in the cloth and thereby prepare it for subsequent bleaching. Little or no bleaching effect is accomplished by the hypochlorite content of this solution.

In introducing the material to the J-box or steam chest, it is essential that certain conditions be observed for maximum effect in the overall bleaching operation in accordance with the present invention. Thus, cloth fed to the steaming chest or zone is permitted to remain therein during the steaming operation for a considerable period of time. Generally the time is so regulated that the cloth is maintained within this zone for a sufficient interval of time to provide for essentially complete removal of the hypochlorite content of the cloth. In addition to the removal of hypochlorite contained within the cloth or fabric fed to the zone, hydrolysis of starchy materials contained in the cloth sizing is accomplished thereby rendering them soluble in the subsequent washing operations. Maximum dispersion of motes present is also realized.

For the successful accomplishment of these results, elevated temperatures are employed in the operation of this steaming step. Thus, temperatures range generally between 180° and 500° F. Preferably steaming is conducted somewhere between about 180° and 220° F. Steaming operations conducted within the above temperature ranges are adequate when the cloth is held in the steaming zone for at least about 15 minutes. Generally the cloth is maintained in this zone for between 15 minutes to about 4 hours, but conveniently a one-hour treatment is usually sufficient.

The hypochlorite bleaching tank or saturator **23** of the instant invention contains aqueous hypochlorite solutions which contain hypochlorite in a range of between 0.3 to 5 grams active chlorine per liter of solution. Preferably the hpyochlorite concentration is so maintained that there is provided between 1 and 3 grams active chlorine per liter of solution. The solution is maintained on the alkaline side of the pH scale, that is, above pH 7. The pH of the solution is usually maintained between 7 and 11 preferably in the 8 to 9 range on the pH scale. The temperature of the hypochlorite bleaching bath may conveniently comprise ambient temperature (70° F.) but can

range between 40° and 120° F. Usually the temperature is in the range of 70° to 95° F.

Generally speaking, the same considerations are applied to the cloth fed to the hydrogen peroxide saturator or bleaching tank as are given to cloth fed to the caustic saturator and hypochlorite bleaching tank with respect to the holdup times employed. Thus, the cloth is usually permitted a holdup in the peroxide saturator sufficient to permit a saturation of the cloth to the degree that a solution pickup of 50 to 150 percent by weight basis the weight of dry fabric is accomplished. Expression of solution from the cloth if necessary is accomplished as it leaves the tank through nip rolls 28 and 29 in the same manner as it is accomplished wtih the cloth leaving the caustic saturator and hypochlorite bleaching tank. Thus, cloth as it leaves the hydrogen peroxide saturator has its solution content regulated to between 50 and 150 percent by weight of solution basis the weight of the dry fabric.

The cloth after the hypochlorite bleaching step is introduced into a J-box 24 operated at ambient temperature 75° F. and stored in this J-box for a period of at least 5 minutes preferably for between 15 and 60 minutes. Storage at these temperatures and times usually are sufficient to permit maximum bleaching action by the hypochlorite to take place.

The hydrogen peroxide concentration permissible to acquire substantial bleaching of the cotton goods in accordance with this invention is regulated so that the hydrogen peroxide content is maintained considerably below 2 percent by weight usually between 0.1 and 1 percent. Preferably the hydrogen peroxide content of the peroxide bleaching bath is maintained somewhere between 0.2 and 0.75 percent by weight hydrogen peroxide based upon the weight of the solution. Thus, as will be readily seen, bleaching is preferably accomplished in the aqueous peroxide solution with a minimum concentration of peroxide being used. This reduction in required peroxide for a given bleaching operation is substantial and contributes to a reduction in the chemical costs for any bleaching operation. Utilizing a hydrogen peroxide bleach of reduced concentration in connection with the hypochlorite-caustic saturator treatment coupled wtih a hypochlorite bleaching step results in the production of bleached cotton fabrics exhibiting extremely high degrees of brightness with little or no loss in tensile strength. Temperatures in the aqueous hydrogen peroxide baths range generally between 40 and 160° F. and preferably are maintained between 80 and 155° F.

In addition to the hydrogen peroxide present in the bleaching bath as described above, there is conveniently employed in this aqueous solution of peroxide small quantities of alkali metal silicate. The use of an alkali metal silicate in the hydrogen peroxide bleaching bath enhances the activity of the bleaching agent. Typical of the silicates contemplated for this use is sodium silicate having the composition $Na_2O(SiO_2)_x$, where x is a value between 2 and 4. Concentrations of between 0.1 and 3 percent by weight of solution of 40° Baumé sodium silicate ($Na_2O(SiO_2)_{2.5}$) are conveniently employed. Preferably an 0.5 percent by weight concentration is employed.

In connection with treatments conducted in the hydrogen peroxide bleaching bath, the hypochlorite bleaching bath, and the caustic saturator, recourse may be had to the use of conventional wetting agents such as alkyl aryl sulfonates and other conventional chemical wetting agents. While these agents may be conveniently employed to insure adequate pickup of solution by the cloth traversing the bath, it is not essential to the bleaching process that they be employed. The operation of the caustic saturator, the hypochlorite bleaching bath, and the aqueous hydrogen peroxide solutions during a bleaching operation has been accomplished without the utilization of wetting agents and adequate pickup of solution obtained. The desirability of using these agents will for the most part be determined by the character of the cloth employed and its capability of picking up solution readily due to the physical construction of the fabric with respect to the type of fibers employed and the tightness or looseness of the weave.

Cloth, after passing through the aqueous hydrogen peroxide bleaching bath, is stored in a J-box or steam chest. Conveniently a J-box is employed for this purpose. Holdup of cloth in the steaming zone is such that it is subjected to the steam at elevated temperature for at least 15 minutes. Preferably steaming is conducted for between 30 minutes to an hour, though generally it may range anywhere between 15 minutes and 2 to 3 hours. The general guide determining the length of time that the hydrogen peroxide impregnated cloth is subjected to a steaming or heating operation is the accomplishment of complete bleaching by the hydrogen peroxide contained within the cloth. This may be easily determined for particular types and weaves of fabric so that a minimum holdup of cloth in the steaming zone for any particular fabric is achieved.

In the operation of the caustic-hypochlorite saturator, it is desirable to employ an alkali metal silicate in the solution to enhance the activity of the hypochlorite treatment occurring therein. Generally sodium silicate of the type described in reference to the peroxide bleaching bath is employed as the preferred alkali metal silicate in this bath and amounts ranging between 0.1 to 3 percent by weight silicate may be added. Conveniently, an 0.5 percent solution of 40° Baumé sodium silicate is employed.

When a sized cotton fabric, i.e., a fabric sized with starch, is bleached in accordance with the teachings of this invention, it is found that acceptable degrees of brightness are attained. Fiber strength remains substantially unaffected and, in some cases, is improved upon over conventional bleaching operations. A sized fabric passing through the bleaching operation usually contains in the neighborhood of 9 percent starch by weight basis the weight of the fabric. In treating such material without the use of a desizing bath utilizing the caustic-hypochlorite saturator, hypochlorite bleaching step, and the hydrogen peroxide bleaching bath of the present invention, a starch content of one percent or less is usually found in the treated fabric upon completion of the bleaching cycle. In some cases it is possible to reduce this starch content even further, depending on the severity of conditions employed in the steaming steps and the concentrations of the various bath solutions. Generally, however, operating in the preferred ranges with respect to chemical concentrations and steaming temperatures and times, a reduction of starch content in a woven cotton fabric to a one percent level is satisfactory.

As previously mentioned, for particularly heavy fabrics, such as poplin, in which some difficulty may be encountered in removing all of the starch materials to the desired low levels, recourse may be had to a conventional enzyme desize. These baths generally are aqueous solutions which contain various well-known enzymatic materials which effectively accomplish a desizing of the cloth. When an enzymatic desizing step is employed in connection with the above described bleaching operation, the singeing step is usually conducted prior to the desizing operation. Thus, cloth so treated is first singed and then desized with the enzymes. After the desizing step, the cloth is fed to a washer and after washing is then treated with the alkaline solution of the alkali metal or alkaline earth metal hypochlorite contained in the caustic-hypochlorite saturator. All other steps in the process remain the same as hereinbefore described. Thus, after the alkaline treatment, a steaming operation is conducted after which the cloth is washed and fed to a hypochlorite bleaching step. The hypochlorite bleach is followed by a storage period after which the cloth is bleached in peroxide and steamed. As can be readily seen, the process is easily adaptable to any bleaching operation of a cotton fabric irrespective of the type or weave.

For a more complete understanding of the present invention, the following examples are given as illustrative of some methods which may be employed in conducting the present invention and the advantages to be obtained thereby.

EXAMPLE I

A sample of print cloth, designated 623, and a sample of sheeting, designated 633, were passed into a caustic saturator having therein a solution temperature of 140° F. and an aqueous solution containing 3 percent sodium hydroxide, 0.5 percent $Na_2O(SiO_3)$ and 0.1 percent NaOCl as active chlorine, all values given being by weight of solution. The cloth in passing through the caustic saturator was allowed to pick up about one pound of solution per one pound of cloth. The cloth upon leaving the caustic saturator was admitted to a J-box and heated for a period of one hour by contact with steam at a temperature of 212° F. The cloth upon removal from the J-box was rinsed in water maintained at a temperature of 75° F. in a two-compartment washer and passed from the washer into a bleaching bath containing an aqueous solution of sodium hypochlorite with an active chlorine concentration of 0.2 percent by weight and maintained at ambient temperatures (75° F). A pickup of one pound of solution per pound of cloth was achieved in the bleaching tank and the material passed to a J-box and stored at ambient temperatures (75° F.) for a period of 20 minutes. After storage the goods were passed into a hydrogen peroxide bleaching bath having a concentration of 0.45 percent H_2O_2, 0.6 percent $Na_2O(SiO_2)$, and 0.1 percent NaOH, all percentages of chemicals given by weight of solution. Upon completion of a solution pickup in the hydrogen peroxide bleaching bath of one pound of solution per pound of cloth, the goods were passed into a J-box and steamed for a period of one hour at a temperature of 212° F. After this steaming, the samples were removed from the compartments and washed in boiling water (212° F.), dried, pressed, and the samples subjected to analysis to determine reflectance, tensile strength, and absorbency. The results of these tests are shown in Table I.

Table I

Sample	Reflectance (Percent Blue)	Absorbency (sec.)	Warp Tensile Strength (lbs./in.)
68255-178-632	89.0	1	57.0
68255-178-633	82.0	1	67.0

Reflectance was measured on a Hunter Multipurpose Reflectometer. Absorbency was measured by dropping water from a pipette held 2 inches from the surface of the unstretched cloth. The time required for the disappearance of the specular reflectance from a drop as visually observed is the measure of the absorbency.

As can be readily seen from the above example, operation in accordance with the teaching of this invention permits the attainment of a high degree of brightness in bleaching operations. Further advantages are obtained in the considerable reductions in the quantity of peroxide bleaching solution necessary to obtain a given quantity of brightness. Good tensile strengths are also obtained and absorbency values are well within the tolerated limits.

While the invention has been described with reference to certain specific examples and drawings, it is of course understood that the invention is not intended to be limited thereby since many modifications may be made in the process within the skill of the art. For example, in lieu of hydrogen peroxide in the peroxide bleach employed, alkali metal peroxide such as sodium peroxide could be employed with peroxide concentrations regulated to provide the peroxide content in this bleach equivalent to the hydrogen peroxide concentrations recited.

We claim:

1. In the bleaching of a sized cotton fabric, the steps comprising introducing the fabric into an aqueous solution of an alkali metal hydroxide and a hypochlorite, maintaining the fabric in contact with the aqueous solution of hypochlorite and alkali metal hydroxide for a period of time sufficient to substantially impregnate the fabric with solution, heating the fabric in an atmosphere of steam for a period of time sufficient to disperse the motes and render the non-fibrous content of the fabric water extractable, washing the fabric in an aqueous solution, introducing the fabric after washing into an aqueous solution of a hypochlorite of the group consisting of alkali metal hypochlorite and alkaline earth metal hypochlorite, storing the fabric for at least 5 minutes, introducing the fabric after storage into a hydrogen peroxide bleaching bath for a period of time sufficient to impregnate the fabric substantially with solution and heating the impregnated fabric at elevated temperatures in an atmosphere of steam for a period of time sufficient to bleach substantially said fabric.

2. In the bleaching of a sized cotton fabric, the steps comprising introducing the fabric into an aqueous solution of an alkali metal hydroxide and a hypochlorite, substantially impregnating the fabric with said solution, heating the impregnated fabric in an atmosphere of steam for a period of time sufficient to disperse the motes and render the non-fibrous content of the fabric water extractable, washing the fabric after heating in an aqueous solution, contacting the washed fabric with an aqueous solution of a hypochlorite of the group consisting of alkali metal hypochlorite and alkaline earth metal hypochlorite to substantially impregnate the fabric with the solution, said aqeuous solution of hypochlorite containing between 0.3 to 5 grams active chlorine per liter of solution, storing the impregnated fabric for at least 5 minutes, contacting the fabric after storage with an aqueous solution of hydrogen peroxide to impregnate substantially the fabric with the hydrogen peroxide solution and heating the impregnated fabric at elevated temperatures in an atmosphere of steam for a period of time sufficient to bleach substantially the impregnated fabric.

3. In the bleaching of a sized cotton fabric the steps comprising contacting the fabric with an aqueous solution of an alkali metal hydroxide and a hypochlorite for a period of time sufficient to impregnate the fabric with from 50 to 150 percent solution by weight basis the dry fabric, heating the impregnated fabric in an atmosphere of steam for a period of time sufficient to disperse motes present in the fabric and render the non-fibrous content of the fabric water extractable, washing the fabric in an aqueous solution to remove the nonfibrous content thereof, contacting the fabric with an aqueous solution of a hypochlorite of the group consisting of alkali metal hypochlorite and alkaline earth metal hypochlorite for a period of time sufficient to impregnate the fabric with from 50 to 150 percent of the solution by weight of the fabric, said aqueous solution containing between 0.3 to 5 grams active chlorine per liter of solution, storing the impregnated fabric for at least 5 minutes, contacting the fabric with an aqueous hydrogen peroxide solution for a time sufficient to impregnate the fabric with from 50 to 150 percent of solution by weight of the fabric and heating the impregnated fabric in steam at elevated temperatures to bleach substantially the impregnated fabric.

4. In the bleaching of a sized cotton fabric the steps comprising contacting the fabric with an aqueous solution of an alkali metal hydroxide and a hypochlorite, impregnating the fabric with the solution to provide in the fabric from 50 to 150 percent solution by weight, said solution containing between 0.3 to 5 grams active chlorine per liter of solution and having a pH of between 10 and 14, heating the impregnated fabric in steam for at least 15 minutes, washing the fabric in an aqueous medium, contacting the

fabric with an aqueous solution of a hypochlorite of the group consisting of alkali metal hypochlorite and alkaline earth metal hypochlorite, impregnating the fabric with the solution to provide in the fabric from 50 to 150 percent of the solution by weight, said solution containing between 0.3 to 5 grams active chlorine per liter of solution, storing the fabric at least 5 minutes, contacting the fabric with an aqueous solution of hydrogen peroxide containing between 0.1 and 1 percent hydrogen peroxide by weight, impregnating the fabric with the hydrogen peroxide solution to provide in the fabric from 50 to

150 percent solution by weight and heating the impregnated fabric in steam for at least 15 minutes.

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