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METHOD OF BLEACHING LINEN AND LIKE
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This invention relates to improvements in the bleaching of bast fibers such as linen, jute, hemp and the like.

The usual methods for the bleaching of cellulose are based on combinations of treatments with alkaline solutions and hypochlorite solutions, sours, antichlors and washes being used at the various stages when they are considered to be necessary. Treatments with solutions containing peroxides and persalts have also been used in conjunction with combinations of treatments of the above type. These various methods have resulted very largely from an empirical development over a long period, and while they can be operated to give very good results as regards whiteness, they are somewhat lengthy and frequently give rise to considerable chemical degradation of the cellulose. This is particularly true in the bleaching of linen and other bast fibers, and for this reason the description hereinafter will be directed more especially to the bleaching of linen.

The chemical degradation of cellulose has an important influence in reducing the effective life of the bleached material, and therefore it is obviously desirable to avoid this type of attack on the goods being bleached. As a convenient means of expressing the degree of chemical degradation of linen we use the term "solubility number." This number furnishes a measure of the amount of the material soluble in caustic soda solutions under closely specified conditions, and since it is mainly the chemically degraded cellulose that dissolves under these conditions, high solubility numbers are associated with severe degradation and low numbers with but slight attack. The conditions and method of determining solubility numbers are set out in a paper by C. R. Nodder in "The Journal of the Textile Institute 1931, 22, T416."

It is one of the objects of the present invention to provide a rapid and convenient process whereby bast fibers such as linen, can be bleached to any degree of white without undue attack on the cellulose as evidenced by the solubility number.

It is a further object to provide a rapid and convenient process whereby linen yarn can be bleached to any desired degree of whiteness with a solubility number less than 5 and even less than 4.

A still further object is to produce bast fibers of any desired degree of whiteness and a low solubility number. Further objects will appear hereinafter.

According to the present invention bast fiber materials are bleached by a process comprising at least two stages in one of which the materials are treated with a hypochlorite solution maintained within a substantially neutral pH range, and in a subsequent stage or stages with an alkali and an alkaline solution containing hydrogen peroxide.

These steps are almost invariably preceded and followed by other operations. For example, it is necessary that the material being bleached should be capable of being rapidly and uniformly wetted by the hypochlorite solution when this is applied, therefore at least one scour is usually given before the hypochlorite treatment. It is also necessary to wash the goods at various stages, and it is generally found that the best results are not obtained unless a sour in acid is introduced between the treatment with the neutral hypochlorite and the subsequent alkaline treatments.

The preliminary treatment of the goods prior to the hypochlorite treatment may be merely a thorough wetting out by means of a solution of a wetting agent. Preferably, however, the goods are subjected to an alkaline scour which may be mild or severe, provided only that it renders the fibers readily wettable by the hypochlorite. It will be evident that preliminary treatments of widely differing degrees of severity may be used. We have found it possible to combine successfully all such differing treatments with the fundamental features of the invention, but in order to achieve the best results it is necessary to control the various stages of the process with reference to one another as will be explained more fully hereinafter. As a general guide it may be stated that satisfactory results have been consistently obtained on linen yarn by the complete process when using scours containing 5 per cent to 10 per cent of sodium carbonate on the weight of the goods applied for 2 to 3 hours at 65° to 85° C. With woven goods it is usually preferable to scour more severely because of the physical condition of the material.

The preparation and maintenance of the hy-

pochlorite solution within the controlled pH range are conveniently effected by the addition to a suitable hypochlorite solution, e. g. sodium or calcium hypochlorite, of a salt having the required buffer characteristics. More particularly, we have found that excellent results can be achieved by the addition of sodium bicarbonate in sufficient quantity to a hypochlorite solution. For example, in preparing the initial bath it is convenient to dilute strong stock solutions of bleaching powder and of sodium bicarbonate with such a quantity of water as will yield a liquor of the required strength of available chlorine and of buffer salt. As an example a suitable liquor of wide range of applicability contains before use between 2.5 and 3.5 grams per litre available chlorine and about 8 grams per litre of the bicarbonate. Such a liquor is substantially neutral, the precise pH value depending on a number of factors including the alkalinity of the stock bleaching powder liquor and the quality of the water which is used for its preparation. As a further guide to the amount of buffer salt necessary to keep the liquor in the required substantially neutral pH range we have found it advisable when making a liquor of a strength 1.5 grams per litre available chlorine that there should be added at least 3 grams per litre sodium bicarbonate; for a liquor of 3 grams per litre available Cl_2 at least 5 grams per litre sodium bicarbonate; and for a liquor of 5 grams per litre available Cl_2 at least 8 grams per litre sodium bicarbonate.

To obtain bleached material with a minimum degree of chemical degradation we have found that the concentration of the neutral hypochlorite liquor should not be higher than 4.5 to 5.0 grams of available chlorine per litre when treating material scoured in a normal manner. We have also found that with an available chlorine concentration of less than about 1.5 grams per litre, satisfactory results cannot easily be obtained.

For the attainment of whiteness, the time and temperature at which the hypochlorite bath can be used are not unduly critical, and we do not find it necessary to pay any marked attention to the color which is achieved solely by treatment with the neutral hypochlorite, as the subsequent steps of the process can be operated to furnish the desired whiteness.

It is, however, necessary to have regard both to time and temperature and to a number of other variable conditions when the minimum degree of chemical degradation is desired in conjunction with a high degree of whiteness.

One of these conditions is the presence of light during the treatment of the goods with the neutral hypochlorite solution. It is one of the features of the present invention that this treatment is carried out with the substantial exclusion of actinic rays. For most purposes this can be achieved by the screening of the vessels in which the hypochlorite treatment is carried out, in such a manner as to prevent the access of bright light, such as direct sunlight, to the goods undergoing treatment. As an example of the permissible light in the treatment of linen, we may instance the use of a normal electric light bulb of 60 c. p. placed not less than about 6 feet from the material undergoing treatment.

Another of the conditions is the pretreatment of the material before the hypochlorite. As previously stated an essential condition of the material is that it shall be capable of being rap-

idly impregnated by the hypochlorite solution in a thorough and uniform manner. This condition may be achieved by a mild treatment, e. g. with an aqueous solution of a wetting agent, or by a severe one, such for example as a boil in an alkaline solution. Goods treated by either of these extremes or by any treatment of intermediate severity, can be effectively treated with the neutral hypochlorite in such a manner as to avoid a marked increase in solubility number. This is most conveniently illustrated with reference to linen. In scouring an unbleached linen, various degrees of severity can give varying losses in weight up to about 25 per cent. We have found that it is desirable to adjust the severity of the conditions of the hypochlorite treatment roughly inversely as the severity of the scour. Thus, when treating linen from which 25 per cent of the weight had been removed by scouring, we should use a neutral hypochlorite solution containing say 1.5 grams of available chlorine per litre, while a solution containing 4.5 to 5.0 grams per litre available chlorine could be used on material from which practically no impurities had been removed. In addition, it will of course be evident that factors other than the concentration of available chlorine determine the severity of the hypochlorite treatment, notably the temperature and the time of treatment. With regard to the temperature we find that it is undesirable at any time to apply a neutral hypochlorite solution to cellulosic materials at temperatures higher than about 20° C. if undue chemical degradation is to be avoided. Advantageously we use a temperature in the neighbourhood of 15° C. The time of treatment is, however, variable within very wide limits and is to a large extent adjustable with reference to the strength of the solution. Thus with a weak solution the time of treatment may be longer than with a stronger one. A considerable amount of care in the control of the time with the stronger solutions is necessary, and in this connection it must be remarked that we find it advantageous not to use a longer time than about half an hour when treating goods with neutral hypochlorite solutions containing more than 3 grams available chlorine per litre. With liquors containing 1.5 grams available chlorine per litre, we have treated goods for four hours with satisfactory results.

At this stage it is desirable to make reference to a detail of operating procedure which may have great practical importance in the avoidance of chemical degradation, and the attainment of perfectly even treatment of the goods. There are two main methods of treating textiles with liquids. In one the material is totally immersed and in the other it is partly immersed, e. g. by being suspended from a rotating reel as explained below. In the former method used with a neutral hypochlorite solution, we find it essential to have a weaker solution than with partial immersion for the same time of treatment. Also, in a partial immersion treatment it is imperative to have a uniform and thorough circulation of the liquor through the goods, or the goods through the liquor. An example of the latter method is the practice of "reeling" yarn. In this method hanks of yarn are suspended on rotating arms of wood or other material, so that the lowest portion of the hank dips into a volume of liquor while the hank constantly rotates. The speed of rotation and the depth of immersion have a considerable influence on

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the amount of liquor carried out by the yarn, and with rapid rotation the reeling treatment approximates to an immersion of the hank. This fact must be borne in mind when adjusting the severity of the hypochlorite treatment when working in this manner. Thus the more rapid the rotation the more should the severity of the treatment be reduced to approach that used with complete immersion of the yarn.

The above description has had reference to a neutral hypochlorite solution as prepared initially from fresh materials. It is, however, equally applicable to liquors which have been previously used and replenished. During the first application of the liquor the available chlorine concentration naturally falls and it is also found that the liquor tends to become slightly more acid. At the conclusion of the operation its pH value may then be in the range 6.0 to 7.0, which is still substantially neutral. For the treatment of a further batch of material it is now only necessary to add such a quantity of a strong hypochlorite solution as will bring the available chlorine content to the desired figure, and a quantity of a stock sodium bicarbonate solution dependent on the hypochlorite added. For example, a weight of sodium bicarbonate equal to the weight of the added available chlorine has been found to give satisfactory results. We have found that these additions make no substantial alteration to the pH value of the liquor, and this is equally true of subsequent additions over a considerable number of successive usages and replenishings of the bath.

In preparing the neutral hypochlorite solution we have up to the present referred only to the use of sodium bicarbonate as the buffer salt having the required characteristics. We have done this as we prefer to use this salt on account of its cheapness and general convenience. The invention is, however, not restricted to the use of this material and may, if desired, be operated using other substances for the adjustment of the liquor to the required stabilised condition of substantial neutrality. Other salts which may be used to maintain the required condition are alkali metal phosphates and borates. It is also to be noted in this connection that throughout the specification when we refer to substantial neutrality we do not restrict ourselves to the precise neutral point but to a region within approximately one unit above and below 7 on the pH scale. We have, for example, obtained very good results when using hypochlorite liquors which, when tested by means of the glass electrode, have shown pH values of 6.1, 6.4, 6.9, 7.4, and 7.8. More particularly have we obtained excellent results in the region of pH 6.5.

Following the hypochlorite treatment we have found it desirable to rinse the goods with cold water and then to sour. This latter step is of importance in the treatment of linen goods, and is of effect for dealing with the woody fragments of the plant remaining in the yarn after spinning, and commonly known as "sprit." The sour should preferably be applied cold and may be of any strength normally applied to cellulose fibers. We have found satisfactory a liquor containing about 0.5% HCl applied for half an hour. Sulphuric acid may be used but it is better to use a hydrochloric acid sour when the hypochlorite bath has been made up from bleaching powder. The risk of calcium sulphate remaining on the fibre due to its relatively low solubility is thereby avoided.

After the sour the goods are thoroughly washed in cold water and then treated in an alkaline solution and with an oxidising bleaching agent. This treatment may comprise two stages such as a plain treatment at an elevated temperature with an alkaline solution, followed by hydrogen peroxide solution. Advantageously, however, we combine the alkali and oxidising bleaching treatment by using an alkaline solution containing hydrogen peroxide.

The hydrogen peroxide bath may be made up in the normal manner from any source which will give hydrogen peroxide in solution. This may be done by dissolving sodium peroxide in water, or in an amount of dilute acid which is sufficient to give complete or partial neutralization, depending on the degree of alkalinity desired in the peroxide bath. In the event of the peroxide being completely neutralized, a suitable alkaline material is then added to put the liquor into bleaching condition. We may also make further additions to the peroxide solution, as, for example, to stabilize or maintain a desirable condition of alkalinity. Such additions include, for example, silicates and calcium and magnesium salts.

Alternatively, the peroxide bath may be prepared by diluting a strong hydrogen peroxide solution with water and adding a suitable alkali. Other additions as have been mentioned in connection with the bath made from sodium peroxide may also be made.

In co-pending British application 18,009/37 which particularly describes the use of a hydrogen peroxide liquor containing sodium carbonate in processes of the present type, there is described a further method of preparation by dissolving sodium peroxide and sodium bicarbonate in the requisite quantity of water.

The concentrations of the alkali and peroxide in the liquor are capable of being varied within very wide limits, while still enabling very good whites to be attained. It will be evident, however, that there are minimum values below which results of commercial value are not obtained, and for this reason we find it desirable to use liquors having an alkalinity equal to or greater than 0.15 per cent Na_2O and a peroxide content equal to or greater than 0.05 per cent H_2O_2 . The upper limits of the concentrations are influenced by the desirability of avoiding undue attack on the material and in the case of the peroxide economic considerations are also of importance. While in many cases the upper limits set out below may be exceeded, yet we prefer when a caustic alkali is present in the liquor that the total alkalinity should not be equivalent to more than 0.4 per cent Na_2O . Having in mind only the desirability of avoiding undue chemical degradation of the cellulose, the peroxide may be used in a concentration up to about 1 per cent H_2O_2 . The figure is, however, very much more than is normally permissible by economic considerations, and for these reasons it is best not to exceed a concentration of about 0.2 per cent H_2O_2 . The other factors which it is necessary to consider in this treatment are temperature and time. If the attainment of a degree of whiteness is the sole consideration then there is no necessity for a strict control of these conditions, and the treatment may be at any temperature up to boiling point for a time which gives the highest shade of white with the liquor being used. We have found, however, that in the peroxide treatment as in the hypochlorite treatment, control of the conditions

is necessary to preserve the qualities of the material. For this reason we prefer to observe a temperature maximum of 85° C., and in general find that we can obtain good whites by treatments at between 65° and 75° C. for three hours with liquors of the limits of compositions set out above.

As is well known, textile materials are capable of being bleached to different shades of white. In the case of linen there are generally recognised the shades known as half-white, three-quarter white, and full white. We have found that with normal qualities of linen yarn a half white stage can be attained with the following series of operations carried out in accordance with the general principles laid down above:—(a) scour and wash, (b) treat with neutral hypochlorite solution, rinse, sour and wash, (c) treat with alkaline peroxide. If the half white is the shade required the material will now be washed, finished as desired, and dried. If, however, higher shades of white are desired it is only necessary to apply one or more treatments with hypochlorite liquors and alkaline liquors alternately as required. These treatments may be carried out with neutral hypochlorite solutions and alkaline peroxide solutions in which case they will be on the same general principles as already set out but with reduced severity. On the other hand, alkaline hypochlorite liquors and alkali scalds may be used in accordance with well known practice.

In the foregoing we have described in considerable detail the special characteristics of the fundamental steps comprising the invention. We have not thought it necessary to describe methods whereby the particular liquors can be applied to textile materials as these will be apparent to those having a knowledge of the processing of textile materials. Neither have we thought it necessary to draw attention to those elementary precautions which are well known to bleachers and others dealing with cellulosic fibers, and which are necessary to prevent damage when treating such fibers with acids and alkalies.

The following examples illustrate but do not limit the invention.

Example I

570 lbs. of linen yarn were scoured for three hours at about 65° C. in 800 gallons (imperial gallons) of liquor containing 45 pounds soda ash, and then washed. The hanks of yarn were then transferred to a reeling machine and treated for thirty minutes in a neutral hypochlorite solution at 14° C. in subdued light. For this operation 900 gallons of liquor were used containing initially 3.5 grams per litre available chlorine and having a pH value 6.5. The liquor was prepared from a batch which had been previously used several times in similar operations, by adding a stock solution of bleaching powder to give the desired content of 3.5 grams per litre available chlorine, and a stock solution of sodium bicarbonate. The ratio of these stock solutions was such that about equal weights of available chlorine and sodium bicarbonate were added. During the reeling the direction of rotation was reversed several times, and throughout the operation approximately 15 inches of each hank were immersed in the liquor and the linear speed at which the hanks were moving through the liquor was six feet per minute. At the conclusion of the operation the hypochlorite liquor was run off rapidly and the yarn was immediately rinsed in three changes of cold water in the same machine. It was then removed from the machine

and soured for half an hour in cold 0.5 per cent hydrochloric acid and washed.

An alkaline peroxide bath was prepared by dissolving 18 pounds of sodium peroxide in 700 gallons of water containing 20 pounds 168° Tw. sulphuric acid, and then adding 4 gallons of 84° Tw. sodium silicate solution. The yarn was heated in this bath for 3 hours at 65° C. and was then washed off and dried.

The dried yarn was a good half white and weighed 510 lbs. Tests were made on the solubility number and strength of the yarn before and after bleaching, and the following results were obtained:

	Solubility No.	Strength
Brown yarn.....	2.9	Ounces 37.7
Bleached yarn.....	3.8	34.6

Example II

The hypochlorite liquor for this example was prepared by adding to 720 gallons of water 60 gallons of a stock bleaching powder solution containing 4.5 per cent available chlorine and 100 gallons of a solution containing 90 pounds of Na₂HPO₄. After mixing thoroughly the pH value was adjusted to 6.8 by the addition of a small amount of caustic soda solution.

The peroxide liquor was made up as in Example I.

The bleaching was carried out in a very similar manner to that described in Example I. A batch of linen yarn was scoured in a liquor containing 10 per cent soda ash on the weight of the yarn for 2½ hours at 65° C. and thoroughly washed. The scoured yarn was then reeled in the hypochlorite liquor for 30 minutes at 15° C., rinsed in cold water, soured in 0.5 per cent HCl for 15 minutes and washed. It was then bleached in the peroxide liquor for 2½ hours at 65° C., washed off and dried. The yarn was somewhat better than a half white and had a solubility number 3.7.

Example III

This example is illustrative of the bleaching of linen yarn to the full white stage.

A batch of yarn was treated precisely as in Example I but was not dried at the finish. Instead it was immersed for 30 minutes in a neutral hypochlorite liquor containing 0.5 gram per litre of available chlorine and 1.5 grams per litre of sodium bicarbonate. The temperature was 15° C. The yarn was then washed and again bleached for 3 hours at 65° C. in a peroxide liquor made up in a similar manner to the previous one but using only half the quantities of peroxide and acid. After washing, another immersion in neutral hypochlorite was given for the same time and at the same temperature, but using a liquor containing only 0.35 gram per litre of available chlorine. Finally the goods are washed, given an antichlor in 0.1 per cent sodium thiosulphate, washed off and dried. The full white yarn had a solubility number of 4.1.

Example IV

For this example showing the bleaching of hemp, a neutral hypochlorite liquor was made up precisely as in Example I, and of the same strength. The peroxide liquor was prepared by diluting strong hydrogen peroxide solution with

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water to give a liquor containing 0.1 per cent H_2O_2 and adding alkali. For each 100 gallons of bath there were used as alkali 1 gallon of 60° Tw. sodium silicate and 2½ pounds caustic soda.

- 5 Hemp yarn was scoured in a 0.5 per cent solution of caustic soda at 70° C. for three hours and washed. It was then reeled as in the previous examples in the neutral hypochlorite for 30 minutes at 15° C., rinsed, soured and washed in cold
10 water. The bleaching in the peroxide bath was carried out for 3 hours at 65° C. and the yarn washed off and dried. The color was three-quarter white and no sprit was observed.

Example V

- 15 This example is illustrative of the bleaching of a 50 per cent flax-jute mixture yarn. For the make up of 900 gallons of neutral hypochlorite liquor there were used 60 gallons of a stock
20 bleaching powder solution containing 4.2 per cent available chlorine and 45 gallons of a sodium bicarbonate solution containing about 10 per cent $NaHCO_3$. The peroxide solution was made up precisely as in Example IV, and of the same
25 strength.

- The yarn was first scoured in a 1 per cent solution of caustic soda at 60° C. for three hours and washed. It was then reeled in the neutral hypochlorite for thirty minutes at normal temperature, washed, bleached in the peroxide liquor
30 for 2½ hours at 65° C., washed off and dried.

Example VI

- 35 For this example which is illustrative of the bleaching of cloth, the same general methods of preparing the hypochlorite liquors were used as are described in Examples I, III, IV, and V, while the peroxide baths were prepared similarly to those in Examples IV and V.

- 40 The series of operations used were as follows: Scoured twice in soda ash solution for 5 hours at 75° C. For the first scour the liquor contained 4.5 per cent soda ash on the weight of the goods, and for the second 3.5 per cent. Washed, treated
45 in a neutral hypochlorite liquor containing 1.5 grams per litre of available chlorine for 4 hours at normal temperature, rinsed, soured in 0.5 per cent HCl and washed. Bleached for 5 hours at 75-80° C. in a peroxide liquor containing 0.1
50 per cent H_2O_2 , rinsed, soured and washed. Treated in neutral hypochlorite containing 0.5 gram per litre of available chlorine for three hours cold, washed, soured and washed. Bleached
55 in peroxide liquor as before, rinsed, soured and washed. Treated in neutral hypochlorite containing 0.3 gram per litre of available chlorine, washed, antichlored, and washed off.

- In the above examples we have used only bleaching powder as the material from which
60 to prepare the hypochlorite liquors. We could have prepared the liquors from other hypochlorites which are commercially available, e. g. high strength calcium hypochlorite, basic calcium hypochlorite and sodium hypochlorite. We could
65 also have used potassium hypochlorite.

- For the maintenance of the desired condition of substantial neutrality of the hypochlorite solution we could have used instead of the sodium bicarbonate and phosphate which are illustrated,
70 other salts which have a buffering action in the range desired, e. g. the corresponding potassium salts. We could also have used sodium or potassium borates.

- As many apparently widely different embodiments of this invention may be made without

departing from the spirit and scope thereof, it is to be understood that we do not limit ourselves to the specific embodiments thereof, except as defined in the appended claims.

We claim:

1. In bleaching linen and like relatively long bast fibers to obtain a bleached material having a solubility number less than 5 and a whiteness of at least half white by a two-stage bleaching operation using hypochlorite primarily and hydrogen peroxide secondarily, the improvement which
10 consists in first contacting the unbleached material with a substantially neutral hypochlorite solution having a pH value between 6 and 8 and containing between 1.5 and 5 grams per liter of
15 available chlorine together with a sufficient amount of a buffer compound to maintain the pH value within the stated range during the period of contact, the contact being at a temperature not exceeding 20° C. during the operation
20 and for a time sufficient to attack and remove most of the coloring and non-cellulosic constituents of said material but insufficient to materially deteriorate the bast fibers, and thereafter contacting the so treated material with an alkaline
25 solution of hydrogen peroxide until a bleached bast fiber having a solubility number less than 5 and a whiteness of at least half white is obtained.

2. The process of claim 1 wherein the pH value of the hypochlorite solution is maintained between pH 6.3 and 6.7.

3. The process of claim 1 wherein said buffer compound is sodium bicarbonate.

4. The process of claim 1 wherein the bleaching with said hypochlorite solution is effected at temperatures between 14° and 20° C. and the bleaching is continued for from one-half to four hours.

5. The process of claim 1 wherein the unbleached material is preliminarily treated with a wetting-out agent to facilitate uniform penetration of the said hypochlorite solution.

6. The process of claim 1 wherein the unbleached material is wetted and scoured with an aqueous solution of sodium carbonate prior to the contacting with hypochlorite solution.

7. The process of claim 1 wherein the unbleached material is preliminarily scoured at temperatures of 65° to 85° C. for 2 to 3 hours with a scour containing 5 to 10 per cent sodium carbonate on the weight of the goods.

8. As an improvement in bleaching linen yarn, the improved process which comprises scouring the linen yarn with dilute aqueous soda ash solution containing 5 to 10 per cent sodium carbonate on the weight of the yarn at about 65° C. for 3 hours, washing the so-scoured yarn, reeling the yarn in a neutral hypochlorite solution having a pH of 6.5 and initially containing 3.5 grams per liter of available chlorine and 3.5 grams of sodium bicarbonate, at 14° C. in subdued light for 30 minutes, drawing off the hypochlorite liquor, rinsing the so-bleached yarn with cold water, souring the rinsed yarn with cold 0.5 per cent hydrochloric acid for one-half hour, washing the so-soured yarn and then bleaching the so-treated yarn with an alkaline peroxide solution at 65° C. for 3 hours, and washing the so-bleached yarn to remove residual bleached liquor, thereby obtaining a bleached linen yarn having a whiteness corresponding to one-half white and having a solubility number less than 4.

9. The process of claim 8 wherein the half-white linen yarn is further bleached to a full

white by immersing such yarn in a neutral hypochlorite liquor containing 0.5 gram per liter of available chlorine and 1.5 grams per liter of sodium bicarbonate at 15° C. for 30 minutes, washing the so-treated yarn, next bleaching the washed 5 yarn in an alkaline peroxide liquor at 60° C. for 4 hours, washing the so-bleached yarn, again immersing the washed yarn in neutral hypochlorite

solution containing 0.3 gram per liter of available chlorine, washing the so-bleached yarn, treating the washed yarn with 0.1 per cent solution of sodium thiosulfate as an antichlor, washing and drying the yarn, to obtain a yarn having a solubility number of 4.1 and having a full white color. 5

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