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BLEACHED CELLULOSIC PRODUCT

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This relates to an improved cellulosic product in the nature of pulp which has been thoroughly digested in a suitable way and then bleached in a particular manner. The new product is highly suitable for the manufacture of various kinds of papers, parchments, cellulose specialties, transparent cellulose films, viscose, artificial silk and similar articles or substances containing cellulose or its derivatives. It possesses certain improved characteristics which impart to articles of the type mentioned certain desirable qualities and characteristics not obtainable prior to our invention.

The improved product of the present invention may be produced by the processes disclosed in our pending application Ser. No. 487,758, filed October 10, 1930, for Process of bleaching fibrous cellulose material, now Patent No. 1,957,937 and Ser. No. 579,896, filed December 9, 1931, for Bleaching process, now Patent No. 1,957,938. This application is a continuation in part of said prior cases.

Reference may be had to our prior applications for a full disclosure of the processes by which our improved products may be produced. For the purposes of this application these processes need be but briefly explained.

The material to be bleached, according to our methods, is a thoroughly digested pulp derived from any suitable source, such as wood. While the fibers of the material may be liberated by any of the well-known processes, such as the soda, sulfite or sulfate processes, the improved characteristics are developed to a particularly marked degree in a product obtained by the bleaching of pulp produced by the kraft or sulfate process from coniferous woods. Ordinarily pulps of this character are so difficult to bleach for the production of white paper or other white cellulosic products that attempts to produce a bleached kraft pulp have proved prohibitively expensive. Furthermore, the severity of the treatment required according to prior bleaching processes has been such that the physical and chemical character of the pulp has been seriously modified and the resulting product has not been useful for many purposes. Our bleaching methods, on the other hand, are capable of converting the normally dark brown kraft pulp into a white product which is not appreciably deteriorated and, in fact, is improved in many respects. This has made it possible to derive the full benefit of the desirable characteristics of kraft pulp in products in which a fully refined, white pulp is required. It has not been possible, for example, prior to the development of our improved methods, to obtain a white pulp having the long fibers characteristic of kraft pulp and having a high alpha cellulose content. Our methods, however, make it possible to effectively and economically bleach kraft pulp to produce a white product without destroying the fiber length of any of the other desirable physical and chemical characteristics of the original kraft. The original high alpha cellulose content is substantially retained without subjecting the material to a special treatment, such as a drastic caustic soda treatment after bleaching. In fact various characteristics of the pulp are improved by our bleaching treatment.

In the bleaching of kraft or other forms of pulp, according to our methods, the pulp should first be reduced to a desired physical state for a rapid and vigorous reaction with gaseous chlorine. For this purpose a large part of the water carried by the pulp as it is delivered from the mill is first removed in some convenient manner, as by squeezing the pulp in a screw press or in a variety of other ways, as explained in our patents. Air is also removed from the pulp and the fibers are expanded so as to present a vast number of more or less evacuated cells. Therefore, when the pulp is subjected to the action of gaseous chlorine, the fibers are substantially dry, the mixture having preferably only between 60 and 70% water and between 30 and 40% dry fibers, or in any event more than fifteen percent (15%) dry fibers, the water being principally distributed over the interior and exterior surfaces of the walls of the fibers and the latter being expanded and largely evacuated for the ready reception of the gaseous chlorine. If desired, prior to, or in the course of, the production of the pulp in this particular state, it may be impregnated with a suitable quantity of an alkali, such as caustic soda, capable of reacting with the chlorine, when the latter is introduced, to provide active bleaching agents in the nascent state throughout the stock. Now, as the chlorine is introduced into the vessel containing the substantially dry, alkalized, expanded, and evacuated material, it penetrates instantly into all portions of the material and reacts in part directly with the coloring matters to be removed and in part with the alkali to produce a nascent bleaching agent to attack the coloring matters. Within but a few minutes, a relatively thorough bleaching action may be effected in this way.

The subsequent treatment of the material may vary according to the particular use for which the

pulp is intended. If it is desired to produce a high grade of paper, for example, the material, after a single chlorination, may first be washed to remove remaining traces of chlorine and then subjected to the action of sulfur dioxide and washed again for the purpose of removing products of the chlorination that are not directly soluble in water. This partly bleached and partly purified material may then be subjected to further bleaching by an ordinary bleaching liquor treatment, as set forth in our Patent No. 1,957,937.

In lieu of the subsequent treatment above specified, the material, after the first chlorination, may simply be washed with water or a solution of caustic soda or similar alkali and then restored to the same state of dryness and evacuation previously explained and subjected to a second chlorinating treatment of the same type. If desired this operation may be repeated again and the material subjected to a third chlorination of the same character. When the pulp has attained the desired degree of whiteness, it may then be thoroughly washed. If desired, the washing treatment may be supplemented by a treatment with sulfur dioxide. This multi-stage treatment is more fully set forth in our Patent No. 1,957,938. The product resulting from this treatment is exceptionally well suited for the manufacture of viscose silk. For further details as to the conduct of the processes, reference should be had to the two patents mentioned.

It will be found that the product resulting from either of these treatments, and particularly when kraft pulp is used, is characterized by an extreme purity, freedom from ash and oxycellulose, a low beta and gamma cellulose content, an extremely high white color, great strength, high absorbency, high alpha cellulose content, and a capability of producing a constant and high viscosity, viscose solution. The advantageous fiber length of the original pulp is retained so that an exceptionally strong sheet of paper may be produced. At the same time the pulp is highly porous so that water may readily be drained through and from it as it is formed into a mat or sheet on a paper machine. This freeness or porosity, however, does not interfere with the removal from the water, by the fibers, of suspended colloids or solids used as fillers or in the sizing of the paper produced from the pulp. While the pulp is essentially soft and pliant, it is readily adaptable to impregnation with size and similar substances for the manufacture of a stiff paper having rattle and great strength. By virtue of these characteristics, it is possible to manufacture from the improved pulp extremely thin sheets of paper with even texture or formation and extremely high white color and strength. Papers produced from the pulp have an improved opacity as compared with other papers without fillers or having the same quantity and character of filler. The surfaces of a sheet produced from the pulp are smooth and may be highly polished. The ink receptivity of the product is exceptionally good and the paper is such that coating materials may be readily applied and evenly distributed over the entire surface.

In the manufacture of specialties, the pulp will be found to be extremely soft and fluffy, highly porous and extremely absorbent. Due to the extreme purity of the pulp, the products produced from it are resistant to decay over long periods of time and resistant to the destructive chemical reaction of the substances normally used in the manufacture of paper and other cellulose derivatives. When the improved pulp is used in the manufacture of artificial silk, it will be found to produce a viscose solution of extremely high viscosity capable of forming a strong filament, film and fabric. The bleached pulp will be found to produce at least as great a viscosity in the viscose solution as the unbleached material. Furthermore, the viscosity does not vary as it does when the ordinary types of pulp are employed. It is significant in this connection that our new product can be converted into viscose with only 30 to 40% of the quantities of sodium hydroxide and carbon bisulfide usually employed. Due to the purity of our product, it is possible to produce a pure viscose solution from which silk may be made that is so pure that the usual dyeing difficulties encountered in the use of other pulps are not met with. Our improved product lends itself readily to parchmentizing, waxing, or impregnation with oils, size, latex and the like, so that a paper sheet or card may be highly and evenly impregnated with these substances to produce a product free from defects. This is particularly desirable in the production of electrical insulating papers where an even dielectric resistance is of paramount importance.

In the treatment of unbleached kraft pulp by our processes, it is possible to produce a thoroughly bleached pulp containing more than 89% of alpha cellulose. Prior to the development of our process, it has been impossible to produce a bleached kraft pulp having an alpha cellulose content of more than 85%, without subsequent treatments. The percentage of alpha cellulose in a given batch of pulp may be increased by a drastic caustic soda treatment but this merely removes a portion of the beta and gamma cellulose, which is thus wasted. In other words, the increase in the alpha cellulose content is at a sacrifice of a portion of the total product. According to our processes, however, a high alpha cellulose content is brought about without sacrifice of any of the product. The significance of this may be made more clear from a consideration of the fact that pulp as ordinarily produced by the kraft process will have an alpha cellulose content of about 90%. Our bleaching processes will have little or no effect upon this content and will at most reduce it about 1%, or to 89%. The method of our earlier Patent No. 1,957,937, will generally have a slightly greater effect, in this respect, than the later method. For some reason, which we will not attempt to explain, our bleaching methods appear simply to convert a portion of the beta cellulose into gamma cellulose while prior processes tend to convert alpha cellulose into beta and gamma cellulose. As a result of this peculiarity of our processes the final, bleached product will be found to have a lower beta cellulose content than the original unbleached pulp, without subjecting the material to any special treatment for this purpose after the bleaching. So far as we know, the products of other bleaching processes are invariably higher in their beta cellulose content than the original unbleached stock. Furthermore, our processes have no tendency to increase the oxycellulose content of the pulp so that the bleached product, particularly when bleached simply by a series of chlorination treatments, will have no more oxycellulose than the original unbleached material.

An appreciation of the advantages of our product as compared with prior products may be obtained from a consideration of the fact that other

bleaching processes, and particularly the bleaching liquor processes, tend to reduce the alphacellulose content of the original stock by degradation, to the extent of 7 to 9%. Therefore, assuming that we start with a raw material having an alphacellulose content of 90%, our processes will provide a bleached product having an alphacellulose content of about 89%, or even more, whereas prior bleaching methods will ordinarily result in a product having an alphacellulose content between 81 and 83%. Now, if an attempt is made to increase the alphacellulose content of these products of prior bleaching methods by drastic caustic soda treatments, an appreciable percentage, i. e. 7 to 9%, of the total stock must be sacrificed and at the same time the physical and chemical character of the material is changed. These changes, for example, make it difficult to obtain a uniform product, particularly from the standpoint of providing a constant viscosity viscose solution. Different batches of the material, having apparently the same alphacellulose content, will be found to provide quite different viscosity characteristics in viscose solutions. Furthermore, the drastic caustic soda treatment seems to seriously affect the strength of the fibers and of the paper products produced therefrom. It is extremely difficult to develop beaten strength in high alpha pulp obtained by the caustic soda treatment of the bleached products of other processes. In contrast with this the products of our processes are capable of developing a high beaten strength in spite of their relatively high alphacellulose content.

The color of the product resulting from our processes as applied to kraft pulps has been found to be as high as 81 on the Hess-Ives tintometer. It is to be understood that we refer here to the color of the bleached product without any special subsequent treatment, such as a drastic caustic soda treatment or the like. Prior to our methods it has been considered impossible to bleach a kraft pulp to this degree of whiteness.

A rather remarkable characteristic of our products is that upon ignition of the bleached material, it will be found to contain less than .1% of ash. In fact if the bleaching is conducted in accordance with our Patent No. 1,957,938 the ash content may be as low as .06%. So far as we know, no one prior to the development of our processes has succeeded in producing a bleached pulp with an ash content below .1%. A possible explanation for our low ash content is the development in our process of a relatively concentrated hydrochloric acid solution which tends to dissolve a large portion of the ash-producing ingredients normally remaining in other pulps. It is to be noted in this connection that the hydrochloric acid developed in our processes does not remain in contact with the fibers for a sufficient length of time to do any appreciable harm to the pulp but at the same time the contact is sufficient to remove the ash-producing ingredients.

Returning now to a consideration of the beaten strength developed in our product, it will be understood that unbleached pulps produced by the sulfite and kraft processes are ordinarily capable of producing a relatively strong sheet upon proper beating treatment. However, so far as we know, no bleached kraft product prior to ours has been capable of developing a higher beaten strength than the unbleached kraft subjected to the same character of beating treatment. It is recognized, of course, that different beating treatments tend to develop different degrees of strength but if the same treatment is applied to the unbleached as to the bleached material, it will be found that the bleached product of prior processes develops less strength than the unbleached material. By way of example, samples of unbleached and bleached kraft pulps (the bleached pulp having been treated by the process of our Patent No. 1,957,937) were subjected to the same beating treatments carried out substantially as follows: A beater of the Valley Iron Works Company, Niagara laboratory type, having a capacity of 1½ lbs., modified to hold, when running, 29 to 31 litres of pulp slush, was used. A weight of 20 lbs. was applied to the lever arm to create a pressure between 25 and 30 lbs. on the bed plate. The hard naval bronze roll was operated at a speed of 500 R. P. M. or 1000 lineal feet per minute at the circumference. Into this beater was first introduced 675 grams of bone-dry fiber of the unbleached kraft pulp in a 2.25 per cent suspension. This was beaten by the operation of the roll at the speed indicated for a period of 130 minutes. Samples were taken from the beater at 15 minute intervals and formed into a hand sheet of paper of a standard basis weight of 60 pounds for 480 sheets of 24" x 36". The sheet as formed was squeezed between blotters for one minute under a pressure of 123 lbs./sq. in. of the sheet, then dried at 100° C. and conditioned for 24 hours at 65% humidity and 70° F. This sheet was then subjected to a Mullen pop test and the readings taken as to the pressure per square inch required to burst the sheet. From this a computation was made as to the per cent points per pound obtained by dividing the pressure noted by the basis weight of the sheet and multiplying the result by 100. The computed results of these tests upon the different pulps were as follows.

Mullen bursting strength of kraft pulps

Beating interval, minutes	Before the bleaching procedure, per cent points per pound		
	1	2	3
0	34.0	40.0	42.0
25	85.0	85.0	87.0
40	106.0	107.0	110.0
55	120.0	120.0	128.0
70	129.5	135.0	140.0
85	137.5	140.0	145.0
100	141.5	141.0	147.5
115	141.0	140.5	147.5
130	140.5	139.0	145.0

In a similar way three separate samples of 675 grams of bone-dry fiber in a 2.25% pulp suspension, derived by the bleaching of quantities of the same raw stocks tested as above explained and each subjected to one chlorination treatment followed by a hypochlorite treatment in accordance with our Patent No. 1,957,937, was introduced into the same beater and subjected to the same beating action as the unbleached stock. Samples were withdrawn at 15 minute intervals, as indicated above, and hand sheets of the same basis weight, i. e. 60 lbs. of 480 sheets 24" x 36", were made therefrom, dried and conditioned as before and subjected to the Mullen pop test. The computations from these readings in terms of per cent points per pound for the three pulps are as follows:

Mullen bursting strength of kraft pulps

Beating interval, minutes	After the bleaching procedure, per cent points per pound		
	1	2	3
0	46.0	40.0	47.0
25	112.5	95.0	109.0
40	136.0	119.0	125.0
55	150.0	135.0	137.0
70	160.0	147.5	149.0
85	165.0	153.0	157.0
100	167.5	151.5	171.0
115	167.5	148.0	163.0
130	165.0	145.0	160.0

From the foregoing it will be noted that the maximum strength of 147.5 of the unbleached pulp (No. 3) was developed after 100 minutes of the beating treatment and the maximum strength of 171.0 of the bleached pulp derived from the same source was similarly developed after 100 minutes of the beating treatment. On the other hand, pulp No. 2 developed its maximum beaten strength of 141.0 for the unbleached material after 100 minutes while the corresponding bleached sample developed a maximum strength of 153.0 after only 85 minutes.

Simultaneously with the beaten strength data set forth above, tests as to the freeness of the pulp taken from the beater at each 15 minute interval was made upon a Canadian standard freeness tester. In these tests a liter of a .3% suspension of pulp at 20° C. was introduced into the cylinder of the tester. The freeness tests upon the unbleached and bleached materials gave the following data, the figures specified being the quantity of water that drained through the side discharge of the funnel:

Canadian standard freeness of kraft pulps

Beating interval, minutes	Before the bleaching procedure			After the bleaching procedure		
	Cubic centimeters drainage			Cubic centimeters drainage		
	1	2	3	1	2	3
0	750	725	750	735	750	740
25	675	675	700	650	678	640
40	590	635	640	550	610	520
55	475	585	540	410	505	385
70	337	520	420	250	377	275
85	225	410	305	125	260	205
100	135	286	200	100	198	160
115	75	200	150	75	125	125
130	50	130	125	70	100	105

It will be noted from the foregoing data that the freeness of the bleached pulp at its maximum developed strength is at least a hundred and in two of the three instances was considerably higher. Pulp showing a freeness of 100, by this test, is quite satisfactory for the manufacture of the better grades of paper. This characteristic of our product is of particular importance since, as is well recognized in the paper industry, there is frequently a limitation upon the beaten strength that may be utilized on account of the slowness of the pulp when this strength is attained.

By way of comparison tests have been conducted upon kraft pulp bleached by a hypochlorite bleaching process to determine its beaten strength and freeness by the same methods explained above. The results of these tests were as follows:

	Mullen	Freeness
0	12	775
25	55	675
40	74	550
55	85	400
70	90	275
85	87	170
100	65	85

In the determination of the absorption characteristics of our new product, suitable tests were conducted with reference to the bleached product itself and the unbleached, raw stock employed in our processes.

There are two primary factors involved in absorbency, i. e. the rate of absorption and the quantitative ability to absorb. The rate at which liquids, such as oil and water, will spread over the surface of a sheet of the pulp or the rate at which such liquids will penetrate into a block of the pulp may be determined by the following simple test:

One drop of colored water is delivered from a 50 cc. burette upon a double thickness of tissue sheet, each sheet being 10 pounds basis weight (480 sheets of 24" x 36") after conditioning at 65% relative humidity. The materials used for the test are held at 65° F. The sheets are placed one over the other and supported on a ring 1.5 inches in diameter. The liquid is dropped onto the sheets at substantially the center of this ring. A reading is taken of the time in seconds for the drop to spread to a diameter of one inch. This is an index of the rate of absorbency of the pulp.

Our bleached kraft pulp takes from 0.5 to 1.5 seconds to spread out one inch.

The unbleached kraft pulp, from which this pulp is made by our process, ordinarily takes from 2 to 4 seconds to spread out to the same exent. We are not unfamiliar with unbleached kraft pulps taking less than 2 seconds to spread to a diameter of one inch but such pulps will invariably show a corresponding decrease in time of spreading out when bleached by our processes. If these pulps are bleached by processes other than ours, the spreading out time of the bleached pulp is, for kraft and soda, always greater than that of the unbleached pulp from which they are produced while for sulphite pulp it is usually, if not always, greater. Pulps other than those bleached by our process usually require a spreading out time greater than nine seconds under this test.

Another test, which apparently combines the factors of rate and quantity of absorption, is based upon the determination of the distance to which liquids such as oil and water travel across the surface of the pulp within a limited time. The test we prefer to use for this purpose is similar to that already described except that after a drop of the liquid has acted upon the material for 5 seconds, the area covered by the liquid is measured. For our unbleached pulps, this area is approximately 20 x 16 mm. while after bleaching by our process the area will amount to approximately 38 x 40 mm. Other bleached pulps will usually allow spreading to an area of 19 x 14 mm., or even less, in 5 seconds.

The quantity of absorption may be measured by determining the amount of water taken up by a given amount of pulp and that will not drip out of the pulp. We prefer to use the following

test for this purpose. The pulp is made into a thick sheet or card which, after couching from the hand mould, is pressed wet at a pressure of 246 pounds per square inch of the material pressed. The card is next completely dried and then conditioned at 65% relative humidity. The dry conditioned card should weigh 0.4 gram per square inch of material. This card is submerged to a depth of one inch in water at 65° F. for 10 seconds, then removed and drained for 10 seconds and then weighed.

By this test, our bleached pulp, without any special treatment, will be found to absorb from 2.75 to 3.5 times its own weight of water; i. e. a card 5 inches square will weigh 10 grams before the test while after the test the card will weigh 27.5 to 35.0 grams. Some unbleached pulps may fall in between these limits but any pulp after bleaching by our process will have a greater absorbency than the same pulp from which it was made, while pulps bleached by other processes will invariably have an absorbency less than 2.75 times the original weight of the material by this test.

It will be noted from the foregoing that the absorption rate and capacity of our bleached product is greater than the absorption rate and capacity of the unbleached material as determined by all of the three tests. This, we believe, is an unusual characteristic.

Various pulps have been tested to determine the viscosity of our improved product in cupra-ammonium solutions in comparison with other products. These tests have shown that our product has substantially the same, or even greater, viscosity in these solutions as the unbleached material from which our bleached product is formed. These tests also indicate that the same conditions would arise in connection with the production of viscose solutions. This is an unusual characteristic inasmuch as prior bleaching processes have had a tendency to reduce the viscosity of viscose and cupra-ammonium solutions by the nature of the chemical processes involved.

The results of the particular viscosity test, to be described more fully hereinafter, as applied to a large number of samples of kraft pulp in an unbleached condition and pulp which has been subjected to a varying number of chlorination treatments in accordance with the disclosure of our Patent No. 1,957,938 are as follows:

	Seconds
Unbleached material	57.8
Material subjected to one chlorination	59.2 to 59.8
Material subjected to two chlorinations	60.5
Material subjected to three chlorinations	63.4
Material subjected to four chlorinations	60.0

The foregoing figures in each instance are the results of a large number of viscosity determinations in which practically no variation was shown, except for the material subjected to a single chlorination. This material, as indicated in the table, varied only slightly in its viscosity. A peculiarity of the treatment is that the materials which varied slightly after the first chlorination became of like viscosity after subsequent chlorinations. This constancy of viscosity of the materials after the second, third and fourth chlorination treatments is an admirable characteristic of our product. A further desirable feature in this connection is the relatively high viscosity of the bleached material after each of the chlorination treatments. It is to be noted that after the third chlorination treatment the viscosity is particularly high, while after each of the chlorination treatments the viscosity is higher than for the unbleached material.

Our preferred method of determining viscosity is the 1% Dudley test using a 100 cc. Dudley pipette calibrated to deliver 100 cc. of water at 25° C. in exactly 36 seconds. The material to be tested is air dried, then shredded finely to eliminate all lumps, then dried 3 hours at 100 to 105° C. and cooled in a desiccator to constant weight. Two grams of this material are mixed with 3.05 grams of anhydrous cuprous hydrate (CuOH). Strong ammonia, 225 cc. (measured at 25° C.), is added and the whole mixed by shaking well in a stoppered 6 ounce bottle for exactly two minutes. The resultant solution is run through a 100 cc. Dudley pipette, jacketed with water held constantly at 25° C. and the time required to deliver 100 cc. of the solution is measured in seconds by a stop watch.

The time thus determined in seconds is the viscosity as listed above. This figure may, if desired, be divided by the water constant of the pipette (36 seconds) to obtain the relative viscosity. For example, the unbleached material, as listed above, gave a reading under the test of 57.8 seconds viscosity; this figure divided by 36 (the water constant of the pipette) gives 1.605 as the relative viscosity of the material.

The cuprous hydrate used in this test had been screened through a 40 mesh screen and 10 grams of it was entirely soluble in 100 cc. of concentrated ammonia. It was free from water soluble materials and practically anhydrous. The ammonia used in the test had a specific gravity of 0.9 tested at 15.5° C.

By way of comparison with our product the same viscosity test was conducted upon samples of kraft pulp bleached by the ordinary hypochlorite, bleaching liquor method. These tests showed a variation in the viscosity of the different samples between 44.0 and 50.5 seconds. Sulfite pulps similarly bleached indicated a viscosity, according to the same test, varying between 47.4 and 48.8 seconds. The same sulfite pulps in unbleached condition showed a viscosity of 54.8 seconds.

In order to determine the quantities of caustic soda and carbon bisulfide required to xanthate our bleached product by the ordinary Cross & Bevan method, different batches of the material were subjected to the action of these chemicals and the quantities necessary for the xanthation were determined. It has been found from these tests that our product containing 100 pounds of dry fiber will require merely from 9 to 12 pounds of carbon bisulfide and between 16 and 20 pounds of caustic soda to xanthate the material. These quantities of caustic soda and carbon bisulfide are not more than 30 to 40% of the quantities of these substances normally required for the xanthation of other bleached pulps.

While we have explained the characteristics and properties of our new product in considerable detail, it should be understood that we do not wish to limit ourselves to these specific details other than as indicated by the claims which follow. In the use of the expression "derived from a plurality of different sources" in certain of the claims, it is to be understood as indicating that the pulp is either derived from a plurality of different digesters or different opera-

tions of the same digester, or that the pulp derived from a single operation of a digester has been put through different bleaching operations in either the same or different bleaching equipments. In effect, therefore, the expression refers to the continuous output of a particular plant. When reference is made in the claims to "sulfate pulp" this is to be understood as meaning pulp produced by the alkaline, sulfate process in the ordinary way without special treatment, either before or after the sulfate process, for the purpose of modifying the alpha cellulose content, pentosan content or the like, as by the removal of cellulosic constituents of the pulp. The product claimed is the result of treatment of this ordinary sulfate pulp by one of applicants' high-density, chlorine bleaching processes. In certain claims when reference is made to the pulp in its "natural state" this is to be understood as referring to the absence of sizing and other special ingredients and to the freedom from any special mechanical treatment, or the like, for increasing the absorption characteristic of the pulp as normally produced.

What we claim is:

1. Non-hydrolyzed pulp having the interior and exterior surfaces of the fibers bleached at least in part at a dry fiber content of more than 15% by gaseous chlorine, said pulp having a high alpha cellulose content, being capable of developing a maximum beaten strength within less than two hours in a laboratory beater higher than 150 per cent points per pound according to the Mullen pop test, being convertible into readily spinnable viscose by the ordinary Cross and Bevan method of xanthation with only about 16 to 20 pounds of caustic soda and 9 to 12 pounds of carbon bisulfide for 100 pounds of the dry pulp fibers, having a relative viscosity of more than 1.60 as determined by the 1% Dudley test and being capable of absorbing water at such a rate that a drop applied to the surface of two superposed ten-pound basis weight tissue sheets will spread to a diameter of one inch within less than two seconds.

2. Non-hydrolyzed pulp having the interior and exterior surfaces of the fibers bleached at least in part at a dry fiber content of more than 15% by gaseous chlorine, said pulp having a color of not less than 81 according to the Hess-Ives tintometer, having a high alpha cellulose content, being capable of developing a maximum beaten strength within less than two hours in a laboratory beater higher than 150 per cent points per pound according to the Mullen pop test, being convertible into readily spinnable viscose by the ordinary Cross and Bevan method of xanthation with only about 16 to 20 pounds of caustic soda and 9 to 12 pounds of carbon bisulfide for 100 pounds of the dry pulp fibers, having a relative viscosity of more than 1.60 as determined by the 1% Dudley test and being capable of absorbing water at such a rate that a drop applied to the surface of two superposed ten-pound basis weight tissue sheets will spread to a diameter of one inch within less than two seconds.

3. Non-hydrolyzed sulfate pulp having the interior and exterior surfaces of the fibers bleached at least in part at a dry fiber content of more than 15% by gaseous chlorine, said pulp having a high alpha cellulose content, being capable of developing a maximum beaten strength within less than two hours in a laboratory beater higher than 150 per cent points per pound according to the Mullen pop test, being convertible into readily spinnable viscose by the ordinary Cross and Bevan method of xanthation with only about 16 to 20 pounds of caustic soda and 9 to 12 pounds of carbon bisulfide for 100 pounds of the dry pulp fibers, having a relative viscosity of more than 1.60 as determined by the 1% Dudley test and being capable of absorbing water at such a rate that a drop applied to the surface of two superposed ten-pound basis weight tissue sheets will spread to a diameter of one inch within less than two seconds.

4. Non-hydrolyzed sulfate pulp having the interior and exterior surfaces of the fibers bleached at least in part at a dry fiber content of more than 15% by gaseous chlorine, said pulp having a color of not less than 81 according to the Hess-Ives tintometer, having a high alpha cellulose content, being capable of developing a maximum beaten strength within less than two hours in a laboratory beater higher than 150 per cent points per pound according to the Mullen pop test, being convertible into readily spinnable viscose by the ordinary Cross and Bevan method of xanthation with only about 16 to 20 pounds of caustic soda and 9 to 12 pounds of carbon bisulfide for 100 pounds of the dry pulp fibers, having a relative viscosity of more than 1.60 as determined by the 1% Dudley test and being capable of absorbing water at such a rate that a drop applied to the surface of two superposed ten-pound basis weight tissue sheets will spread to a diameter of one inch within less than two seconds.

5. Non-hydrolyzed sulfate pulp having the interior and exterior surfaces of the fibers bleached at least in part at a dry fiber content of more than 15% by gaseous chlorine, said pulp having a high alpha cellulose content, and being capable of developing a maximum beaten strength within less than two hours in a laboratory beater higher than 150 per cent points per pound according to the Mullen pop test.

6. Non-hydrolyzed sulfate pulp having the interior and exterior surfaces of the fibers bleached at least in part at a dry fiber content of more than 15% by gaseous chlorine, said pulp having a high alpha cellulose content, being capable of developing a maximum beaten strength within less than two hours in a laboratory beater higher than 150 per cent points per pound according to the Mullen pop test, and having a freeness at maximum beaten strength of not less than 100 according to the Canadian standard freeness test.

7. Non-hydrolyzed pulp having the interior and exterior surfaces of the fibers bleached at least in part at a dry fiber content of more than 15% by gaseous chlorine, said pulp having a high alpha cellulose content and being convertible into readily spinnable viscose by the ordinary Cross and Bevan method of xanthation with only about 16 to 20 pounds of caustic soda and 9 to 12 pounds of carbon bisulfide for 100 pounds of the dry pulp fibers.

8. Non-hydrolyzed sulfate having the interior and exterior surfaces of the fibers bleached at least in part at a dry fiber content of more than 15% by gaseous chlorine, said pulp having a high alpha cellulose content and being convertible into readily spinnable viscose by the ordinary Cross and Bevan method of xanthation with only about 16 to 20 pounds of caustic soda and 9 to 12 pounds of carbon bisulfide for 100 pounds of the dry pulp fibers.

9. Non-hydrolyzed pulp having the interior and exterior surfaces of the fibers bleached at

least in part at a dry fiber content of more than 15% by gaseous chlorine, said pulp having a high alpha cellulose content, and having a relative viscosity of more than 1.60 as determined by the 1% Dudley test.

10. Non-hydrolyzed sulfate pulp having the interior and exterior surfaces of the fibers bleached at least in part at a dry fiber content of more than 15% by gaseous chlorine, said pulp having a high alpha cellulose content, and having a relative viscosity of more than 1.60 as determined by the 1% Dudley test.

11. Non-hydrolyzed sulfate pulp having the interior and exterior surfaces of the fibers bleached at least in part at a dry fiber content of more than 15% by gaseous chlorine, said pulp having a high alpha cellulose content, and being capable of absorbing water at such a rate that a drop applied to the surface of two superposed ten-pound basis weight tissue sheets will spread to a diameter of one inch within less than two seconds.

12. Non-hydrolyzed sulfate pulp, having the interior and exterior surfaces of the fibers bleached at least in part at a dry fiber content of more than 15% by gaseous chlorine, and having a color of not less than 81 according to the Hess-Ives tintometer, and containing not less than 89% of alpha cellulose.

13. As a new product a white, non-hydrolyzed pulp having the interior and exterior surfaces of the fibers bleached at least in part at a dry fiber content of more than 15% by gaseous chlorine, said pulp having a high alpha cellulose content and containing less beta cellulose and more gamma cellulose after bleaching than before.

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