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METHOD OF PRODUCING ABSORBENT OR RESILIENT FELT

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The invention relates to a method of producing kinked, curled, or crimped fibres from finished or prepared cellulosic fibrous pulp material and to the production of a felted material having substantial bulk and absorbency and resiliency, and to the production of a felted product having substantial resilience and water-proof qualities.

An object of the invention is the production of curled fibre by means of a treating solution or solutions having the characteristic of pronounced physico-chemical reactivity or drasticity for effecting curling of the fibres, and capable of producing pronounced curling effect in the fibres.

Another object is to provide a method employing treating solutions of certain classes of chemicals for the production of curling, kinking, or crimping of prepared fibres, said classes broadly comprising curling agents, materials having a concentrating effect on the curling agents, and accelerators or gelatinizing agents.

Another object is to provide a method employing treating solution of increased effectiveness in curling fibres by adding to a solution of a most active treating agent, one or more of certain less reactive chemicals which serve to step up or boost the curling effectiveness or drasticity of the treating solution, although the less reactive chemicals alone have but little curling effect on the fibres.

Another object is to provide a variation of methods of treatment in which the sequence of steps may be adding the less reactive material to fibre and then treating with a solution of most active treating agent, or forming a fibre mix including most active treating agent solution, and either adding the less reactive material thereto or discharging the said mix into a solution of the less reactive material.

Another object is to provide a variation of the sequence of the compounding steps to suit the capabilities of impregnation of whatever grade of prepared pulp material may be used.

Another object is to provide a method of curling fibre by a chemical treating solution or suspension which method is particularly adapted to enable the reuse of the spent combination of chemicals to produce other grades of product.

A further object is to provide a method employing treating materials having an accelerating effect and a gelatinizing or cellulose combining effect and causing said materials to contact the individual fibres to form gel reactive to the curling agent.

Another object is to provide a method whereby the accelerating agent may be washed from the fibre or may be permitted to remain thereon to provide a sizing and preserving effect.

Another object is the production of a felted product of substantial absorbency and resiliency.

The invention results in a product which has a marked affinity for waterproofing agents.

Other objects will appear from the following disclosure.

The invention involves forming a solution of a material which is physico-chemically reactive to produce a curling, crimping, or kinking effect upon the fibres of prepared or finished pulp, and adding a less physico-chemically reactive material or materials to that solution to step up or boost the fibre curling reactivity of the solution or mixture, and treating the fibre with the solution or mixture to curl the same.

The invention also involves the addition to a fibre mix including a solution of a most active treating agent, or the addition to fibre to which the most active treating agent is afterward supplied, of a less reactive material to step up or boost the fibre curling reactivity of the most active treating agent.

The invention also involves the formation of a fibre mix including a solution of a most active treating agent and discharging it into a solution of a less reactive material, having a gelatinizing or cellulose combining function.

I have discovered that an increase of the concentration of the treating solution by the addition of a less reactive chemical such as one or more of those hereinafter referred to, causes the less active chemical to act to step up or boost the reactivity of the most active treating agent in the mixture.

For instance, if in one case 10% caustic soda solution is used for the curling treatment and in another case 5% of sodium chloride and 5% of sodium sulfate are added dry to a 10% solution of caustic soda, then pulp treated with the mixture of chemicals will show more curling than pulp treated with the 10% caustic soda solution alone, although it has been shown that sodium sulfate and sodium chloride by themselves will have very little curling effect on the fibres under any conditions. In this instance all other physico-chemical conditions are held the same except the change noted in the solution constituents.

My invention contemplates the use of the materials hereinafter referred to either by themselves, as those of Class A, or in chemically workable combinations.

These compounds should be divided generally into three classes.

(A) Those having a curling or mercerizing or deterging effect such as caustic soda or caustic potash, sodium sulfide, sodium sulfite, sodium carbonate, ammonium hydrate, calcium hydrate, and soaps such as spent or partially spent saponaceous liquors.

(B) Those having only a concentrating effect upon the Class A. These may include almost any soluble and more or less inert salt. In this class will be listed sodium chloride, sodium phosphate, sodium sulfate, calcium chloride and many other soluble salts.

(C) The third class are those which are gelatinizing agents and accelerators with a reaction bordering on catalysis. In this class are the copper, zinc and aluminum salts and other salts of metals which are chemically reactive to cellulose.

It is possible by combination of these various types of chemicals to reuse the spent chemicals of one grade, with slight fortification or not as the case may be, to produce another grade of product.

The product which I have produced might be described as a fibrous mass which, due to its extreme freeness, is incapable of being tested satisfactorily by the standard Schopper Riegler freeness tester and requires a modified Schopper tester as described in Volume XCI—No. 9 of the Paper Trade Journal, August 28th, 1930, written by Robert M. Boehm, using a bottom orifice of 9/64" opening. With the extremes of my method of treatment, using five liters of mixture and 25 grams of bone dry pulp, the bottom readings will be from 350 to 710 c. c.

In commercial practice we will always be making definite grades or qualities of product and we will therefore in commercial practice always be comparing the concentrations required to produce a drasticity of treating solution which may be used to produce the grade of product which we may have under consideration. A method of measuring the quality of product is the freeness test as described above using the modified Schopper-Riegler freeness tester.

The following list of treatments and freeness tests is therefore presented:—

Duration of treatment	Treating solution (concentration)	Bottom outlet freeness
(1) 10 minutes	Water	718 c. c.
(2) 10 minutes	10% NaOH 12% NaCl	430 c. c.
(3) 10 minutes	10% NaOH	450 c. c.
(4) 10 minutes	10% Na_2S	575 c. c.
(5) 15 minutes	5% NaOH	600 c. c.
(6) 10 minutes	5% NaOH 12% NaCl	565 c. c.
(7) 10 minutes	4% NaOH 11% Na_2S	480 c. c.
(8) 10 minutes	4% NaOH 14% Na_2CO_3	625 c. c.

It is to be noted that the particular grade of "kraft" pulp tested in this particular case (namely, Bamble Koos) has a freeness of only 718. The mixture of item (2) compared with item (3) shows the increase in freeness or decrease in slowness (20 c. c.) caused by the presence of the sodium chloride in the solution which increases the concentration of the caustic soda solution. Comparison of items (3) and (4) shows the relative freeness produced by the same concentration of solutions, the caustic being more drastic than the sulfide and producing greater freeness. Items (5) and (6) show that 15 minutes' treatment with 5% caustic soda produces only 600 c. c. bottom outlet freeness whereas 10 minutes with the concentrating effect of sodium chloride produces an increased bottom outlet freeness of 565 c. c. Comparison of items (7) and (8) shows the relative freeness produced by 11% sodium sulfide and 14% sodium carbonate each added to a 4% caustic solution in a 10 minute treatment, the 11% sodium sulfide showing greater freeness than the 14% sodium carbonate. It will also be seen that the 4% sodium hydroxide with the 11% Na_2S of item (7) compares quite favorably with the 10% caustic solution of item (3). The tests above listed deal with the materials listed in Classes A and B as above noted.

When using an accelerator (as noted in Class C), such as a copper salt, maximum curling will not be obtained unless the fibres are very carefully broken apart so that the treating solution may obtain access to the individual fibres. If this breaking down or fibre separation is not carefully and thoroughly done the fibres within the sheet masses are not reached because of the gelatinized coating formed on the surface of the fibre mass which can not be permeated by the treating solution to allow the solution to surround each individual fibre, before the copper is withdrawn and used up.

The reaction between cellulose fibre and the copper and caustic solution mixture is extremely rapid. When using dry sheet pulp the rapidity of the reaction may cause a gelatinization of the sheet mass thereby effecting impermeability and inability of the solution to surround and treat the individual fibres. I have overcome this difficulty in the following manner:

A copper salt solution is added to caustic soda solution of the desired treating strength thereby causing a precipitate of copper hydroxide. This mixture of caustic soda and copper hydroxide suspension is added to the pulp or the pulp is added to this mixture to make up the desired density of mix and the whole is agitated until the fibres are disintegrated. Thereafter the copper hydroxide which is intimately mixed in the fibre mass is thrown into solution by the addition of a solvent such as ammonia, Rochelle salts, sugar or other copper hydroxide solvent. The copper and caustic soda reaction on the fibre starts immediately.

Another method is to make a wet mix of copper hydroxide and fibre. When thoroughly and homogeneously intermixed the mass is dropped into a solution of caustic soda and copper hydroxide solvent and the whole is thoroughly stirred.

Another method is to mix thoroughly disintegrated pulp fibres with a sufficient volume of the treating chemicals in water, that the whole may be quickly stirred in a manner to surround and treat each fibre simultaneously with both accelerator and curling agent.

Another method which has given excellent results is to intermix the fibres with caustic soda and after such treatment to discharge the pulp and caustic mass into a copper salt solution of such strength that the resultant caustic, fibre and copper salt mix shall be a fluid mass i. e., less than 10% density or consistency of fibre. Of course, if agitation is sufficiently rapid and thorough a resultant non-fluid mass would be workable, i. e. over 10% density. This method has several advantages.

1. The caustic solution strengths indicated herein in connection with the copper treatment are weak enough so that rapid disintegration of fibre masses into separated fibres readily takes

place, without the formation of difficultly handled and slimy hemicellulose compounds in amounts or concentrations sufficient to interfere with continuous operation.

2. The less than ordinary drastic caustic treating solution dissolves organic substances from the fibres which dissolved substances act like sugar, Rochelle salts and ammonia in holding the copper hydroxide in solution.

In cases of certain metals which may be deposited on the surface of the fibre I have found very marked acceleration of the caustic reaction. This is particularly true of copper and zinc salts. I have found that a solution made up as described by Cohn in Patent No. 655,850, 9° Bé. at 100° C. (equivalent to 9.75% NaOH) using copper in the mixture equivalent to 7% of the weight of the fibre, figuring the copper as copper oxide, will give a curling effect greater than a 20% caustic solution under the same conditions of pulp suspension and mechanical treatment.

In order to make the copper effective in the curling operation it is only necessary to hold the copper hydroxide in solution in the presence of the caustic soda or caustic lye. The copper hydroxide may be prepared by starting with metallic copper and an acid or by making a solution of copper salt such as copper sulfate. Holding the copper hydroxide in solution in the presence of the caustic may be accomplished in a number of different ways, among which may be mentioned, the addition of ammonia, Rochelle salts, sugar, or, the copper hydroxide may be taken up in a 30% to 40% caustic solution and the whole afterwards diluted. It is necessary to figure the copper compound, or zinc if used, on a different basis from the caustic because the copper is withdrawn and deposited on the fibre and must therefore be figured on the basis of the weight of the fibre to be treated and not on the basis of the strength or concentration of the copper in the solution. The caustic lye on the other hand must be figured on the basis of concentration of solution. In other words, the less the consistency or density of the pulp and chemical solution mix, the less will be the concentration of the copper salt solution. The concentration of the caustic lye solution will be kept constant for a definite grade of product regardless of the density or consistency of the pulp and solution mix (up to 15% density). In this connection reference is made in my copending application Ser. #561,242 filed September 4, 1931, and hereinafter mentioned, to the retarding of the desired curling effect in using a pulp mix above a density of about 15% pulp to 85% treating solution. A mix above this density requires a caustic solution of increased concentration in order to secure the desired curling effect.

The following examples show the approximate ratio of parts by weight of copper compound, caustic soda, and fibre in mixes of 2%, 5%, and 10% density:—

2% Density mix

Analysis of mix:

2 parts fibre by weight	14
97.86 parts 9.75% caustic solution=97.86 parts ×.0975=9.5 parts NaOH	68
.14 of 1% CuO	1

Approximate ratio—CuO:NaOH:fibre=1:68:14

5% Density mix

Analysis of mix:

5 parts fibre by weight	14
94.65 parts 9.75% caustic solution=94.65 parts ×.0975=9.2 parts NaOH	26
.35 of 1% CuO	1

Approximate ratio—CuO:NaOH:fibre=1:26:14

10% Density mix

Analysis of mix:

10 parts fibre by weight	14
89.3 parts 9.75% caustic solution—89.3 parts ×.0975=8.7 parts NaOH	13
.7 of 1% CuO	1

Approximate ratio—CuO:NaOH:fibre=1:13:14

After the curling operation a weak acid wash will quickly and easily remove the copper from the surface of the fibre. This removal is easily distinguishable by the disappearance of the green color which has been imparted to the surface of the fibre during the treatment and is necessary to obtain maximum absorbency but need not be removed where resiliency and slight sizing effect may be desired.

Microscopic examination indicates that caustic soda solution causes a thickening of the fibre wall. In the process of thickening, irregularities of the fibre wall are emphasized or magnified, thereby causing the fibre to twist, curl and crinkle.

In the felting or piling up of these twisted fibres countless spaces of capillary function are formed, thereby imparting to the felted product its commercially valuable characteristics of absorbency, extreme bulk, capability of being impregnated, and resiliency.

The curled or crimped fibres have marked affinity for attaching to themselves precipitated waterproofing agents such as rosin, aluminum hydrate, copper hydrate, zinc hydrate, etc., and when so treated that these substances are deposited on the surface of the fibres in insoluble form, a springy, waterproof, relatively non-absorbent product is the result,—a waterproof product which may be compressed and released many times without losing its resiliency.

I have discovered that the copper compound must be in solution contact with the fibre in order to produce the desired result. The copper must be in quantity less than the amount required to completely dissolve the cellulose present. According to Cross and Bevan the amount of copper necessary to make a cellulose solution is as follows:—

2 to 2½% copper (CuO).
10 to 15% ammonia (NH_3).

It requires from 10 to 20 times the weight of this solution figured on the weight of the cellulose to completely dissolve the fibre and make a 5% to 10% cellulose solution. According to these figures the weight of copper compared with the weight of the cellulose would be, maximum, approximately 50% CuO on the weight of the cellulose while the minimum is 20% of CuO on the weight of the cellulose. These results are shown by the following calculations:—

Under the maximum conditions with 2½% CuO, 20 times the weight of the solution, and 10% cellulose solution

10 parts cellulose by weight
20×10=200 parts solution
2½% of 200 parts=5 parts copper

$$\frac{\text{5 parts copper}}{\text{10 parts cellulose}} = \text{50\% CuO on the weight of the cellulose}$$

Under the minimum conditions it will similarly be seen that with 5% cellulose solution or 5 parts cellulose

$10 \times 5 = 50$ parts solution.

2% of 50 parts = 1 part CuO

$$\frac{\text{1 part CuO}}{\text{5 parts cellulose}} = \text{20\% CuO on the weight of the cellulose}$$

It will be seen that the minimum amount of CuO, i. e. 20%, disclosed by this authority for complete solution is approximately three times the amount (i. e. 7% CuO on weight of fibre) required to accelerate the caustic lye curling as disclosed in the above example. I do not wish to hold myself to the amount shown in this example however as the reaction is one of degree and uses might be found for a product requiring the extreme of treatment i. e. 24% caustic lye solution concentration and 50% CuO on the weight of cellulose fibre used.

The fibre curling drasticity of a mixture containing only 5% caustic soda with 2% on the weight of the fibre of copper oxide gives a curling effect at least equal to a 10% caustic soda solution.

A mixture containing 5% of caustic soda, 1⅓% copper oxide on the weight of the fibre and ½ of 1% zinc oxide on the weight of the fibre is still more reactive in curling fibre than where only the copper oxide is used to boost the caustic solution reactivity.

In the examples which I have given, I have shown insufficient copper to completely dissolve the cellulose fibres. This deficiency of copper for complete dissolution apparently forms a gel on the surface of the fibres. This gel is much more reactive to the caustic soda treating solution than ungelatinized fibre substance.

As hereinbefore noted, the fibres must be separated and each subjected to the action of the solution by mixing so that this reactive gel will not form on the outside of the entire fibrous mass and prevent access of the solution to the individual fibres within the mass.

The present invention therefore involves rendering the fibres more susceptible to curling by chemical or physico-chemical gelatinization of the fibres by employing a chemical or physico-chemical gelatinizing agent for the surfaces of the fibres, other than or in addition to the most drastic treating chemical or the principal curling agent.

The terms boosting and stepping up of the intensity of the curling reactivity of the solution, are employed as it is desired to set forth the fibre curling treatment or method which has resulted from this invention or discovery without attempting to definitely characterize or restrict the invention to any particular theory as to the action which takes place. These terms are applicable broadly to combinations or mixtures of chemicals in Classes A, B, and C hereinbefore noted.

In the examples given above the copper and zinc compounds are apparently catalysts, or in the nature of catalysts, but while this may be the correct theory, the invention is not to be limited thereto.

It is to be noted that in combination with Class C the caustic soda is still the curling agent but the effect of the added substance is like a hypodermic injection in stirring the caustic soda into action.

Reference is made to my copending application Serial No. 561,242, filed September 4, 1931, for Method of producing absorbent or resilient felt, in which treating solutions of similar or the same chemicals are set forth in connection with the treatment of partially bruised fibres, and which treating solutions in that case may be less drastic or of less fibre curling reactivity than ordinary or usual treating solutions as set forth in that specification.

Reference is also made to my copending application Serial No. 558,185, filed August 19, 1931, for Method of producing absorbent or resilient felt, in which is disclosed the method of curling fibres by means of sodium sulfide solution.

I am fully aware that solutions approximating the mixtures shown, as well as caustic lye by itself, have been used for many years for the purpose of reacting with the acid cementaceous intercellular materials which nature has provided to bind together the cellulose fibres of wood and other vegetable substances.

It is not the purpose of this invention to perform the preliminary pulp producing operation of neutralizing and dissolving these cementaceous substances but rather to take cellulose fibres which have been previously separated and cleansed by any of the well known chemical processes and to treat these fibres as herein described for the purpose of presenting a product different from that produced by any of the usual pulp producing processes namely, the soda process, the sulfite process, the mono-sulfite process or the sulfate or kraft process.

The product produced by the action of a caustic soda and sodium sulfide solution mixture upon fully prepared or finished pulp, such solution as would ordinarily be found in the "white liquor" in the kraft or sulfate mill, is a superior curled or crimped product for making an absorbent sheet for impregnation in that the handling of such product on a paper making machine would be more easily accomplished than would be the case with a product produced by the use of caustic soda alone, thus showing that the reactivity is stepped up by the presence of the additional less reactive chemical, such as sodium sulfide, in the mixture.

It will be understood that the terms stepping up, and boosting, as herein used, are broad terms, applicable as well to the aforementioned materials of Class B having the concentrating effect, as to the materials of Class C having the accelerating and gel forming effect.

The classification given is purely general, it being understood that no definite lines can be drawn between these classes of chemicals as there is overlapping of the chemicals, some of which will fall in more than one class. These chemicals are listed according to their more important characteristics, rather than according to their lesser characteristics, which may cause overlapping between the classes given.

For instance, sodium sulfide solution is of itself a curling agent, and falls in Class A, but also has a concentrating effect on the caustic soda and so might be classed in Class B. Also, caustic soda is a gelatinizing agent when used in sufficient strength or concentration, or at low temperatures, and so might be classed in Class C.

It will be particularly noted that many of the stepping up materials have substantially no curling reactivity of themselves.

It will be understood that the terms, curling agent, and stepping up material, as used in the claims, include within their scope, solution, or suspension.

I claim:

1. The method of treating cellulosic fibrous material for producing an absorbent felted product, comprising employing finished or prepared cellulosic fibrous pulp which has been previously cleansed by neutralizing and dissolving the cementaceous intercellular substances, and treating said finished or prepared cellulosic fibrous pulp with a fibre curling or kinking agent and with material having the function of stepping up the reactivity of the fibre curling or kinking agent.

2. The method of claim 1 in which said material has a concentrating effect on said fibre curling agent.

3. The method of claim 1 in which said material has an accelerating effect.

4. The method of claim 1 in which said material has a chemical cellulose combining function.

5. The method of claim 1 in which said material has an accelerating effect with a reaction in the nature of catalysis.

6. The method of claim 1 in which said material has an accelerating effect and forms a reactive gel on the surface of the individual fibres, the said curling agent acting with stepped up reactivity upon the gel surfaced fibres to curl the same.

7. The method of claim 1 in which said material has a concentrating effect on said fibre curling agent and may consist of one or more of the following,—sodium chloride, sodium phosphate, sodium sulfate, calcium chloride.

8. The method of claim 1 in which said material has an accelerating effect and may consist of one or more of the following,—copper salts, zinc salts, aluminum salts.

9. The method of claim 1 in which said material is of itself reactive to curl fibre, and may consist of one or more of the following,—caustic soda, caustic potash, sodium sulfide, sodium sulfite, sodium carbonate, ammonium hydrate, calcium hydrate, spent or partially spent liquors.

10. The method of claim 1 in which said material is a material of less fibre curling reactivity of itself than said fibre curling agent.

11. The method of claim 1 in which said material is a material of less fibre curling reactivity of itself than said fibre curling agent and may consist of one or more of the following:—sodium sulfide, sodium sulfite, sodium carbonate, ammonium hydrate, calcium hydrate, spent or partially spent liquors, sodium chloride, sodium phosphate, sodium sulfate, calcium chloride, copper salts, zinc salts, aluminum salts.

12. The method of claim 1 in which said curling agent is caustic soda and said stepping up material is sodium sulfide.

13. The method of claim 1 in which said stepping up material is a copper compound.

14. The method of claim 1 in which said material comprises a copper compound as a stepping up material and a zinc compound as a stepping up material.

15. The method of claim 1 including washing the treated pulp with acid.

16. The method comprising mixing copper solution and a caustic soda solution, precipitating copper hydroxide in suspension, applying the mixture to finished or prepared fibrous pulp, agitating the mix to disintegrate the fibres and to intimately mix the copper hydroxide therewith and dissolving the copper hydroxide, the copper and caustic soda solution immediately reacting upon the fibres to curl the same.

17. The method according to claim 16 in which a solvent for the copper hydroxide is included and may be ammonia, Rochelle salts or sugar, or organic substances.

18. The method of claim 1 in which said material is a copper compound and said curling agent is caustic soda.

19. The method of claim 1 in which said material is copper hydroxide in solution, and said curling agent is caustic soda.

20. The method of claim 1 in which said fibre curling agent is in the form of a solution and said material is added thereto to step up its reactivity by concentration, and applying said concentrated and stepped up solution to the fibrous pulp material.

21. The method of claim 1 in which said fibre curling agent is in the form of a solution, forming a fibre mix with said solution, and adding said material to the fibre mix so formed.

22. The method of claim 1 in which said fibre curling agent is in the form of a solution, forming a fibre mix with said solution and discharging said fibre mix into said material which is in the form of a solution, to form a resultant mix of curling agent solution, fibre, and stepping up material solution.

23. The method of claim 1 in which said material is a metal or a metal salt and is brought into contact with the cellulose fibre in such a way that the metal becomes chemically combined with the cellulose to render the cellulose more reactive to the said curling agent, said metal or metal salt being in an amount insufficient to completely combine chemically with all of the cellulose.

24. The method of claim 1 in which said stepping up material is a copper compound, the method including the step of washing the treated pulp with acid.

25. The method of claim 1 in which said material comprises a copper compound as a stepping up material and a zinc compound as a stepping up material, the method including the step of washing the treated pulp with acid.

26. The method of treating cellulosic fibrous material for producing an absorbent felted product, comprising employing finished or prepared cellulosic fibrous pulp which has been previously cleansed by neutralizing and dissolving the cementaceous intercellular substances, and treating said finished or prepared cellulosic fibrous pulp with a fibre curling or kinking agent and with material having the function of stepping up the reactivity of the fibre curling or kinking agent, said treatment being carried out by first treating the fibrous pulp with said material and thereafter treating with the curling or kinking agent.

27. The method of treating cellulosic fibrous material for producing an absorbent felted product, comprising employing finished or prepared cellulosic fibrous pulp which has been previously cleansed by neutralizing and dissolving the cementaceous intercellular substances, and treating said finished or prepared cellulosic fibrous pulp with a fibre curling or kinking agent and with material having the function of stepping up the reactivity of the fibre curling or kinking agent, said treatment being carried out by first treating the fibrous pulp with said material which has an accelerating effect by forming a reactive gel upon the surface of the individual fibres, and thereafter treating with said curling or kinking agent which acts with stepped up reactivity upon the gel surfaced fibres to curl or kink the same.

28. The method of treating cellulosic fibrous

material for producing an absorbent felted product, comprising employing finished or prepared cellulosic fibrous pulp which has been previously cleansed by neutralizing and dissolving the cementaceous intercellular substances, and treating said finished or prepared cellulosic fibrous pulp with a fibre curling or kinking agent and with material having the function of stepping up the reactivity of the fibre curling or kinking agent, said material having an accelerating effect and forming a reactive gel upon the surface of the individual fibres, said treatments being carried on simultaneously, the curling agent acting with stepped up reactivity upon the gel surfaced fibres as the gel is formed, to curl or kink the fibres.

29. The method of treating cellulosic fibrous material for producing an absorbent felted product, comprising employing finished or prepared cellulosic fibrous pulp which has been previously cleansed by neutralizing and dissolving the cementaceous intercellular substances, and treating said finished or prepared cellulosic fibrous pulp with a fibre curling or kinking agent and with material having the function of stepping up the reactivity of the fibre curling or kinking agent, said treatment being carried out by first treating the fibrous pulp with said material by applying it in suspension in undissolved form, agitating the mix, throwing said material into solution to form a reactive gel upon the surface of the individual fibres, and thereafter treating with said curling agent which acts with stepped up reactivity upon the gel surfaced fibres to curl the same.

30. The method of claim 1 in which said fibre curling agent is in the form of a solution, forming a fibre mix with said solution and discharging said fibre mix into said material which is in the form of a solution, to form a resultant mix of curling agent solution, fibre, and stepping up material solution, said stepping up material being held in solution in the presence of caustic soda by ammonia, sugar, Rochelle salts or dissolved organic substances.

31. The method comprising mixing a caustic soda solution and finished or prepared pulp and after so mixing introducing a copper solution in such an amount as to produce a kinking of the fibres to any predetermined or desired degree.

32. The method according to claim 31 in which traces of copper in the kinked fibre may be removed by a copper solvent wash.

33. The method according to claim 1 in which said stepping up material reacts upon the fibres to render them more reactively susceptible to the said fibre curling or kinking agent.

34. The method according to claim 1 in which the required amount of said fibre curling or kinking agent is based upon the concentration of a solution thereof, and the relative required amount of said other substance is based upon the weight of the fibre.

35. The method of claim 1 in which said stepping up material comprises a metal salt together with a substance to hold the hydroxide of the metal of the salt in solution to co-act with the curling or kinking agent to curl or kink the fibres.

36. The method of claim 1 in which said fibre curling or kinking agent is caustic soda and said stepping up material comprises a metal salt together with a substance to hold the metal of the salt in solution to co-act with said caustic soda to curl or kink the fibres.

37. The method of claim 1 in which said fibre curling or kinking agent is caustic soda solution, and said stepping up material is a copper salt together with a substance to hold the hydroxide of the copper in solution to co-act with the caustic soda to curl or kink the fibres.

38. The method of claim 1 in which said fibre curling or kinking agent is caustic soda solution, and said stepping up material is a zinc salt together with a substance to hold the hydroxide of the zinc in solution to co-act with the caustic soda to curl or kink the fibres.

39. The method of claim 1 in which said stepping up material is a copper compound and said curling agent is calcium hydrate.

40. The method of claim 1 in which said stepping up material is copper sulphate and said curling agent is calcium hydrate.

41. The method of claim 1 in which said stepping up material is a copper salt and said curling agent is sodium carbonate.

42. The method of claim 1 in which said stepping up material is a copper compound and said curling agent is a mixture of sodium carbonate and calcium hydrate.

43. The method of claim 1 in which said stepping up material is a copper compound and the said curling agent is calcium hydrate fortified by a solution of soluble sodium compound.

44. The hereindescribed process of securing the desired characteristics of absorbency, capillarity, pliability, and bulkiness of a felted paper product of cellulosic fibrous material, comprising employing finished or prepared cellulose fibres from which cementaceous intercellular substances have previously been removed, and treating said fibres with caustic soda solution of non-mercerizing strength, together with a metallic compound of non-cellulose dissolving characteristics and of non-mercerizing effect, thereby forming a chemical or physico-chemical encasement or coating deposit which fixes or sets the fibres as to shape, washing out the water soluble substances, and felting the fibers into a web on a paper making machine, substantially as described.

45. The hereindescribed process of strengthening cellulose fibres treated and impregnated with copper compound, comprising treating the copper covered fibres with an ammonia compound to form a mucilaginous coating on the fibres to bind them more strongly together and to increase the tensile strength of the finished product.

46. The hereindescribed process of securing the desired characteristics of absorbency, capillarity, and bulkiness of a paper-felting product of cellulosic fibrous material, comprising employing finished or prepared cellulose fibres from which cementaceous intercellular substances have previously been removed, and treating said fibres with caustic soda solution of non-mercerizing strength together with a metallic compound of non-cellulose dissolving characteristics and of non-mercerizing effect, thereby forming a chemical or physico-chemical encasement or coating deposit which fixes or sets the fibres as to shape, and washing out the water soluble substances.

47. The hereindescribed process of securing the desired characteristics of absorbency, capillarity, pliability, and bulkiness of a felted paper product of cellulosic fibrous material, comprising employing finished or prepared cellulose fibres from which cementaceous intercellular substances have previously been removed, and treating said fibres with caustic soda solution of non-mercerizing strength and of non-kinking effect alone, together

with a metallic compound of non-cellulose dissolving characteristics, and of non-mercerizing effect, and of non-kinking effect alone, to produce a curling or kinking of the fibres without materially changing the cross-sectional ribbon-like shape of the fibres while causing a series of retroversions or inclines and anticlines or hinged convolutions along the fibre length, and forming a chemical or physico-chemical encasement or coating deposit which fixes or sets the fibres in such flat ribbon-like curled and kinked shape, washing out the water soluble substances, and felting the fibres into a web on a paper making machine.

48. The hereindescribed process of securing the desired characteristics of absorbency, capillarity, and bulkiness of a paper-felting product of cellulosic fibrous material, comprising employing finished or prepared cellulose fibres from which cementaceous intercellular substances have previously been removed, and treating said fibres with caustic soda solution of non-mercerizing strength and of non-kinking effect alone, together with a metallic compound of non-cellulose dissolving characteristics and of non-mercerizing effect, and of non-kinking effect alone, to produce a curling or kinking of the fibres without materially changing the cross-sectional ribbon-like shape of the fibres while causing a series of retroversions or inclines and anticlines or hinged convolutions along the fibre length, and forming a chemical or physico-chemical encasement or coating deposit which fixes or sets the fibres in such flat ribbon-like curled and kinked shaped, and washing out the water soluble substances.

49. The process of claim 46 including a substance to hold in solution the hydroxide of the metal of the metallic compound, such as Rochelle salts, or sugar.

50. The process of claim 46 in which said metallic compound is employed in an amount based not upon concentration of solution, but upon the weight of the fibre in the mixture.

51. The process of claim 46 in which said metallic compound is employed in such an amount as to be completely utilized and absorbed in the reaction so that no stopping of the reaction by dilution or neutralizing is necessary.

52. The method comprising treating finished or prepared cellulosic paper-felting fibres with a curling or kinking agent of non-mercerizing strength, and with such amount of a kinking accelerator or activator of non-mercerizing strength and non-cellulose dissolving characteristics as to be completely used up in the desired reaction without the necessity for dilution or neutralization to stop the reaction.

53. The method comprising treating finished or prepared cellulose paper-felting fibres with caustic soda of non-mercerizing strength and with such amount of a copper salt of non-mercerizing strength as to be completely used up in the physico-chemical or cellulose combining reaction forming a copper deposit or encasement on the surface of the fibre.

54. The process of claim 46 including treating the individually encased fibres with a material to change the color of the encased fibres.

55. The method comprising treating cellulosic paper-felting fibres with a material reacting chemically or physico-chemically to form an encasement of the individual fibres. and treating the individually encased fibres with a material to change the color of the encased fibres.

56. The method comprising treating finished or prepared paper-felting fibrous pulp with material to curl the fibres and to form an encasement of the individual fibres, and treating the individually encased and curled fibres with a material to change the color of the encased fibres, said encasing material including a metallic compound which is deposited on the surface of the individual fibres to form the encasement.

57. A felted paper product comprising finished or prepared cellulose fibres from which cementaceous intercellular substances have previously been removed, said fibres being provided with a chemical or physico-chemical encasement or coating deposit fixing or setting them as to shape.

58. A felted paper product according to claim 57 in which said encasement or coating deposit is a substance of non-mercerizing strength and non-cellulose dissolving characteristics, and of greater specific gravity than the cellulose fibre itself.

59. A fibrous paper-felting product comprising finished or prepared cellulose fibres from which cementaceous intercellular substances have previously been removed, said fibres being provided with a chemical or physico-chemical encasement or coating deposit fixing or setting them as to shape.

60. A fibrous paper-felting product according to claim 59 in which said encasement or coating deposit is a substance of non-mercerizing strength and non-cellulose dissolving characteristics, and of greater specific gravity than the cellulose fibre itself.

61. A felted paper product comprising finished or prepared cellulose fibres from which cementaceous intercellular substances have previously been removed, said fibres being of flat ribbon-like form in cross section provided with a chemical or physico-chemical encasement or coating deposit fixing or setting them as to shape.

62. A fibrous paper-felting product comprising finished or prepared cellulose fibres from which cementaceous intercellular substances have previously been removed, said fibres being of flat ribbon-like form in cross section provided with a chemical or physico-chemical encasement or coating deposit fixing or setting them as to shape.

63. A felted paper product comprising finished or prepared cellulose fibres from which cementaceous intercellular substances have previously been removed, said finished or prepared fibres being artificially curled and kinked, and being provided with a chemical or physico-chemical encasement or coating deposit fixing or setting them in such curled and kinked configuration.

64. A felted paper product according to claim 63 in which said encasement or coating deposit is a substance of non-mercerizing strength and non-cellulose dissolving characteristics, and of greater specific gravity than the cellulose fibre itself.

65. A fibrous paper-felting product comprising finished or prepared cellulose fibres from which cementaceous intercellular substances have previously been removed, said finished or prepared fibres being artificially curled and kinked, and being provided with a chemical or physico-chemical encasement or coating deposit fixing or setting them in such curled and kinked configuration.

66. A fibrous paper-felting product according to claim 65 in which said encasement or coating deposit is a substance of non-mercerizing strength and non-cellulose dissolving characteristics, and of greater specific gravity than the cellulose fibre itself.

67. A felted paper product according to claim

63 in which said encasement or coating deposit comprises a copper compound.

68. A felted paper product according to claim 63 in which said encasement or coating deposit comprises a zinc compound.

69. A felted paper product according to claim 63 in which said encasement or coating deposit comprises aluminum compound.

70. A fibrous paper-felting product comprising artificially curled and kinked finished or prepared cellulose fibres from which cementaceous intercellular substances have previously been removed, said fibres being of the flat ribbon-like cross-sectional shape which characterizes finished or prepared fibres untreated or treated with solutions of non-mercerizing strength, while exhibiting a series of artificial kinks or inclines and anticlines or hinged convolutions, said fibres being provided with a chemical or physico-chemical encasement or coating deposit fixing or setting them as to shape, said encasement or coating deposit being a substance of non-mercerizing strength and non-cellulose dissolving characteristics, and of greater specific gravity than the cellulose fibre itself.

71. A felted paper product prepared from the fibrous paper felting product of claim 70.

72. A fibrous paper-felting product according to claim 70 in which said encasement or coating deposit comprises a copper compound.

73. A fibrous paper-felting product according to claim 70 in which said encasement or coating deposit comprises a zinc compound.

74. A fibrous paper-felting product according to claim 70 in which said encasement or coating deposit comprises an aluminum compound.

75. A fibrous paper-felting product comprising finished or prepared cellulose fibres individually encased in a substance of non-mercerizing strength but of greater specific gravity than the cellulose fibres, said encasement being colored without changing the physical condition of the fibres.

76. A felted paper product comprising finished or prepared cellulose fibres individually encased in a substance of non-mercerizing strength but of greater specific gravity than the cellulose fibres, said encasement being colored without changing the physical condition of the fibres.

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