

- [54] **METHOD OF ADDING A SOLUBLE ALUMINUM SALT TO CHEMICALLY SOFTENED WOOD CHIPS FOLLOWED BY MECHANICAL REFINING**
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- [51] **Int. Cl.<sup>2</sup>**..... **D21C 3/26**
- [58] **Field of Search**..... **162/28, 79**

[56]                      **References Cited**

| UNITED STATES PATENTS |        |                            |
|-----------------------|--------|----------------------------|
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**FOREIGN PATENTS OR APPLICATIONS**

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**OTHER PUBLICATIONS**

"Jordan Refining of Southern Sulphate Pulp," Gillespie et al., Paper Trade Journal, Vol. 129, No. 19, pp. 38-44.

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[57]                      **ABSTRACT**

In the production of pulp by mechanical refining of chemically softened wood chips, typically wood chips chemically softened in a high yield pulping process using a sodium bisulphite solution, a soluble aluminum salt, typically alum, is added to the pulp prior to the mechanical refining to achieve improved stretch, fibre flexibility and conformability.

**8 Claims, No Drawings**

# METHOD OF ADDING A SOLUBLE ALUMINUM SALT TO CHEMICALLY SOFTENED WOOD CHIPS FOLLOWED BY MECHANICAL REFINING

## FIELD OF THE INVENTION

The present invention is directed to the production of chemical pulps, particularly to the production of high yield pulps with improved performance characteristics.

## BACKGROUND TO THE INVENTION

The production of wood pulp in high yield is known from Canadian Pat. No. 546,513 and involves a two-stage treatment in which the wood chips first are treated with pulping chemicals, typically a sodium bisulfite solution, to soften the bonds between the fibres, softened chips being obtained in a high yield, ranging typically from about 55 to about 75%, and thereafter the softened chips are refined by mechanical action by closely spaced rotating discs to cause separation of the fibres one from another while avoiding substantially damage to the fibres. The resulting pulp then may be forwarded to paper-making machines.

It is known that, if only sufficient power is applied to the pulp to separate the fibres, the resulting pulps have less than optimum paper-making properties, as evidenced by low efficiency of paper-making machines using such pulp. The reasons for this observed result are obscure and the subject of some controversy.

It is common practice, therefore, to use mechanical action in excess of the minimum requirement, causing the creation of new fibre surfaces by detachment of fibrils, and kinking, bending and softening of the fibres with resulting increased stretch, fibre flexibility and conformability (i.e., the ability of the fibre to bend and come into intimate contact with other fibres in such a way as to produce more and larger areas of contact and thus greater fibre-to-fibre bonding) all of which are desirable results.

However, such additional refining does suffer from the drawback that it results in the undesirable effects of fibre shortening, generation of fines and a drop in pulp freeness. In refiner operations, it is desirable to maximize the former effects while minimizing the latter effects to achieve an optimum efficiency in paper making.

The mechanical refining operation basically involves two mechanisms, namely:

- i. friction and impact between fibres and the metal plates of the refiner. Fibre cutting and a decrease in freeness tend to be associated with this mechanism; and
- ii. friction between fibres. Development of surfaces, stretch and conformability tend to be associated with this mechanism.

Efforts have been made, therefore, to favour the second mechanism in preference to the first mechanism. One prior art suggestion is to refine the pulp at high consistencies in the range of about 20 to 30%, as discussed more fully in "High Consistency Refining of Fibres," by William B. West, TAPPI Vol. 47, No. 6, pages 313 to 317 (1964). However, refining at high consistencies involves considerable capital investment in thickeners required to achieve these consistencies.

## SUMMARY OF THE INVENTION

In accordance with the present invention, at least one soluble aluminum salt is added to the softened pulp

from the chemical treatment prior to the mechanical refining under conditions which favour the retention of aluminum ion by the pulp.

The addition of a soluble aluminum salt to the pulp prior to refining results in a substantial increase in fibre-to-fibre friction and the production of pulp of a quality at least as good as that realized at high consistencies, without the necessity for the use of expensive thickeners.

## GENERAL DESCRIPTION OF INVENTION

The soluble aluminum salt preferably employed in the process of the present invention is alum ( $\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$ ) due to its cheapness, ready availability and effectiveness over a broad range of conditions. The invention is described more particularly hereinafter with respect to alum, although other suitable water soluble aluminum salts may be employed.

Alum currently is employed in paper-making procedures, generally for the control of pitch and for producing a hardening of the web at the wet end of a paper-making machine. The term "hardening" as used in this context refers to the obtaining of a higher solids content in the web due to an improved drainage. However, there has never been any suggestion, as far as I am aware, to use alum to treat chemically treated stock prior to refining.

Suggestions have been made to incorporate metallic ions, such as aluminum ions derived from alum in refining and beating processes carried out on low yield or slush pulps obtained in a separated form by chemical pulping to control pitch and/or drainage.

For example, in an article by W. F. Gillespie and J. J. Goss entitled "Jordan Refining of Southern Sulphate Pulp," Paper Trade Journal, vol. 124, no. 19, pages 38 to 44, it was concluded that for high efficiency in power consumption the quantity of alum added before refining should be held to a practical minimum and capacity is increased when as little alum as possible is used before refining.

Further, in an article by W. E. Cohen, G. Farrant and A. J. Watson entitled "The Influence of Electrolytes on Pulp and Paper Properties," Australian Pulp and Paper Industry Technical Association Proceedings, 1947, pages 72 to 104, an interaction between electrolytes, including alum, and pulp fibres results in a retardation of beating. The authors concluded that if alum is indispensable to efficient sizing, then a reduction in paper strength must be accepted. On the other hand, so much waste of beating energy is involved that a search for either an alternative sizing agent or a different technique is warranted.

The present invention is directed to an entirely different mill procedure, and, contrary to the authors' position in both articles that alum should be avoided and the observed results on which this conclusion is based, in the present invention alum is added to a high yield chemical pulp which is in chip form to increase the efficiency of the mechanical refining.

The superior results obtained by the process of the present invention probably arise from an ion exchange with the pulp. It has long been known that pulps have cation exchange properties, commonly in the range of 50 to 100 milliequivalents per kg.

It is my theory, although it is not intended that the invention be limited to this interpretation, that the remarkable increase in fibre-to-fibre friction achieved by the process of the present invention is the result of

3

substantial conversion of ion exchange sites on the cellulose to the aluminum salt form.

It is preferred to utilize a pH in the range of about 3 to 6 for the treatment with alum in accordance with the present invention since, in this pH range, aluminum ions are readily absorbed and bound by the pulp by cation exchange. A pH above about 6 usually is avoided due to the tendency of aluminum ions to precipitate as insoluble aluminum hydroxide, in which form it is not readily absorbed by the pulp. Similarly, a pH below about 3 generally is less preferred since at low pH's, metal ions tend to be removed from the pulp and replaced by hydrogen ions.

The quantity of alum which is employed may vary widely, although it is preferred to employ an amount which "saturates" the pulp with aluminum ions, that is, the condition in which the ion exchange groups of the cellulose are substantially in the aluminum salt form. For most chemical pulps, the saturation quantity corresponds to a quantity of alum of about 30 lbs per ton of pulp. However, generally quantities of alum between about 5 and 50 lbs per ton of pulp may be utilized.

The pH of the alum treatment affects the efficiency with which the aluminum ions are absorbed by the fibres, as noted above, and in such instances more alum may be required to produce an optimum result.

In many instances, for example, where refiner power or capacity is limited, development of maximum fibre-to-fibre friction may be undesirable. In such cases, less than the equivalent amount of alum may be added. By varying the amount of alum addition, the energy input to the pulp may be varied, and the pulp properties adjusted to meet particular requirements.

The pulp to which the alum is added prior to refining preferably has a consistency of about 8 to 10%, since these values are readily attained by free drainage of the pulp in conventional equipment. Higher consistencies may be used but, in general, may be attained only with elaborate dewatering devices, such as screw presses. Lower consistencies down to about 3% may be used, although the beneficial effect of the invention is diminished at such lower consistencies.

The chemical pulp to which alum is added prior to refining may be formed in any desired manner, although the invention has particular applicability to wood pulp formed by softening wood chips with sodium bisulfite pulping liquor. The beneficial effect on the refined pulp quality achieved by the process of the invention, is evidenced by increased stretch, fibre-flexibility and conformability, achieved without the undesirable side-effects caused by additional mechanical action and without the necessity for the use of expensive thickeners to increase the consistency of the pulp.

The beneficial effect of the process of the invention is additive to the beneficial effects of refining temperature on pulp properties. An additional benefit results from the greater generation of heat in the refining procedure, caused by the increase in interfibre friction in the alum treated stock.

### EXAMPLES

The invention is illustrated by the following Examples:

#### EXAMPLE 1

3 kg of spruce chips were presteamed 10 minutes and cooked in 12 liters of 4.6%  $\text{Na}_2\text{S}_2\text{O}_5$  solution at pH 3.5. The cooking cycle was 2 hours heating to 160°C and

4

1.5 hours heating at 160°C and 100 psi. The resulting pulp (obtained in a yield of 65%) was washed to pH 5.2 and divided into two equal portions.

One of the portions was treated with 30 lbs./O.D. ton of alum at pH 4.7, and allowed to stand overnight. Both samples were drained to 10% consistency and then refined at a nominal rate of 2 tons/day in a 12 in. Sprout Waldron refiner in two passes, at 0.02 and 0.01 in. plate separation. The results which were obtained for the two portions are reproduced in the following Table I:

TABLE I

|                       | Untreated | Alum Treated |
|-----------------------|-----------|--------------|
| Power, HPD/T 1st pass | 3.82      | 3.82         |
| 2nd pass              | 4.81      | 8.84         |
| Freeness              | 705       | 715          |
| Burst                 | 66.3      | 67.7         |
| Tear                  | 96        | 112          |
| Fibre Classification  |           |              |
| R-14                  | 27.5      | 33.3         |
| R-28                  | 44.3      | 42.6         |
| R-48                  | 15.8      | 17.7         |
| R-100                 | 4.0       | 4.6          |
| P-100                 | 8.4       | 1.8          |
| Wet Web Properties    |           |              |
| SCBL*                 | 113       | 115          |
| % Stretch             | 2.5       | 2.9          |
| Work Factor           | 277       | 330          |

(\*SCBL is Standard Connected Breaking Length)

The results reproduced in the above Table I indicate a substantial increase in refining energy under identical refining conditions. This increase is attributed to an increase in fibre-to-fibre friction resulting from the alum pretreatment. This increased refining was accomplished without loss of freeness and benefits are seen in the increased long fibre fraction, and improved tear and wet web properties.

#### EXAMPLE 2

A commercial spruce pulp was prepared and obtained in a yield of approximately 68% following the procedures of Canadian Pat. No. 546,513. Samples of the pulp were treated with 30 lbs./ton of alum for varying lengths of time and the samples were refined under conditions described in Example 1.

The results obtained are reproduced in the following Table II:

TABLE II

| Duration of Treatment | Refining Power HPD/T | CSF* |
|-----------------------|----------------------|------|
| 24 hrs.               | 45.9                 | 681  |
| 90 mins.              | 49.4                 | 672  |
| 1 min.                | 45.1                 | 655  |
| Control - no alum     | 23.7                 | 653  |

(\*CSF is Canadian Standard Freeness)

The results reproduced in the above Table II indicate that the advantages of this invention may be realized without prolonged pretreatment periods.

#### EXAMPLE 3

Samples of a high yield bisulphite pulp, prepared following the procedures of Canadian Pat. No. 546,513, were treated for 90 min. with varying amounts of alum prior to refining and the samples were refined as described in Example 1. The results are reproduced in the following Table III:

5

TABLE III

| Amount of Alum<br>lb./ton | Refining Power | CSF |
|---------------------------|----------------|-----|
| 0                         | 27.9           | 694 |
| 15                        | 35.3           | 725 |
| 30                        | 51.4           | 687 |

The results reproduced in the above Table III indicate that the amount of alum may be varied to provide the refining power required for a particular application.

SUMMARY

It will be seen, therefore, that the present invention provides a process in which an improved pulp may be provided by treatment of chemically softened pulp with a soluble aluminum salt prior to mechanical refining.

Modifications are possible within the scope of the invention.

What I claim is:

1. In a process for producing wood pulp by the successive steps of treating wood chips with an aqueous solution of a soluble bisulphite salt to soften the bonds between the fibres in the chips and obtain softened chips and subjecting the softened chips to mechanical refining to cause separation of the fibres of the softened chips one from another to provide a wood pulp, the improvement which comprises treating said softened

6

chips after said softening step and prior to said mechanical refining step with a soluble salt of aluminum which yields positive aluminum ions in solution to obtain increased fibre-to-fibre friction during said refining step and to result in increased stretch, fibre-flexibility and conformability of the fibres of the pulp while substantially avoiding fibre shortening, generation of fines and drop in freeness, said soluble salt being used in a quantity of at least 5 lbs. per ton of pulp and at a pH of about 3 to about 6.

2. The process of claim 1 wherein said treatment with a soluble salt of aluminum is carried out to convert a substantial portion of the ion exchange groups on the cellulose of the softened chips to the aluminum form.

3. The process of claim 1 wherein said soluble salt of aluminum is alum.

4. The process of claim 3 wherein said alum is used in an amount between about 5 and about 50 lbs./ton of pulp.

5. The process of claim 4 wherein the amount of alum used is about 30 lbs./ton of pulp.

6. The process of claim 1 wherein said pulp has a consistency of at least about 3% during said mechanical refining.

7. The process of claim 6 wherein said consistency is between about 8 and 10%.

8. The process of claim 1 wherein said aqueous solution is an aqueous solution of sodium bisulfite.

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