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(54) **Wash press modification for oxygen delignification process**

Modifikation von einer Waschpresse zur Delignifizierung mittels Sauerstoff

Modification de presse de lavage pour procédé de delignification à l'oxygène

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DescriptionFIELD OF INVENTION

5 The present invention relates to a method for the treatment of wood pulp, and more particularly to a method for distributing alkaline material upon brownstock pulp prior to oxygen delignification so that a highly delignified pulp can be obtained after oxygen delignification without deleteriously affecting the strength of the pulp.

BACKGROUND OF THE INVENTION

10 Wood is comprised in major proportion of cellulose and hemicellulose fiber and amorphous, non-fibrous lignin which serves to hold the fibrous portions together. The hemicellulose and the cellulose are sometimes referred to collectively as holocellulose. During the treatment of wood to produce pulp, the wood is transformed into a fibrous mass by removing a substantial portion of the lignin from the wood. Thus, processes for the production of paper and paper products generally include a pulping stage in which wood, usually in the form of wood chips, is reduced to a fibrous mass. Several different pulping methods are known in the art; they are generally classified as mechanical, chemical or semi-chemical pulping.

Chemical pulping methods include a wide variety of processes, such as the sulfite process, the bisulfite process, the soda process and the Kraft process. The Kraft process is the predominant form of chemical pulping.

20 Chemical pulping operations generally comprise introducing wood chips into a digesting vessel where they are cooked in a chemical liquor. In the Kraft process, the cooking liquor comprises a mixture of sodium hydroxide and sodium sulfide. After the required cooking period, softened and delignified wood chips are separated from the cooking liquor to produce a fibrous mass of pulp. The pulp produced by chemical pulping is called "brownstock." The brownstock is typically washed to remove cooking liquor and then processed for the production of unbleached grades of paper products or, alternatively, bleached for the production of high brightness paper products.

30 Since chromophoric groups on the lignin are principally responsible for color in the pulp, most methods for the bleaching of brownstock require further delignification of the brownstock. For example, the brownstock may be reacted with elemental chlorine in an acidic medium or with hypochlorite in an alkaline solution to effect this further delignification. These steps are typically followed by reactions with chlorine dioxide to produce a fully bleached product. Oxygen delignification is a method that has been used at an increasing rate in recent years for the bleaching of pulp because it uses inexpensive bleach chemicals and produces by-products which can be burned in a recovery boiler reducing environmental pollutants. Oxygen delignification is frequently followed by bleach stages which use chlorine or chlorine dioxide but require less bleach chemical and produce less environmental pollutants because of the bleaching achieved in the oxygen stage.

35 In some bleaching processes, the pulp is bleached while being maintained at low to medium levels of pulp consistency. Pulp consistency is a measure of the percentage of solid fibrous material in pulp. Pulps having a consistency of less than about 10% by weight are said to be in the low to medium range of pulp consistency. Processes which require bleaching at low to medium consistency are described in the following patents and publications: US-A-4,198,266, issued to Kirk et al; US-A-4,431,480, issued to Markham et al; US-A-4,220,498, issued to Prough; and an article by Kirk et al. entitled "Low-consistency Oxygen Delignification in a Pipeline Reactor - A Pilot Study", TAPPI, May 1978. Each of the foregoing describe an oxygen delignification step that operates upon pulps in the low to medium consistency range.

40 US-A-4,806,203, issued to Elton, discloses an alkaline extraction, preferably for chlorinated pulp, wherein the timed removal of alkaline solution is essential to prevent redepositing of dissolved lignin back onto the pulp. If too short or too long of a time period passes in this stage, the process shows little benefit.

45 Oxygen delignification of wood pulp can be carried out on fluffed, high consistency pulp in a pressurized reactor. The consistency of the pulp is typically maintained between about 20% and 30% by weight during the oxygen delignification step. Gaseous oxygen at pressures of from about 80 to about 100 psig is introduced into and reacted with the high consistency pulp. See, G.A. Smook, Handbook for Pulp and Paper Technologists, Chapter 11.4 (1982). In previous oxygen delignification operations, the pulp after cooking is washed and dewatered to produce a high consistency mat. The pulp mat is then covered with a thin film or layer of an alkaline solution, by spraying the solution onto the surface of the mat. The amount of alkaline solution sprayed onto the mat is about 0.8 to 7% by weight of oven dry pulp.

50 Previously used high consistency oxygen delignification processes have several disadvantages. In particular, it has now been found that spraying an alkaline solution onto a mat of high consistency pulp does not provide an even distribution of solution throughout the fibrous mass, notwithstanding the generally porous nature of such mats. As a result of this uneven distribution, certain areas of the high consistency mat, usually the outer portions, are exposed to excessive amounts of the alkaline solution. This excessive exposure is believed to cause nonselective degradation of the holocellulosic materials resulting in a relatively weak pulp, at least locally. On the other hand, other portions of the

high consistency mat, typically the inner portions, may not be sufficiently exposed to the alkaline solution to achieve the desired degree of delignification. Thus, overall quality declines.

SUMMARY OF THE INVENTION

The present invention provides a novel process for obtaining enhanced delignification selectivity of a pulp during a high consistency oxygen delignification process wherein the oxygen delignified pulp has greater strength and a lower lignin content than has been attainable by prior art processes. In addition, a wash press is utilized to apply a desired quantity of alkaline material onto the pulp while also reducing the amount of solids on the pulp at low consistency of less than 5% by weight which enters the oxygen delignification reactor.

The process in accordance with the present invention, is characterized in that a first amount of alkaline material is applied to pulp at low consistency of less than 5% by weight by treating the pulp in a wash press to dewater wash and displace the water present with the pulp with a solution of an alkaline material and to increase the consistency of the alkaline material containing pulp to a high consistency of at least 18 percent by weight, wherein the alkaline material is added to the wash press and the wash press is operated at a dilution factor of 0.4 or less and at a displacement ratio of at least 0.5, and substantially uniformly distributing the alkaline material throughout the pulp while simultaneously washing the pulp;

pressate is removed from the wash press;

a total amount of alkaline material is provided on the high consistency pulp of at least 0.8 to 7 percent by weight based on the oven dry weight of the pulp, said total amount including said first amount, wherein the first amount represents at least 55% of the total amount of alkaline material; and the alkaline material containing high consistency pulp is oxygen delignified

In one embodiment of the invention, the pulp is brownstock which is washed with a sufficient amount of alkaline material so that the first amount applied to the pulp equals the total amount. The pulp may be mixed with dilution water to obtain a low consistency pulp having a consistency of less than about 5 percent by weight and preferably between about 1 and 4.5 percent by weight before being directed into the wash press. The wash press increases the consistency of the pulp to a high consistency, and removes pressate. At least a portion of this pressate can be used as the dilution water.

The pressate may contain alkaline material and, if so, a portion may be used to wash the pulp prior to directing the pulp to the wash press. Ideally, the wash press is operated at a dilution factor at or near zero and at a displacement ratio of as close to 1 as possible to minimize the total alkaline required. These values are difficult to achieve and maintain in commercial operation, however, so that the wash press should be operated at a dilution factor of 0.4 or less, preferably less than 0.25 and at a displacement ratio of at least about 0.5 and preferably above about 0.75.

In a second embodiment, a split alkaline material addition sequence is used to apply the total amount of alkaline material to the pulp. The first amount of alkaline material is applied to the pulp in the wash press while a second amount is applied to the high consistency pulp. This reduces the amount of alkaline material utilized in the wash press.

For either embodiment, a predetermined quantity of pressate may be retained in a holding tank. This quantity of pressate may be continuously returned or recycled directly to the pulp/dilution water mixing step. The total amount of alkaline material applied to the pulp is generally between about 0.8 and 7 percent by weight based on oven dry pulp, and the pulp is then subjected to oxygen delignification whereby enhanced delignification is achieved.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a graph showing the relationship between pulp viscosity and K No. for softwood pulps treated with alkaline material and delignified with oxygen according to the present invention compared to those representative of the prior art;

Figure 2 is a schematic representation of the process of the present invention;

Figure 3 is a graph showing the relationship between percent viscosity change according to the proportion of alkaline material applied to the pulp at high consistency; and

Figure 4 is a graph showing the percent retention of alkaline material on the pulp for operation of the wash press at various displacement ratios.

DESCRIPTION OF PREFERRED EMBODIMENTS

The present invention relates to a process of treating brownstock pulp with alkaline material prior to high consistency oxygen delignification wherein the pulp is substantially uniformly treated with the alkaline material in a manner

which minimizes usage of alkaline material and solids build up on the pulp.

In US-A-5,085,734 it was demonstrated that delignification selectivity across a high consistency oxygen stage could be increased by substantially uniformly distributing alkaline material throughout the pulp. This distribution is achieved by mixing a solution of alkaline material with low consistency pulp prior to pressing the pulp to high consistency. Thus, a reduction in K No. in the pulp across the oxygen stage of greater than 50% and generally at least 60% or more can be achieved with essentially no damage to the cellulose portion of the pulp.

The examples of the patent demonstrate the unexpected degree of improvement in delignification selectivity compared to spraying the alkaline material onto a pad of high consistency pulp after it emerges from a press or other thickening device. This is shown by the reduction in pulp K No. from about 10 to 26 upon entering the oxygen reactor (depending upon the type of wood and the type of pulping conducted upon the particular wood) to between about 5 and 10 after oxygen delignification with a change in viscosity of the pulp from about 19 cps or more for the incoming pulp to at least about 13 cps for the oxygen delignified pulp. For softwood pulp, this data is summarized and illustrated in the graph of Figure 1.

While this patented technique is successful, it requires the use of greater amounts of alkaline material compared to the spray applied process, because much of the alkaline material is retained in the pressate. The process of the present invention achieves similar results in the uniform distribution of alkaline material throughout the pulp by utilizing a wash press to introduce the alkaline material onto the pulp, while utilizing less alkaline material than the patented alkaline material distribution process. Furthermore, since the same amounts of alkaline material are substantially uniformly distributed throughout the pulp, the same advantages with regard to increased delignification selectivity across the subsequent oxygen delignification stage would be achieved.

A wash press typically includes two synchronous, counter-rotating, dewatering rolls configured and designed to provide a dewatering section, a wash section and a final extraction section. Pulp enters the press at a low consistency of about 3.5 percent by weight in solution with dilution water. In the initial dewatering section, the consistency is increased to about 10 percent by weight and a pad is formed on the rolls. In the wash section, wash water is introduced onto the free side of the pad and begins to be forced to pass therethrough, displacing the dilution water in the pad. In the extraction (or consolidation) section, additional dilution and wash water is displaced from the pad to raise the consistency of the pulp. The pulp then exits the press at a high consistency of between about 25 and 35 percent by weight.

To understand the present invention, one must be familiar with the terms and conditions relating to pulp washing. The term "dilution water" is used to refer to the water associated with the pulp as it enters the press.

The term "wash water" is used to mean the water that is added to the press independent of the pulp.

The term "dilution factor" is used to mean the amount of wash water which is added to the wash press in excess of that required to replace the amount of water which exits with the pulp at the wash press outlet consistency. For an amount of wash water which is needed only to replace only that amount which leaves with the pulp, the dilution factor ("DF") would be zero. This factor is expressed as pounds of water per pound of air dry ("AD") fiber (note: 1 pound AD fiber equals 0.9 pound oven dry ("OD") fiber). The dilution factor can be calculated from the following formula:

$$DF = WT - \left[\frac{0.41 \text{ kg } (0.9 \text{ lb}) \text{ OD fiber}}{\text{kg } (1 \text{ lb}) \text{ AD fiber}} \times \left(\frac{100-C}{C} \right) \right]$$

where

WT is the amount of wash water utilized (in kg (pounds) per kg (pound) of air dry fiber; and
C is the consistency of the pulp exiting the wash press.

For example, for a DF of zero and 28% consistency pulp, the amount of wash water necessary to replace that which leaves with the pulp is calculated as follows:

$$0 = WT - \left[0.9 \times \left(\frac{1 - .28}{.28} \right) \right]$$

or

WT = 2.31 kg (pounds) of water per kg (pound) of air dry fiber

An amount of water greater than this 2.31 value provides an excess which leaves the wash press as pressate.

The term "displacement ratio" is used to mean a fraction representing the actual change in concentration of a dissolved component in the dilution water associated with the pulp exiting the wash press divided by the maximum possible change, i.e., the concentration of the component in the wash water less the concentration of the same component in the dilution water. The displacement ratio ("DR") can be calculated from the following equation:

$$DR = (X_{OUT} - X_{IN}) / (X_W - X_{IN})$$

where

X_{OUT} is the concentration of a particular component in the dilution water leaving with the pulp;
 X_{IN} is the concentration of the same component in the dilution water entering the wash press; and
 X_W is the concentration of the same component in the wash water.

It is readily observed that, when $X_{OUT} = X_W$, the displacement ratio is 1, while for displacement ratio of less than 1,

$$X_{OUT} = (DR) (X_W) + (1-DR) (X_{IN})$$

For example, if DR = 0.75:

$$X_{OUT} = 0.75(X_W) + 0.25(X_{IN})$$

while for a DR of 0.5:

$$X_{OUT} = 0.5(X_W) + 0.5(X_{IN})$$

These washing concepts usually apply to the removal of an unwanted component, such as black liquor solids, from the pulp where the concentration of the component in the wash water is substantially less than in the dilution water. In the present invention, however, these relationships are utilized to illustrate how the concentration of a component in the wash (such as alkaline material) water can be made higher than its concentration in the dilution water so that the component can be added to, rather than removed from, the pulp.

As is evident from the formulae presented above, with a dilution factor of zero and a displacement ratio of 1, all alkaline material added to the wash water (at a concentration of X_W) will theoretically be retained upon the pulp as it exits the wash press. While it is not possible to commercially operate the wash press to achieve complete displacement and substitution of the wash water for the dilution water contained in the pulp, the process should be operated at dilution factors of below about 0.4 and at displacement ratios above 0.5. This provides three advantages for the process of the present invention.

- 1) very little alkaline material is lost from the wash press into the pressate;
- 2) rapid responses to pulp changes can be achieved by changing the concentration of alkaline material in the wash water (X_W); and
- 3) sufficient washing of the pulp occurs in the press so that the carryover of dissolved black liquor or other contaminants into the oxygen reactor is significantly reduced.

Another advantage of this embodiment of the present process is that the control strategy and equipment for the introduction of alkaline material is simplified, in that only one addition point is required.

The present invention therefore provides high quality, high strength, delignified wood pulp from Kraft pulp or pulps produced by other chemical pulping processes. The preferred starting material is unbleached pulp obtained by cooking wood chips or other fibrous materials in a cooking liquor, such as by the Kraft or Kraft AQ process.

With reference to Figure 2, wood chips 1 and a white liquor 2 comprising sodium hydroxide and sodium sulfide are introduced into a digester 3. Sufficient white liquor should be introduced into the digester to substantially cover the

wood chips. The contents of the digester are then heated at a temperature and for a time sufficient to allow the white liquor to substantially impregnate the wood chips and substantially complete the cooking reaction.

This wood chip cooking step is conventionally known as Kraft cooking or the Kraft process and the pulp produced by this process is known as Kraft pulp or Kraft brownstock. Depending upon the lignocellulosic starting material, the delignification results obtained with the conventional Kraft process may be increased by the use of extended delignification techniques or the Kraft-AQ process. Moreover, these techniques are preferred for obtaining the greatest degree of reduction in K No. of the pulp without deleteriously affecting the strength and viscosity properties of the pulp during the cooking stage.

When using the Kraft-AQ technique, the amount of anthraquinone in the cooking liquor should be an amount of at least about 0.01% by weight, based on the oven dried weight of the wood to be pulped, with amounts of from 0.02 to about 0.1% generally being preferred. The inclusion of anthraquinone in the Kraft pulping process contributes significantly to the removal of the lignin without adversely affecting the desired strength characteristics of the remaining cellulose. Also, the additional cost for the anthraquinone is partially offset by the savings in cost of chemicals utilized in the bleaching steps which follow oxygen delignification of the pulp.

Alternatively or additively to Kraft-AQ is the use of techniques for extended delignification such as the Kamyr MCC, Beloit RDH and Sunds Super Batch Methods. These techniques also offer the ability to remove more of the lignin during cooking without adversely affecting the desired strength characteristics of the remaining cellulose.

The digester 3 produces a black liquor containing the reaction products of lignin solubilization together with brownstock 4. The cooking step is typically followed by washing to remove most of the dissolved organics and cooking chemicals for recycle and recovery, as well as a screening stage in which the pulp is passed through a screening apparatus to remove bundles of fibers that have not been separated in pulping. The brownstock 4 is then directed to a blow tank 5.

Brownstock 6 exiting blow tank 5 is washed in washer 7 generally with effluent 8 generated from the washing of pulp downstream of the oxygen delignification reactor. The washed pulp 9 exits the washer 7 at a consistency of about 15 to 18 percent by weight and is directed to a dilution tank 10, where it is diluted to a consistency of about 3.5 percent by weight. The dilution water on startup is supplied by filling the tank 10 with water 11. The pulp/dilution water stream 12 is then directed into wash press 13 where alkaline material is added to the pulp.

A preferred wash press 13 is Displacement Press DP, which is available from Sunds Defibrator AB, Sundsvall, Sweden. Other twin-roll presses may also be used, provided that they possess the combination of dewatering, washing and displacement of the pulp, as described above. The Sunds device includes two synchronous, counter-rotating dewatering rolls in a pressurized vat that has dual pulp inlets. A pad of pulp having a consistency of about 10 percent by weight is formed on the rolls at the end of the dewatering section.

A solution 14 of sodium hydroxide, oxidized white liquor, or other equivalent alkaline material is used to wash the pulp in the wash press 13. This solution 14 is preferably prepared by mixing concentrated alkaline material with bleached pulp wash water effluent. Then, solution 14 is introduced on the free side of the pulp pad and begins to move through the pulp pad to displace the dilution water therein. By attempting to operate at a displacement ratio of close to 1 and a dilution factor of close to zero, most of the alkaline material used to wash the pulp is substantially uniformly distributed throughout the pulp and is retained thereon. As noted above, the wash press 13 should be operated at a dilution factor of less than 0.4 and a displacement ratio of at least about 0.7 to achieve the desired distribution of alkaline material on the pulp. The alkaline material containing pulp then exits the wash press 13 at a consistency of 25 to 35 percent by weight. In a most preferred embodiment, the pulp 15 has a consistency of about 28 to 29 percent by weight.

The wash press 13 enables reduced quantities of alkaline material to be used for application of the desired amount onto the pulp compared to e.g., the use of a chest to add to alkaline material to the pulp. Also, the amounts of organic and/or inorganic solids on the pulp exiting the wash press 13 are reduced, so that less of these contaminants are carried by the pulp into the oxygen reactor. Thus, lesser amounts of chemical are consumed during the oxygen reaction with the pulp. In addition, compared to a conventional washer, less alkaline material is lost to the plant liquid recovery system due to pressate discharge or due to "breakthrough" of pressate into the washer effluent.

One skilled in the art can select the appropriate quantities (i.e., concentrations and flow rates) of alkaline solution 14 to be added to the wash press in this step to achieve a distribution of the desired amount of alkaline material throughout the pulp. In particular, the aqueous sodium hydroxide solution 14 is combined with the pulp in an amount sufficient to provide at least about 0.8 to about 7 percent by weight of sodium hydroxide on pulp based on OD pulp after the consistency is increased by the wash press. As noted above, other sources of alkaline material having equivalent sodium hydroxide content can also be employed, such as oxidized white liquor.

The wash press 13 also removes residual liquid 16, called pressate or wash filtrate, from the pulp. Also, alkaline material which is not retained on the pulp due to less than ideal displacement will be included in pressate 16. This pressate 16 is directed to a holding or seal tank 17, which can be used to achieve smooth, continuous operation of the process by retaining all pressate 16 from wash press 13. At least a portion 18 of pressate 16 is recycled to the dilution tank 10. Upon startup, holding tank 17 is filled with a suitable source of dilution water 11, generally fresh water. During

continuous operation of the process, pressate portion 18 is returned to the dilution tank 10 and constitutes substantially all the dilution water. Thus, stream 11 is utilized only upon startup (i.e., before pressate is generated by the wash press 13) or when additional dilution water is needed. Alternatively, a portion 19 of the pressate can be used to wash the pulp upstream of wash press 13 at washer 7 as part of stream 8. Also, as shown, a split shower can be used on washer 7, with part of the wash water provided by stream 8 and part by stream 19. Pressate portion 19 can be discharged to the plant recovery system as necessary to maintain water balance in the dilution tank/wash press circulation loop.

For the situation where significant amounts of alkaline material are introduced into the pressate due to imperfect displacement of the wash water 14 into the pulp, the concentration of the alkaline material in the wash water 14 can be increased to compensate for such imperfect displacement. The recycling of the pressate to the dilution tank raises the concentration of alkaline material in the dilution water, thus enabling the pulp/dilution water stream 12 to have a greater content of alkaline material. This recycling increases alkaline material retention in the pulp to the desired level at the expense of a slight lowering in the degree of washing action and the reduction of carryover of undesired material on the pulp 15 which exits the wash press.

One skilled in the art having the benefit of this disclosure before them can determine by routine experimentation the appropriate alkaline material concentrations for the wash water 14 based on the actual dilution factors and displacement ratios used to operate the wash press 13 to apply the desired amount to the pulp.

In a second embodiment of the invention, which is also shown in Figure 2, a first portion of the total amount of alkaline material necessary for application to the pulp for the high consistency delignification in the oxygen reactor 21 is added to the wash press 13 in the manner described above.

In WO-A-92/12288 it was demonstrated that the application of about half of the desired amount of alkaline material to the pulp in a substantially uniform distribution, such as by mixing low consistency pulp with a solution of a alkaline material, followed by applying the remaining half of the amount by spraying onto high consistency pulp enables the pulp to achieve comparable increased delignification selectivities compared to the application of all alkaline material to the low consistency pulp. In addition, the quantity of alkaline material needed to apply the desired amount onto the pulp was reduced compared to the full low consistency application, while the spraying of a portion of the alkaline material onto the high consistency pulp enables that process to provide rapid modification or adjustment of the total amount to be applied to the pulp to compensate for changes in the properties of the pulp or to vary the degree or extent of the oxygen delignification of that pulp.

Examples 6 to 9 of that patent application illustrate the benefits obtainable by application of the alkaline material according to the split addition process. Figure 3 of the present invention illustrates the effect of increasing the percentage of proportion of alkaline material utilized in treating the high consistency pulp. The solid horizontal line proximate to the 0 viscosity change numeral corresponds to the baseline viscosity achieved with all alkaline material applied to low consistency pulp. The two broken horizontal lines on either side of the solid 0 line delineate the boundaries of a typical $\pm 6\%$ deviation in viscosity. As is evident from Figure 3, as the amount of alkaline material applied onto the high consistency pulp exceeds about 50% of the total applied to the pulp, the viscosity of the delignified pulp drops below the acceptable deviation. The benefits of enhanced delignification selectivity are also reduced for applications of 50% or more of the alkaline material to the high consistency pulp. Therefore, at least about 55 to 90% of the alkaline material should be applied to the low consistency pulp, with the balance applied to the high consistency pulp.

The present invention contemplates similar advantages by applying about half of the total amount of alkaline material during the wash press 13 treatment described above. Thereafter, a second amount of additional alkaline material 20 is applied to the high consistency brownstock 15 exiting the wash press 13 by conventional spray techniques to obtain the desired total amount of alkaline material on the pulp prior to oxygen delignification. This second amount of alkaline material is selected to apply the remaining amount necessary (again, about one-half of the total amount) to achieve the desired extent of delignification in the subsequent oxygen delignification step which is carried out on the alkaline material treated high consistency pulp.

As noted above, the total amount of alkaline material actually applied onto the pulp will generally be between 0.8 and 7 percent by weight based on OD pulp, and preferably between about 1.5 and 4 percent by weight for southern softwood and between about 1 and 3.8 percent by weight for hardwood. In the alternate embodiment of Figure 2, about half these amounts are preferably applied in each of the low consistency and high consistency treatments. Thus, about 0.5 to 2 percent by weight, preferably about 0.5 to 1.9 percent by weight for hardwood and 0.75 to 2 percent by weight for softwood, is applied onto the pulp during each of the low and high consistency pulp alkaline treatments.

The split addition process of this invention further improves control of the addition of alkaline material to the pulp. The high consistency alkaline treatment step allows rapid modification or adjustment of the total amount of the alkaline material present in or upon the pulp which will enter the oxygen delignification reactor 21. The combination of easy control of both the amount of alkaline material added to the wash water of the press with the amount sprayed onto the high consistency pulp creates an optimum response to changing delignification requirements in that the precise total amount to be applied to the pulp can be easily and rapidly varied to compensate for changes in the properties (i.e., wood type, K No. and viscosity) of the incoming brownstock, or to vary the degree or extent of oxygen delignification

for a particular pulp.

The fully alkaline material treated pulp 15 is then forwarded to the oxygen delignification reactor 21 where it is contacted with gaseous oxygen 22 by any of a number of well known methods. Suitable conditions for oxygen delignification according to the present invention comprise introducing gaseous oxygen at about 80 to about 689 kPa (100 psig) to the high consistency pulp while maintaining the temperature of the pulp between about 90 and 130°C. The average contact time between the high consistency pulp and the gaseous oxygen ranges from about 15 minutes to about 60 minutes.

After oxygen delignification in reactor 21, the delignified pulp 23 is washed to remove dissolved organics and to produce a high quality, low color pulp. As noted above, the effluent from this washing stage can be recycled for use on washer 7 or for introduction as stream 11 for dilution tank 10. A portion of this stream is preferably utilized as stream 14 after the addition of concentrated sodium hydroxide or oxidized white liquor thereto. The oxygen delignified pulp can be used to form paper products of unbleached brownstock, or can be sent to subsequent bleaching stages to produce a fully bleached product.

Additional advantages of the present invention can be obtained during the subsequent bleaching of the oxygen delignified pulp 23. Such bleaching can be conducted with any of a wide variety of bleaching agents, including ozone, peroxide, chlorine, chlorine dioxide, hypochlorite or the like. When conventional chlorine/chlorine dioxide bleaching processes are used to increase the degree of brightness of the pulps which have been treated with alkaline material as described above, a substantially reduced amount of total active chlorine is used compared to the bleaching of pulps which are oxygen delignified by prior art techniques. The total amount of chlorine-containing chemicals utilized according to the present invention is reduced compared to the amount needed for the same starting pulp which is not treated with alkaline material in a wash press. Similarly, when the chlorine/chlorine dioxide treated pulp is followed by an alkaline extraction stage, substantially reduced amounts of alkaline material are needed in this stage compared to a bleaching process for pulps which have not been uniformly combined with alkaline material at low consistency. The amount of alkaline material utilized in the extraction step would also be reduced for pulp treated with alkaline material at in a wash press as disclosed herein.

In addition to providing cost advantages with respect to the reduced amounts of chemical necessary for such treatments, the process of the present invention also reduces the amounts of environmental pollutants caused by the use of chlorine, since reduced amounts of chlorine are used. Furthermore, due to the lower usage of chemicals in this portion of the system, the amount of contaminants in the waste water from the plant which is to be treated is correspondingly reduced with similar savings in waste water treatment facilities and related costs.

EXAMPLES

Example 1:

A mathematical model was used to illustrate the process of the present invention on softwood pulp as described in Figure 2 with the wash press operated at a dilution factor of 0 and a displacement ratio of 0.95. For this embodiment, pressate portion 19 is utilized as wash water 8 on washer 7. The flow rates for the applicable streams would be as follows:

Process Stream (Fig. 2)	Flow Rate			Pulp Consistency (%)	Sodium Hydroxide	
	liquid		pulp		kg/hr	(lb/hr)
	(lpm)	(gpm)	(t/d)			
9	1908.4	(504.2)	580.8	18	95.0	(209.5)
12	10319.8	(2726.5)	580.8	3.5	695.7	(1533.8)
14	938.3	(247.9)	--	--	550.4	(1213.3)
15	1181.7	(312.2)	580.8	28	526.1	(1159.8)
16	10076.4	(2662.2)	--	--	720	(1587.3)
19	1665.4	(440.0)	--	--	118.8	(262.0)

Thus, the table shows that the pulp exiting the wash press (stream 15) at a flow rate of 580.8 t/d has a consistency of 28% and contains 1159.8 lb/hr of sodium hydroxide. This calculates to an amount of sodium hydroxide applied to the pulp of about 2.4%. If the wash press could be operated at a displacement ratio of 1, than all alkali added to the wash press by stream 14 would be applied to the pulp leaving the press at stream 15. For operation at displacement ratios of less than 1, a portion of the alkaline material added to the wash press by stream 14 will be lost into the pressate.

Example 2:

To illustrate the transfer of alkaline material to the pulp when operating at different displacement ratios, the graph of Figure 4 is presented. This illustrates a mathematical model for a wash press that is operated at a dilution factor of 0 and shows how the amount of alkaline material applied to the pulp can vary as the displacement ratio is changed. In this model, the pressate is recycled to both the dilution tank and stream 18 and to brownstock washer 7 as a portion of stream 8. The results thus show the benefit of increased alkaline material retention on the pulp due to recycling.

Claims

1. A process for obtaining enhanced delignification selectivity of a pulp during high consistency oxygen delignification, characterized in that a first amount of alkaline material is applied to pulp at low consistency of less than 5% by weight by treating the pulp in a wash press to dewater, wash and displace the water present with the pulp with a solution of an alkaline material and to increase the consistency of the alkaline material containing pulp to a high consistency of at least 18 percent by weight, wherein the alkaline material is added to the wash press and the wash press is operated at a dilution factor of 0.4 or less and at a displacement ratio of at least 0.5, and substantially uniformly distributing the alkaline material throughout the pulp while simultaneously washing the pulp;

pressate is removed from the wash press;
a total amount of alkaline material is provided on the high consistency pulp of at least 0.8 to 7 percent by weight based on the oven dry weight of the pulp, said total amount including said first amount, wherein the first amount represents at least 55% of the total amount of alkaline material; and the alkaline material containing high consistency pulp is oxygen delignified.
2. The process of claim 1 wherein the pulp is brownstock and which further comprises washing the brownstock in the wash press with a sufficient amount of alkaline material solution so that the first amount applied to the brownstock equals the total amount.
3. The process of claim 1 which further comprises mixing the pulp with dilution water to obtain a low consistency pulp having a consistency of less than 5 percent by weight and directing the pulp into the wash press to apply the alkaline material thereto.
4. The process of claim 3 wherein the low consistency of the mixed pulp is between 1 and 4.5 percent by weight and which further comprises recycling at least a portion of the pressate from the wash press for use as the dilution of water in the mixing step.
5. The process of claim 4 wherein substantially all dilution water comprises pressate.
6. The process of claim 1 which further comprises holding the pressate which is removed from the wash press and continuously returning a portion of the pressate directly to the pulp/dilution water mixing step.
7. The process of claim 1 which further comprises applying a second amount of alkaline material onto the high consistency pulp wherein the combination of the first and second amounts equals the total amount of alkaline material provided on the high consistency pulp.
8. The process of claim 1 wherein the consistency of the pulp is increased to between 25 and 35 percent by weight prior to oxygen delignification.
9. The process of claim 1 wherein the oxygen delignifying step obtains enhanced delignification selectivity by decreasing the K No. of the high consistency pulp by greater than 50% without significantly damaging the cellulose components of the pulp.
10. The process of claim 9 wherein the K No. is decreased from 10 to 26 before delignification to 5 to 10 after delignification.
11. The process of claim 7 wherein the pulp is unbleached softwood pulp and the total amount of alkaline material applied to the pulp is between 1.5 and 4 percent by weight, with the first and second amounts each ranging between

0.75 and 2 percent by weight.

12. The process of claim 7 wherein the pulp is unbleached hardwood pulp and the total amount of alkaline material applied to the pulp is between 1 and 3.8 percent by weight, with the first and second amounts each ranging between 0.5 and 1.9 percent by weight.

13. The process of claim 1 wherein the pressate contains alkaline material and which further comprises washing the pulp with at least a portion of the pressate prior to applying alkaline material thereto in the wash press.

14. The process of claim 1 which further comprises operating the wash press at a dilution factor of 0.4 or less and a displacement ratio of at least 0.5.

15. The process of claim 14 wherein the dilution factor is 0.25 or less and the displacement ratio is at least 0.75.

16. The process according to claim 1, characterized in that:

the pulp is unbleached pulp;
prior to the application of alkaline material, the unbleached pulp is mixed with dilution water to obtain a low consistency pulp having a consistency of between 1 and 4.5 percent by weight and the pulp is directed to a wash press;
the wash press is operated at a dilution factor at or near zero and a displacement ratio of as close to 1 as possible at least a portion of the pressate is recycled as dilution water for the mixing step; and
a total amount of alkaline material of at least 0.8 to 7 percent by weight based on the oven dry weight of the pulp is provided on the high consistency pulp by washing the unbleached pulp in the wash press with a sufficient amount of an alkaline material solution so that the first amount applied to the pulp equals the total amount.

17. The process of claim 16 which further comprises holding the pressate which is removed from the wash press and continuously returning a portion of the pressate directly to the pulp/dilution water mixing step.

18. The process according to claim 1, characterized in that:

the pulp is unbleached pulp;
prior to the application of alkaline material, the unbleached pulp is mixed with dilution water to obtain a low consistency pulp having a consistency between 1 and 4.5 percent by weight and the pulp is directed to a wash press;
the wash press is operated at a dilution factor at or near zero and a displacement ratio of as close to 1 as possible;
at least a portion of the pressate is directly recycled as dilution water for the mixing step; and
a second amount of alkaline material is applied onto the high consistency pulp after it exits the wash press, wherein the combination of the first and second amounts equals a total amount of at least 0.8 to 7 percent by weight based on the oven dry weight of the pulp of alkaline material on the high consistency pulp.

19. The process of claim 18 wherein the pulp is softwood pulp and the total amount of alkaline material applied to the pulp is between 1.5 and 4 percent by weight, with the first and second amounts each ranging between 0.75 and 2 percent by weight.

20. The process of claim 18 wherein the pulp is hardwood pulp and the total amount of alkaline material applied to the pulp is between 1 and 3.8 percent by weight, with the first and second amounts each ranging between 0.5 and 1.9 percent by weight.

21. The process of claim 18 wherein the first amount of alkaline material applied to the pulp in the wash press is at least 55 to 90% of the total amount.

Patentansprüche

1. Ein Verfahren zum Erhalt einer verbesserten Lignit-Entfernungsselektivität eines Breis während hochdichter Sauerstoff-Lignit-Entfernung, dadurch gekennzeichnet, daß einem Brei eine erste Menge alkalischen Materials bei-

gegeben wird bei einer niedrigen Dichte von weniger als 5 Gewichtsprozenten, indem der Brei bearbeitet wird in einer Waschpresse zwecks Entwässerung, Waschen und Ersetzen des in dem Brei vorhandenen Wassers durch eine Lösung eines alkalischen Materials, und Erhöhung der Dichte des Breis, der das alkalische Material enthält, das Brei enthält, auf eine hohe Dichte von wenigstens 18 Gewichtsprozenten, wobei das alkalische Material der Waschpresse zugeführt wird und die Waschpresse bei einem Verdünnungsfaktor von 0,4 oder weniger und einem Verdrängungsverhältnis von wenigstens 0,5 betrieben wird und wobei das alkalische Material nahezu einheitlich auf den Brei verteilt wird, während der Brei gleichzeitig gewaschen wird;

das Preßprodukt wird aus der Waschpresse entfernt;

eine Gesamtmenge an alkalischem Material von wenigstens 0,8 bis 7 Gewichtsprozenten auf der Grundlage des ofentrocknen Gewichts des Breis wird dem hochdichten Brei beigegeben, wobei diese Gesamtmenge die erste Menge umfaßt und wobei diese erste Menge wenigstens 55 % der Gesamtmenge alkalischen Materials darstellt;

und Lignit mittels Sauerstoffs aus dem alkalischen hochdichten Brei enthaltenden Material entfernt wird.

2. Verfahren nach Anspruch 1, in dem der Brei Brownstock ist und das weiter das Waschen des Brownstock in der Waschpresse mit ausreichender Menge alkalischer Materiallösung umfaßt, so daß die erste Menge, die dem Brownstock beigegeben wird, mit der Gesamtmenge übereinstimmt.

3. Verfahren nach Anspruch 1, das weiter das Mischen und Verdünnen des Breis mit Wasser umfaßt, um einen Brei mit niedriger Dichte zu erhalten mit einer Dichte von weniger als 5 Gewichtsprozenten, sowie die Zufuhr des Breis zur Waschpresse, um ihm das alkalische Material hinzuzufügen.

4. Verfahren nach Anspruch 3, in dem die niedrige Dichte des gemischten Breis zwischen 1 und 4,5 Gewichtsprozenten gelegen ist und das weiter das Recycling von wenigstens einem Teil des Preßprodukts aus der Waschpresse umfaßt, um als Verdünnungswasser in der Mischstufe verwendet zu werden.

5. Verfahren nach Anspruch 4, in dem nahezu sämtliches Verdünnungswasser Preßprodukt ist.

6. Verfahren nach Anspruch 1, das weiter die Verwahrung des Preßprodukts umfaßt, das aus der Waschpresse entfernt worden ist, und die kontinuierliche unmittelbare Rückführung eines Teils des Preßprodukts in die Brei/Verdünnungswasser-Mischstufe.

7. Verfahren nach Anspruch 1, das weiter die Zufuhr einer zweiten Menge alkalischen Materials zum hochdichten Brei enthält, wobei die Kombination der ersten und der zweiten Mengen gleich der gesamten Menge alkalischen Materials ist, die dem hochdichten Brei beigegeben wird.

8. Verfahren nach Anspruch 1, wobei die Dichte des Breis auf zwischen 25 und 35 Gewichtsprozenten erhöht wird, bevor der Lignit mittels Sauerstoffs entfernt wird.

9. Verfahren nach Anspruch 1, wobei die Stufe der Entfernung des Lignits mittels Sauerstoffs eine erhöhte Lignit-Entfernungsselektivität erreicht, indem die K-No. des hochdichten Breis um mehr als 50 % herabgesetzt wird, ohne erhebliche Beschädigung der Zellstoff-Komponenten des Breis.

10. Verfahren nach Anspruch 9, wobei die K No. von 10 auf 26 vor der Lignit-Entfernung auf 5 bis 10 nach der Lignit-Entfernung herabgesetzt wird.

11. Verfahren nach Anspruch 7, wobei der Brei ungebleichter Weichholz-Brei ist und die Gesamtmenge alkalischen Materials, die dem Brei beigegeben wird, zwischen 1,5 und 4 Gewichtsprozenten gelegen ist, wobei die erste und die zweite Menge jeweils im Bereich zwischen 0,75 und 2 Gewichtsprozenten gelegen ist.

12. Verfahren nach Anspruch 7, wobei der Brei ungebleichter Hartholzbrei ist und die Gesamtmenge alkalischen Materials, die dem Brei beigemischt wird, zwischen 1 und 3,8 Gewichtsprozenten gelegen ist, wobei die erste und die zweite Menge jeweils im Bereich zwischen 0,75 und 1,9 Gewichtsprozenten gelegen ist.

13. Verfahren nach Anspruch 1, wobei das Preßprodukt alkalisches Material enthält und weiter den Schritt enthält des Waschens des Breis mit wenigstens einem Teil des Preßprodukts, bevor ihm in der Waschpresse alkalisches Material beigegeben wird.

14. Verfahren nach Anspruch 1, das weiter den Betrieb der Waschpresse bei einem Verdünnungsfaktor von 0,4 oder weniger und bei einem Verdrängungsverhältnis von wenigstens 0,5 umfaßt.

15. Verfahren nach Anspruch 14, wobei der Verdünnungsfaktor 0,25 oder weniger beträgt und das Verdrängungsverhältnis wenigstens 0,75 beträgt.

16. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß:

der Brei ungebleicht ist;

bevor alkalisches Material beigegeben wird, wird der Brei gemischt und mit Wasser verdünnt, um einen Brei mit niedriger Dichte zwischen 1 und 4,5 Gewichtsprozenten zu erhalten, und wird der Brei einer Waschpresse zugeführt;

die Waschpresse wird bei einem Verdünnungsfaktor von nahezu Null betrieben und bei einem Verdrängungsverhältnis, das möglichst auf eins geht, und wobei wenigstens ein Teil des Preßprodukts als Verdünnungswasser für die Mischstufe wiederverwendet wird; und

eine Gesamtmenge alkalischen Materials von wenigstens 0,8 bis 7 Gewichtsprozenten, basiert auf ofentrocknem Gewicht des Breis wird dem hochdichten Brei durch Waschen des ungebleichten Breis in der Waschpresse mit ausreichender Menge einer alkalischen Materiallösung beigegeben, so daß die erste Menge, die dem Brei beigegeben wird, mit der Gesamtmenge übereinstimmt.

17. Verfahren nach Anspruch 16, das weiter die Verwahrung des Preßprodukts, das aus der Waschpresse entfernt worden ist, sowie die kontinuierliche unmittelbare Rückführung eines Teils des Preßprodukts in die Brei/Verdünnungswasser-Mischstufe umfaßt.

18. Verfahren nach Anspruch 18, dadurch gekennzeichnet, daß:

der Brei ungebleicht ist;

bevor alkalisches Material zugeführt wird, wird der Brei gemischt und mit Wasser verdünnt, um einen Brei mit niedriger Dichte zwischen 1 und 4,5 Gewichtsprozenten zu erhalten und der Brei einer Waschpresse zugeführt wird;

die Waschpresse wird bei einem Verdünnungsfaktor von nahezu Null betrieben und bei einem Verdrängungsverhältnis, das möglichst weit auf eins geht und wobei wenigstens ein Teil des Preßprodukts als Verdünnungswasser für die Mischstufe wiederverwendet wird; und eine zweite Menge alkalischen Materials dem hochdichten Brei zugeführt wird, nachdem er die Waschpresse verläßt, wobei die Kombination der ersten und der zweiten Menge gleich der Gesamtmenge von wenigstens 0,8 bis 7 Gewichtsprozenten basiert auf ofentrocknem Gewicht des Breis des alkalischen Materials zum hochdichten Brei ist.

19. Verfahren nach Anspruch 18, wobei der Brei Weichholz-Brei ist und die Gesamtmenge des alkalischen Materials, die dem Brei beigegeben wird, zwischen 1,5 und 4 Gewichtsprozenten gelegen ist, wobei die erste und die zweite Menge jeweils im Bereich zwischen 0,75 und 2 Gewichtsprozenten gelegen ist.

20. Verfahren nach Anspruch 18, wobei der Brei Hartholzbrei ist und die Gesamtmenge des alkalischen Materials, die dem Brei beigegeben wird, zwischen 1 und 3,8 Gewichtsprozenten gelegen ist, wobei die erste und die zweite Menge jeweils im Bereich zwischen 0,5 und 1,9 Gewichtsprozenten gelegen ist.

21. Verfahren nach Anspruch 18, wobei die erste Menge alkalischen Materials, die dem Brei in der Waschpresse beigegeben wird, wenigstens 55 bis 90 % der Gesamtmenge ist.

Revendications

1. Procédé pour obtenir une sélectivité améliorée de l'enlèvement d'une pulpe lors d'un enlèvement d'oxygène-lignite haute densité, caractérisé en ce qu'on introduit une première quantité de matière alcaline à une pulpe lors d'une basse densité de moins de 5 pour cent en poids en traitant la pulpe dans une presse à laver pour la déshydrater et laver et pour remplacer l'eau présente dans la pulpe par une solution d'une matière alcaline et pour augmenter la densité de la pulpe comprenant la matière alcaline à une haute densité de 18 pour cent en poids, la matière alcaline étant ajoutée à la presse à laver et la presse à laver étant opérée à une dilution de 0,4 ou moins et à un rapport de déplacement d'au moins 0,5, et la matière alcaline étant répartie sensiblement uniformément sur la

pulpe pendant le lavage simultané de la pulpe;

le produit de presse est enlevé de la presse à laver; une quantité totale de matière alcaline est ajoutée à la pulpe de haute densité d'au moins 0,8 à 7 pour cent en poids basé sur le poids sec de la pulpe, cette quantité totale comprenant la première quantité, et la première quantité représentant au moins 55% de la quantité totale de matière alcaline; et

du lignite est enlevé de la matière alcaline comprenant de la pulpe à haute densité au moyen d'oxygène.

2. Procédé selon la revendication 1 dans lequel la pulpe est du brownstock, et comprenant ensuite le lavage du brownstock dans la presse à laver avec une quantité suffisante de solution de matière alcaline, de manière que la première quantité introduite au brownstock est égale à la quantité totale.

3. Procédé selon la revendication 1, comprenant ensuite le mélange et la dilution de la pulpe avec de l'eau pour obtenir une pulpe à basse densité de moins de 5 pour cent en poids, et l'introduction de la pulpe à la presse à laver pour y ajouter la matière alcaline.

4. Procédé selon la revendication 3, dans lequel la basse densité de la pulpe mélangée est comprise entre 1 et 4,5 pour cent en poids et comprenant ensuite le recyclage d'au moins une partie du produit de presse provenant de la presse à laver afin de l'utiliser comme eau de dilution dans l'étape de mélange.

5. Procédé selon la revendication 4, dans lequel pratiquement toute l'eau de dilution est du produit de presse.

6. Procédé selon la revendication 1, comprenant ensuite la conservation du produit de presse enlevé de la presse à laver, et le retour direct continu d'une partie du produit de presse à l'étape de mélange de pulpe/eau de dilution.

7. Procédé selon la revendication 1, comprenant ensuite l'introduction d'une seconde quantité de matière alcaline à la pulpe de haute densité, la combinaison de la première et de la seconde quantité étant égale à la quantité totale de matière alcaline délivrée à la pulpe de haute densité.

8. Procédé selon la revendication 1, la densité de la pulpe étant augmentée à une densité entre 25 et 35 pour cent en poids avant l'enlèvement du lignite au moyen d'oxygène.

9. Procédé selon la revendication 1, l'étape d'enlèvement du lignite au moyen d'oxygène atteignant une sélectivité augmentée d'enlèvement de lignite en baissant le no. K de la pulpe à haute densité de plus de 50% sans détérioration importante des composants de cellulose de la pulpe.

10. Procédé selon la revendication 9, le no. K étant baissé de 10 à 26 avant l'enlèvement du lignite jusqu'à 5 à 10 après l'enlèvement du lignite.

11. Procédé selon la revendication 7, la pulpe étant de la pulpe de bois tendre non blanchie et la quantité totale de matière alcaline introduite à la pulpe étant comprise entre 1,5 et 4 pour cent en poids, la première et la seconde quantité étant chacune comprise entre 0,75 et 2 pour cent en poids.

12. Procédé selon la revendication 7, la pulpe étant de la pulpe de bois dur non blanchie et la quantité totale de matière alcaline introduite à la pulpe étant comprise entre 1 et 3,8 pour cent en poids, la première et la seconde quantité étant chacune comprise entre 0,5 et 1,9 pour cent en poids.

13. Procédé selon la revendication 1, le produit de presse comprenant de la matière alcaline, et comprenant ensuite l'étape de lavage de la pulpe avec au moins une partie du produit de presse avant d'ajouter de la matière alcaline à la pulpe dans la presse à laver.

14. Procédé selon la revendication 1, comprenant ensuite l'opération de la presse à laver à une dilution à 0,4 ou moins et à un rapport de déplacement d'au moins 0,5.

15. Procédé selon la revendication 14, la dilution étant 0,25 ou moins et le rapport de déplacement étant au moins 0,75.

16. Procédé selon la revendication 1, caractérisé en ce que:

la pulpe est non blanchie;

avant d'introduire de la matière alcaline, on mélange la pulpe et on la dilue avec de l'eau pour obtenir une pulpe de basse densité avec une densité entre 1 et 4,5 pour cent en poids, et on la conduit à une presse à laver; la presse à laver est opérée à une dilution à proximité de zéro et à un rapport de déplacement qui se trouve le plus près possible de 1, au moins une partie du produit de presse étant recyclée comme de l'eau de dilution pour l'étape de mélange; et

une quantité totale de matière alcaline d'au moins 0,8 à 7 pour cent en poids basé sur le poids sec de la pulpe est ajouté à la pulpe de haute densité en lavant la pulpe non blanchie dans la presse à laver avec une quantité suffisante de dilution de matière alcaline, de manière que la première quantité introduite à la pulpe est égale à la quantité totale.

17. Procédé selon la revendication 16, comprenant ensuite la conservation du produit de presse enlevé de la presse à laver, et le retour direct continu d'une partie du produit de presse à l'étape de mélange de pulpe/eau de dilution.

18. Procédé selon la revendication 1, caractérisé en ce que:

la pulpe est non blanchie;

avant d'introduire de la matière alcaline, on mélange la pulpe et la dilue avec de l'eau pour obtenir une pulpe de basse densité avec une densité entre 1 et 4,5 pour cent en poids, et on la conduit à une presse à laver; la presse à laver est opérée à une dilution à proximité de zéro et à un rapport de déplacement qui se trouve le plus près possible de 1, au moins une partie du produit de presse étant recyclée comme de l'eau de dilution pour l'étape de mélange; et

une seconde quantité de matière alcaline est introduite à la pulpe de haute densité après être sortie de la presse à laver, la combinaison de la première et de la seconde quantité étant égale à la quantité totale d'au moins 0,8 à 7 pour cent en poids basé sur le poids sec de la pulpe de matière alcaline en rapport avec la pulpe de haute densité.

19. Procédé selon la revendication 18, la pulpe étant de la pulpe de bois tendre et la quantité totale de matière alcaline introduite à la pulpe étant comprise entre 1,5 et 4 pour cent en poids, la première et la seconde quantité étant chacune comprise entre 0,75 et 2 pour cent en poids.

20. Procédé selon la revendication 18, la pulpe étant de la pulpe de bois dur et la quantité totale de matière alcaline introduite à la pulpe étant comprise entre 1 et 3,8 pour cent en poids, la première et la seconde quantité étant chacune comprise entre 0,5 et 1,9 pour cent en poids.

21. Procédé selon la revendication 18, la première quantité de matière alcaline introduite à la pulpe dans la presse à laver étant au moins 55 à 90% de la quantité totale.

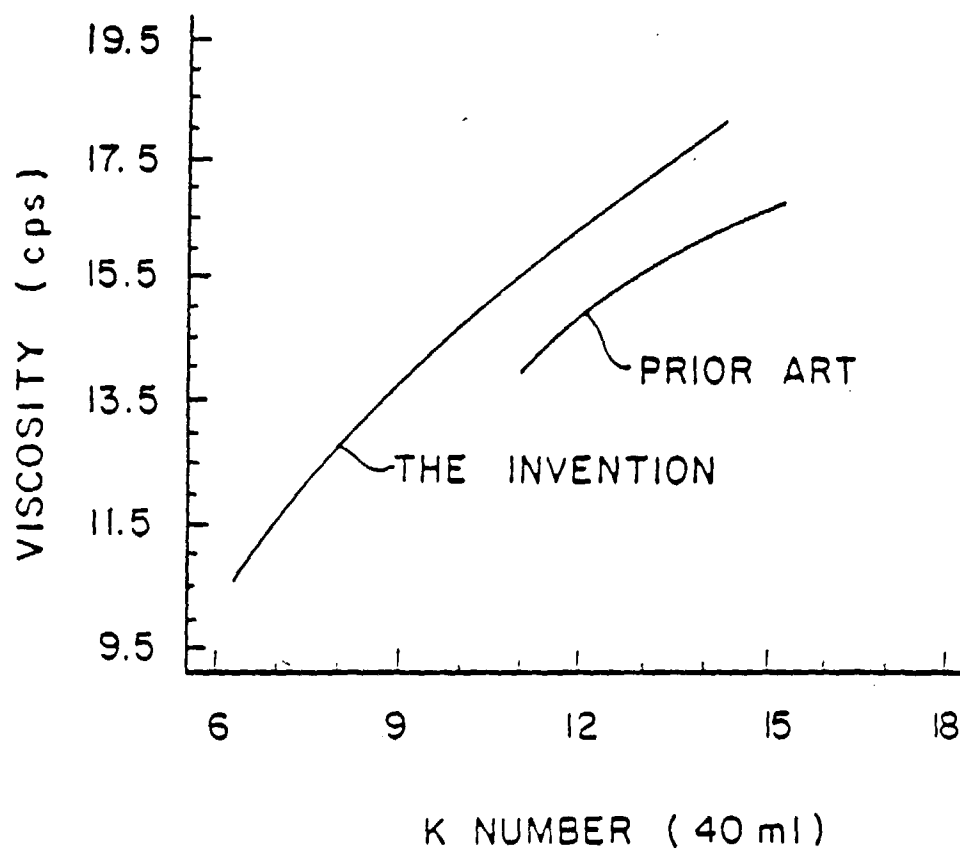


FIG. 1

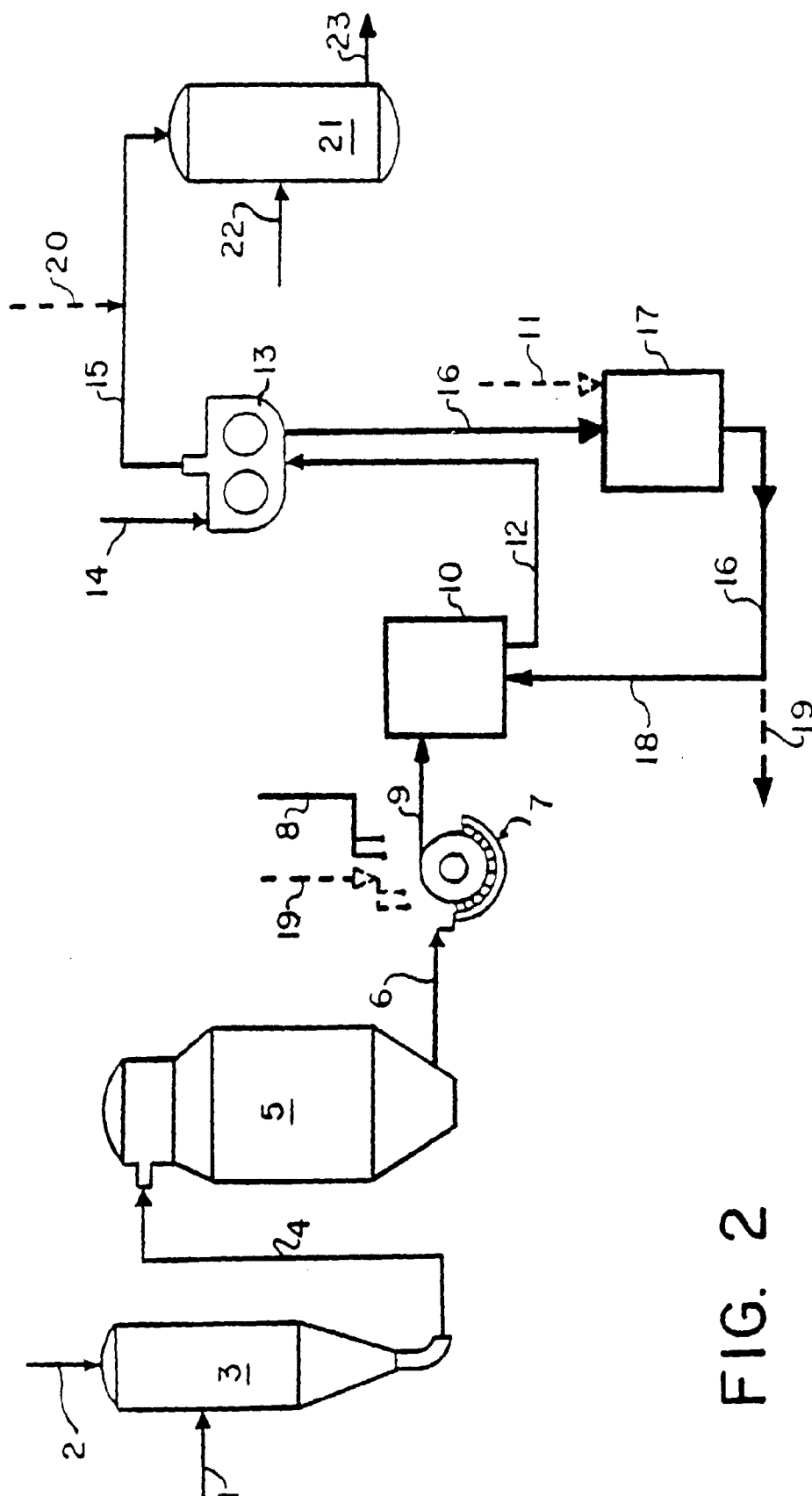


FIG. 2

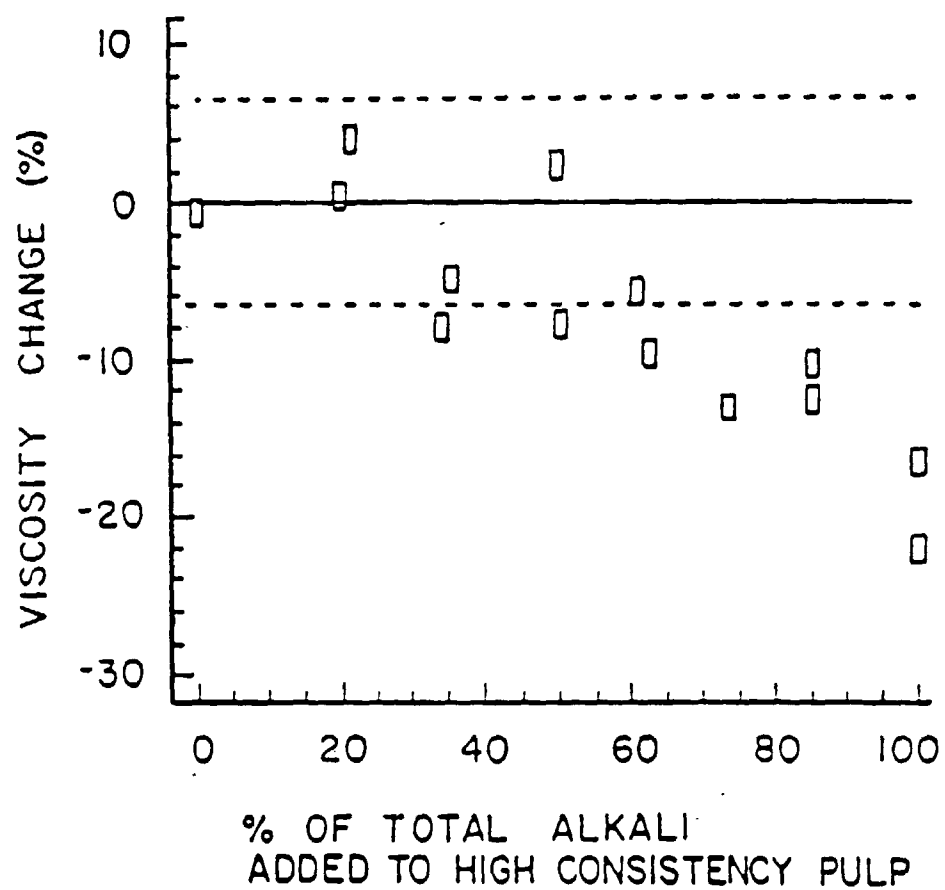


FIG. 3

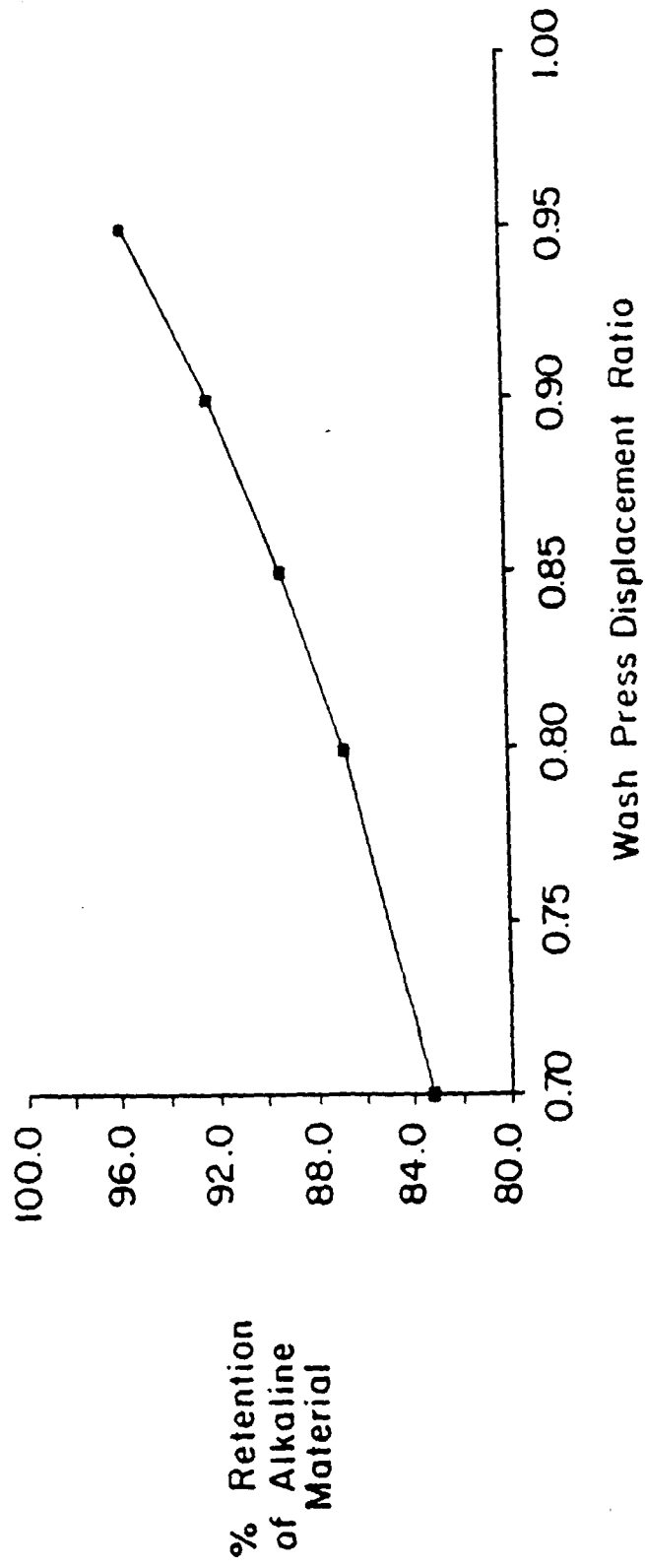


FIG. 4